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Paternal and maternal negative parenting, self-esteem, and adolescent aggression - mediating pathways and coping moderation in Chinese adolescents

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Previous research has confirmed that self-esteem mediates the relationship between negative parenting styles and adolescent aggression. A critical research gap lies in how paternal and maternal negative parenting styles are differentially linked to adolescent aggression through distinct psychological pathways. To address this research gap, we conducted a cross-sectional study involving 1100 Chinese adolescents aged 15–19 from multi-child families, who completed validated measures of negative parenting styles, self-esteem, coping styles, and aggressive behavior. Results revealed that self-esteem partially mediated the associations between both maternal and paternal negative parenting and adolescent aggression. Notably, coping styles specifically moderated the latter stage of the mediating pathway when maternal negative parenting served as the independent variable: adolescents employing positive coping strategies displayed lower baseline aggression and showed a more pronounced reduction in aggression as self-esteem increased, compared to those using negative coping strategies. These findings highlight the necessity of developing parent-specific interventions to mitigate the adverse outcomes of negative parenting on adolescent aggression.

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Introduction

Aggression, defined as the intent to cause harm or the execution of harmful actions toward objects or living beings (Anderson and Bushman, 2002; Ferencz, 1972; Ramírez, Andreu (2006)), is a multifaceted construct. Buss and Perry's (1992) widely adopted framework categorizes aggression into four dimensions: physical aggression (e.g., striking, kicking), verbal aggression (argumentative or confrontational communication), anger (intense, poorly regulated frustration), and hostility (enduring negative attitudes like bitterness). Neurodevelopmental research highlights that incomplete maturation of prefrontal regions governing inhibitory control in adolescence (Constantinidis and Luna, 2019; Delalande et al., 2019) renders this stage a high-risk period for aggressive tendencies. Empirical evidence consistently links elevated aggression to increased vulnerability to emotional disorders (Abd Razak et al., 2019; Okumu et al., 2020) and even suicidal outcomes (Baiden and Tadeo, 2020), underscoring the urgency of investigating its determinants.

Drawing on Bandura's social cognitive theory, individual aggression emerges from the dynamic interplay of personal traits, environmental influences, and behavioral patterns (Baranowski et al., 2002). Among environmental factors, parenting styles have been established as critical predictors of adolescent aggression, with numerous studies demonstrating their close association with aggressive tendencies (Malonda et al., 2019; Rajendran et al., 2016; Hartini et al., 2022). Within the Chinese cultural framework, negative parenting practices, which are characterized by punitive discipline, excessive protection, or emotional withdrawal, have garnered significant attention for their impact on adolescent development (Kang et al., 2024; Li et al., 2023). To operationalize the construct of negative parenting styles, scholars in China commonly utilize specific subscales from the locally validated Chinese version of the Egna Minnen Beträffande Uppfostran (EMBU) scale (Yue et al., 1993). This instrument, adapted to reflect cultural nuances in parenting practices, includes validated dimensions that align with punitive, overprotective, or emotionally withdrawn behaviors (see Measures section for detailed operational definitions).

The general aggression model (Anderson and Bushman, 2002) posits that external stressors like negative parenting styles shape aggression via internal variables such as self-esteem, which is defined as a subjective appraisal of self-worth (Wang et al., 2020). Research confirms that negative parenting erodes self-esteem (Kang et al., 2024), which in turn heightens aggressive tendencies. However, this relationship is not uniform: some low-self-esteem adolescents exposed to negative parenting do not exhibit aggression, suggesting the role of moderators.

Coping strategies, defined as efforts to manage stress (Lazarus and Folkman, 1984), are prime candidates for such moderators. Emotion-focused coping (e.g., avoidance, rumination) often exacerbates negative outcomes, whereas problem-solving coping (direct stressor resolution) mitigates distress (Okechukwu et al., 2022; Wu et al., 2020). Adolescents using emotion-focused coping under negative parenting may channel frustration into aggression, while those using problem-solving coping may regulate impulses more effectively (Lodygowska et al., 2019). Yet, how these strategies interact with parenting to shape aggression remains understudied.

Additionally, a notable void in existing research pertains to the distinct impacts of maternal and paternal parenting styles on adolescent aggression (Dou et al., 2020; Yaffe, 2023). Maternal parenting, marked by emotional nurturance and attentive caregiving, tends to mold internalizing processes such as self-esteem and emotional regulation. In contrast, paternal parenting, which is often centered on rule-setting, boundary establishment, and

resilience cultivation, exerts a more direct impact on externalizing behaviors like aggression or defiance (Jeynes, 2016; Van Heel et al., 2019). This divergence in their spheres of influence underscores the critical need to investigate their unique pathways: how maternal and paternal approaches respectively mold adolescent behavior through disparate psychological mechanisms.

In the Chinese context, policy shifts from the "universal two-child" to "three-child" policy have increased non-only-child families, altering sibling dynamics. Resource dilution theory (Öberg, 2017) posits that an expanded family size reduces the parental resources available to each child, such as time, emotional care, and economic support, thereby intensifying sibling competition. This competitive dynamic is particularly pronounced during adolescence, a developmental stage when sibling rivalry tends to peak (Ferencz et al., 2023). Chinese cultural values emphasizing intergenerational harmony and sibling hierarchy further shape these dynamics, making multi-child households an ideal context to study how parenting interacts with family structure to influence aggression.

Guided by these theoretical and contextual insights, the current study included 1100 adolescents from non-only-child families and administered validated questionnaires to examine the pathways through which paternal and maternal negative parenting styles influence adolescent aggression, with a specific focus on the roles of self-esteem and stress coping styles. We formulated the following hypotheses: (1) Self-esteem and coping strategies serve as key mediating or moderating factors in the association between negative parenting styles and aggression among adolescents with siblings; (2) Paternal and maternal negative parenting styles influence adolescent aggressive behaviors through distinct psychological pathways.

Materials and methods

Participants. Data collection was conducted using the Wenjuanxing online platform, where participants completed measures of negative parenting styles, self-esteem, coping styles, and aggression. Wenjuanxing's built-in feature requiring sequential question completion ensured no missing data in the dataset. The present study included 1100 adolescents (487 males, mean age = 16.39 ± 0.73 years, range: 15–19) who reported having at least one sibling for subsequent analyses. Prior to participation, all adolescents provided oral assent after reviewing the study objectives, and their parents provided written informed consent. Participants received compensation for their involvement. The study protocol was approved by the Institutional Review Board of Henan Provincial Key Laboratory of Psychology and Behavior (grant number 20230208001) and adhered to the principles of the Declaration of Helsinki.

Measures

Negative parenting styles. The study used specific subscales of the Egna Minnen av Barndoms Uppfostran (EMB; Perris et al., 1980) to assess parental negative parenting styles. The Chinese version (Yue et al., 1993) includes 66 items, with six paternal subscales (e.g., severe punishment, rejection, overprotection) and five maternal subscales (e.g., severe punishment, excessive interference, overprotection, rejection), rated on a 1–4 scale (1 = "never", 4 = "always"). Following Li et al. (2023), paternal negative parenting styles were operationalized by using paternal subscales: severe punishment, rejection, excessive interference and overprotection, with their combined scores serving as the indicator. For maternal negative parenting styles, maternal subscales, severe punishment, excessive interference and protection, and rejection, were used to calculate the composite score.

Table 1 Correlations among main study variables.

	1	2	3	4	5	6	7	8
1 Age	1							
2 Gender	0.14***	1						
3 Paternal negative parenting styles	−0.07*	0.12***	1					
4 Maternal negative parenting styles	−0.08**	0.04	0.61***	1				
5 Self-esteem	0.1**	0.01	−0.21***	−0.06*	1			
6 Positive coping	0.13***	0.00	−0.06*	0.08**	0.39***	1		
7 Negative coping	0.03	0.06	0.22***	0.17***	−0.23***	0.20***	1	
8 Aggression	−0.08**	−0.02	0.27***	0.17***	−0.35***	−0.23***	0.29***	1

0 = females, 1 = males. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Previous research (Ju et al., 2020) confirmed the EMBU's reliability and validity in Chinese samples, and current data showed strong internal consistency for composite scores $\alpha = 0.90$ for paternal negative parenting styles and $\alpha = 0.90$ for maternal negative parenting styles, validating the specific subscales used.

Self-esteem. The Chinese version of 10-item Self-Esteem Scale (SES) measures individuals' self-esteem and presents high psychometrical attributes (Wang et al., 2018; Wang et al., 2020). All items are rated on a 4-point scale ranging from 1 = "strongly disagree" to 4 = "strongly agree". Total score of all items was used for statistical analysis. Cronbach's α for the present study was 0.89.

Coping styles. To evaluate stress coping styles among Chinese participants, the study utilized the 20-item Simplified Coping Style Questionnaire (SCSQ; Xie, 1998), comprising a 12-item Positive Coping Style subscale assessing problem-focused strategies (e.g., problem-solving, social support-seeking) and an 8-item Negative Coping Style subscale measuring emotion-focused strategies (e.g., avoidance, distraction), with items rated on a 4-point scale (0 = "never", 3 = "always"). Following the methodology validated by Fu et al. (2020), raw scores for each subscale were first computed by summing item responses (positive coping: 0–36; negative coping: 0–24), then standardized into z-scores using the sample mean (μ) and standard deviation (σ). Coping style groups were defined by calculating the differential between positive coping z-scores and negative coping z-scores (Differential = $Z_{pos} - Z_{neg}$) where participants with a positive differential (Differential > 0) were classified as positive copers (indicating a relative preference for problem-focused strategies), and those with a non-positive differential (Differential ≤ 0) were labeled negative copers (reflecting greater reliance on emotion-focused strategies). Both subscales exhibited strong internal consistency, with Cronbach's α coefficients of 0.85 for positive coping and 0.77 for negative coping in the present study.

Aggression. We employed the 29-item Chinese version of the Buss-Perry Aggression Questionnaire (BPAQ; Buss and Perry, 1992; Luo, 2008) to assess participants' aggressive behaviors. The scale comprises four original subdomains: physical aggression (9 items), verbal aggression (6 items), anger (5 items), and hostility (9 items). Items were rated on a 5-point scale (1 = "strongly disagree", 5 = "strongly agree"), with higher scores indicating greater aggression.

Following canonical correlation analysis results, the verbal aggression subdomain was excluded from subsequent analyses due to its low canonical and cross loadings ($\leq |0.253|$), which did not meet the study's construct relevance criteria. Instead, the remaining three subdomains were used to form the aggression composite score. The Chinese BPAQ demonstrated good internal

consistency for the retained subdomains: the composite score (excluding verbal aggression) achieved $\alpha = 0.86$, while the physical aggression, anger, and hostility subscales showed $\alpha = 0.65$, 0.78, and 0.77, respectively.

Statistical analysis. All data organization and analyses were performed based on SPSS 25.0. Descriptive analysis and simple correlation analysis of the main study variables were performed. Afterwards, we separated the negative parenting styles of fathers and mothers, and constructed separate models for each. Using the PROCESS macro in SPSS, we constructed the mediation Model (Model 4) with the following variables: the z-scores of paternal/maternal negative parenting styles as the independent variables (X), the aggression as the dependent variable (Y), the z-score of self-esteem as the mediating variable (M). Based on it, we conducted the moderated mediation Model (Model 14) with coping style group as the moderator (W). The coping was dummy-coded as 0 (negative coping) and 1 (positive coping). Demographic information such as gender and age was regarded as covariates in statistical analysis. The results were valid, if the Bootstrapped (5000 times) confidence interval didn't contain 0.

Results

Simple correlations among study variables. As shown in Table 1, paternal negative parenting styles exhibited significant associations with self-esteem, coping, and aggression (all $p < 0.05$). Maternal negative parenting styles also significantly correlated with self-esteem, coping, and aggression (all $p < 0.05$). Self-esteem demonstrated significant relationships with coping and aggression (all $p < 0.05$). Coping significantly associated with aggression (all $p < 0.05$). Given the significant associations between demographic variables and key study variables—age was negatively correlated with negative parenting styles and aggression, while positively correlated with self-esteem and positive coping; gender significantly linked to paternal negative parenting styles (all $p < 0.05$), these factors were included as covariates in Model 4 (mediation analysis) and Model 14 (moderated mediation analysis). Analyses were conducted separately for models with paternal and maternal negative parenting styles as independent variables to isolate parent-specific effects.

Self-esteem and coping in paternal negative parenting models.

In the current study, the same statistical analysis was replicated, specifying paternal negative parenting styles as the independent variable. Mediation model analysis yielded a significant mediating effect of self-esteem in the pathway from paternal negative parenting styles to aggression (Effect = 0.082, SE = 0.014, 95% CI [0.057, 0.111]; see Table 2). However, in the moderated mediation model with paternal negative parenting styles as the independent variable, this study detected a non-significant interaction effect

Table 2 Mediation model (Model 4) and moderated mediation model (Model 14) with paternal negative parenting styles as independent variable.								
Process	Variables	Model 4			Model 14			
		β	SE	t	β	SE	t	
Self-esteem	constant	−1.608	0.670	−2.401*	−1.608	0.670	−2.401*	
	Paternal negative parenting styles	−0.298	0.029	−10.281***	−0.298	0.029	−10.281***	
	Age	0.107	0.040	2.712**	0.107	0.040	2.712**	
	Gender	−0.098	0.059	−1.670	−0.098	0.059	−1.670	
	$R^2 = 0.096, F = 39.276$				$R^2 = 0.096, F = 39.276$			
Aggression	constant	0.608	0.645	0.944	0.585	0.632	0.926	
	Paternal negative parenting styles	0.227	0.029	7.788***	0.201	0.029	6.950***	
	Self-esteem	−0.276	0.029	−9.564***	−0.219	0.030	−7.310***	
	Age	−0.048	0.038	−1.246	−0.047	0.037	−1.263	
	Gender	0.109	0.057	1.933	0.134	0.056	2.414*	
	Coping				−0.384	0.059	−6.567***	
	Self-esteem × Coping				−0.111	0.058	−1.907	
	$R^2 = 0.168, F = 55.971$				$R^2 = 0.203, F = 46.803$			

SE Bootstrapped sampling standard error, CI Bootstrap confidence interval. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

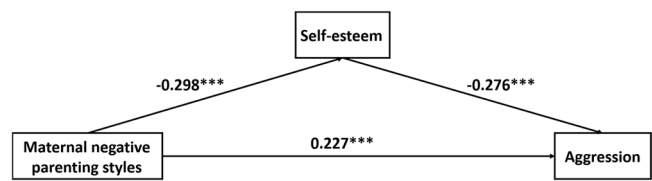


Fig. 1 The mediation model with paternal negative parenting styles as independent variable. *** $p < 0.001$.

between self-esteem and coping style on aggression ($\beta = -0.111$, $SE = 0.058$, 95% CI $[-0.225, 0.003]$; see Table 2), wherein the 95% confidence interval of the interaction effect included zero. This suggests that the hypothesized moderated mediation pathway - wherein coping was expected to moderate the relationship between self-esteem and aggression—was not supported, indicating that the moderated mediation model did not hold in this context. Figure 1 shows the constructed mediation model.

Self-esteem and coping in maternal negative parenting models.

As shown in Table 3, the mediation model analysis revealed a significant mediating effect of self-esteem in the relationship between maternal negative parenting styles and aggression (Effect = 0.082, $SE = 0.014$, 95%CI $[0.056, 0.109]$). More importantly, the moderated mediation effect was significant (index = 0.039, $SE = 0.020$, 95%CI $[0.001, 0.080]$), with the mediation effect being 0.045 ($SE = 0.014$, 95%CI $[0.019, 0.073]$) for negative copers and 0.084 ($SE = 0.018$, 95%CI $[0.052, 0.121]$) for positive copers, indicating that coping moderated the mediating role of self-esteem in the relationship between maternal negative parenting styles and adolescent aggression (see Table 4). As depicted in Fig. 2, the simple slope analysis revealed that the negative relationship between self-esteem and aggression was more pronounced in positive copers (simple slope = -0.277 , 95%CI $[-0.361, -0.193]$) compared to negative copers (simple slope = -0.148 , 95%CI $[-0.227, -0.070]$). Interestingly, in the other moderated mediation model with maternal negative parenting styles as the independent variable, self-esteem exhibited a significantly negative predictive effect on aggression ($\beta = -0.213$, $SE = 0.030$, 95%CI $[-0.272, -0.155]$). Additionally, there was a significant interaction effect between self-esteem and coping style on aggression ($\beta = -0.129$, $SE = 0.058$, 95%CI $[-0.243, -0.015]$, see Table 3).

As depicted in Fig. 2, the simple slope analysis revealed that the negative relationship between self-esteem and aggression was more pronounced in positive copers (simple slope = -0.277 , 95% CI $[-0.361, -0.193]$) compared to negative copers (simple slope = -0.148 , 95%CI $[-0.227, -0.070]$), with positive coping amplifying self-esteem’s inhibitory effect on aggression. Figure 3 illustrates the constructed moderated mediation model.

Discussion

This study is among the first to differentiate between paternal and maternal negative parenting styles, examining whether these styles are associated with adolescent aggression through distinct pathways. The results indicate that self-esteem partially mediates the relationship between both paternal and maternal negative parenting and aggression; however, coping strategies only moderate the latter part of this mediating effect in the model specifying maternal negative parenting styles. Consistent with prior findings (Gómez-Ortiz et al., 2016; Malonda et al., 2019), negative parenting styles were significantly associated with higher levels of adolescent aggression, suggesting that adolescents exposed to such parenting are more likely to exhibit aggressive behaviors. More importantly, the study demonstrated that paternal and maternal negative parenting styles were linked to aggression via distinct pathways. Specifically, paternal negative parenting was not only directly linked to adolescent aggression but also indirectly associated with it via self-esteem. Self-esteem serves as a critical psychological resource: low self-esteem elevates the risk of aggression, whereas high self-esteem mitigates it (Chen and Qin, 2020; Descartes et al., 2019; Yu et al., 2020). These findings align with Gomez-Baya et al., (2018) proposition that high self-esteem enhances individuals’ ability to process external information and adapt to their environment, whereas low self-esteem impairs this capacity. Among adolescents experiencing paternal negative parenting, a potential chain of effects may emerge: paternal negativity is associated with lower self-esteem, which in turn correlates with increased aggression. This highlights the importance of fostering self-esteem in interventions aimed at mitigating the adverse impacts of fathers’ negative parenting on adolescent aggression. In contrast, maternal negative parenting influenced aggression through an additional pathway: beyond the mediating role of self-

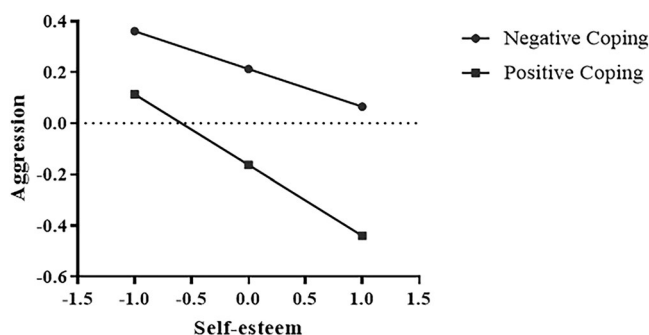
Table 3 Mediation model (Model 4) and moderated mediation model (Model 14) with maternal negative parenting styles as independent variable.

Process	Variables	Model 4			Model 14		
		β	SE	t	β	SE	t
Self-esteem	constant	-1.458	0.670	-2.178*	-1.458	0.670	-2.178*
	Maternal negative parenting styles	-0.304	0.029	-10.556***	-0.304	0.029	-10.556***
	Age	0.094	0.040	2.383*	0.094	0.040	2.383*
	Gender	-0.058	0.058	-0.995	-0.058	0.058	-0.995
	$R^2 = 0.101, F = 41.206$				$R^2 = 0.101, F = 41.206$		
Aggression	constant	0.477	0.643	0.742	0.463	0.630	0.736
	Maternal negative parenting styles	0.244	0.029	8.441***	0.221	0.029	7.669***
	Self-esteem	-0.269	0.029	-9.337***	-0.213	0.030	-7.156***
	Age	-0.037	0.038	-0.968	-0.037	0.038	-0.968
	Gender	0.081	0.056	1.454	0.081	0.056	1.454
	Coping				-0.376	0.058	-6.449***
	Self-esteem \times Coping				-0.129	0.058	-2.221*
	$R^2 = 0.111, F = 46.008$				$R^2 = 0.210, F = 48.911$		

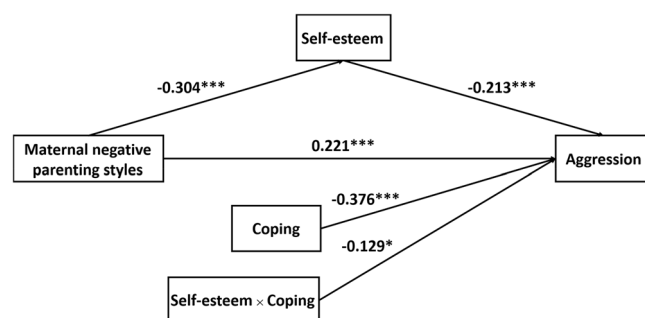
* $p < 0.05$, *** $p < 0.001$ **Table 4 Conditional indirect effects of maternal negative parenting styles aggression.**

Process	Variables	Effect	Boot SE	Boot 95% CI
Conditional indirect effects of maternal negative parenting styles on aggression according to values of the moderator (Coping)	Mediator self-esteem, negative Coping	0.045	0.014	[0.019, 0.074]
	Mediator self-esteem, positive Coping	0.084	0.017	[0.052, 0.120]

SE Bootstrapped sampling standard error, CI Bootstrap confidence intervals.

**Fig. 2 The moderating role of coping in the relationship between self-esteem and aggression.** All values are standardized.

esteem, coping styles (problem-solving vs. emotion-focused) moderated the association between self-esteem and aggressive behaviors. Prior studies have demonstrated that problem-solving coping strategies are more effective in enhancing stress management, reducing negative emotions, and mitigating aggression compared to emotion-focused strategies (Fu et al., 2020; Huang et al., 2021). This study advances this knowledge by clarifying how coping styles differentially moderate the self-esteem-aggression pathway: adolescents relying on emotion-focused strategies (e.g., avoidance, emotional suppression) are more prone to heightened aggression because these strategies fail to address stressors directly, instead allowing unmanaged emotional tension to escalate into impulsive behavior (Dodge, 2013; Okechukwu et al., 2022). In contrast, problem-solving coping acts as a protective mechanism, equipping adolescents with adaptive tools to resolve stressors constructively, thereby weakening the link between low self-esteem and aggressive tendencies. While prior

**Fig. 3 The moderated mediation model with maternal negative parenting styles as independent variable.** * $p < 0.05$, *** $p < 0.001$.

research has noted associations between coping and aggression (Wu et al., 2020), this study emphasizes the moderating role rather than bidirectional cyclical patterns. The interaction between self-esteem and coping strategies aligns with Anderson and Bushman's (2002) General Aggression Model, highlighting that coping styles serve as critical moderators that shape how internal factors like self-esteem translate into behavioral outcomes. Specifically, low-self-esteem adolescents with limited problem-solving resources may be more vulnerable to aggression when facing stress, yet this risk is buffered by adaptive coping skills. This framework suggests that interventions should prioritize enhancing both self-esteem and problem-solving coping skills to disrupt the maternal negative parenting-aggression pathway, particularly by strengthening adolescents' capacity to use constructive strategies that break the chain from emotional distress to aggressive behavior.

The difference in the moderating effects between maternal and paternal negative parenting styles can be attributed to mothers'

role as primary emotional caregivers. Problem-solving coping strategies mitigate the impact of maternal negativity by fostering secure attachments and adaptive emotion regulation, processes that are vital for adolescents to navigate emotionally charged family environments (Cassidy et al., 2013; Ward and Lee, 2020). In contrast, paternal negative parenting, potentially rooted in compensatory motivations, may undermine adolescent autonomy through distinct mechanisms. This alternative pathway lessens the relevance of coping styles in mediating the relationship between paternal negativity and aggression, as the erosion of autonomy might occur through channels less influenced by individual coping resources (Li et al., 2023).

Conclusion

This study yielded meaningful findings. First, paternal negative parenting styles were found to have dual detrimental associations with outcomes in adolescents from multi-child families: they were directly linked to increased aggressive behavior and, concurrently, negatively related to self-esteem - with lower self-esteem in turn associated with higher aggression. Second, the relationship between maternal negative parenting styles and adolescent aggression was observed to be complex, as it was mediated by self-esteem and moderated by stress coping strategies in this sample. Based on these results, targeted interventions tailored to different parental roles may be beneficial. For fathers, promoting positive interaction patterns could help reduce adolescent aggression and may contribute to enhancing self-esteem, thereby addressing the dual negative impacts identified in this study. For mothers, interventions could focus on assisting adolescents in developing positive stress coping strategies and nurturing self-esteem, which may mitigate the complex effects of maternal negative parenting within the observed context.

Limitations

This study offers valuable insights into interventions for adolescent aggression in multi-child families, though several limitations merit careful consideration. First, the sample was exclusively composed of adolescents from multi-child families, which restricts the generalizability of findings to other family structures (e.g., only-child families, single-parent households, or blended families). While multi-child dynamics were the focus, distinct parenting challenges in non-multi-child contexts may alter the observed relationships between negative parenting, self-esteem, coping, and aggression. Researchers applying these findings to broader populations should therefore exercise caution and explicitly contextualize results within family structure-specific frameworks. Second, socioeconomic status (SES) was neither measured nor controlled in the analysis. Households with lower SES often face chronic stressors (e.g., financial strain, limited educational resources), which may increase reliance on negative parenting styles as a coping mechanism. Failing to account for SES introduces potential confounding: the observed effects of negative parenting on aggression might be partially explained by SES disparities. Consequently, conclusions about parenting-aggression links may not fully apply to populations with diverse SES profiles, limiting the robustness of intervention recommendations for high-stress, low-resource families. Third, while gender and age were statistically controlled as covariates, their roles in mediating or moderating processes (e.g., whether coping strategies buffer aggression differently for males vs. females, or across developmental stages) were not systematically explored. Prior research highlights gendered patterns in aggression (e.g., males displaying more physical aggression, females more relational aggression; Iorga et al., 2022) and age-related changes in coping (Folkman et al., 1987), suggesting these variables may alter the

pathways identified here. Ignoring such moderators restricts the precision of tailored interventions, as strategies effective for adolescent males may not resonate with females, or vice versa.

Data availability

Data is provided within supplementary information files.

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Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by HG. The first draft of the manuscript was written by HH and PZ. SZ commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Competing interests

The authors declare no competing interests.

Ethical approval

All research procedures undertaken in this study adhered to the ethical standards of the institutional ethics committee and were consistent with the 1964 Helsinki Declaration and its subsequent amendments, as well as comparable international ethical guidelines. The study was formally approved by the Institutional Review Board of Henan Provincial Key Laboratory of Psychology and Behavior (Approval No.: 20230208001) on 8 February 2023.

Informed consent

For minor participants in this study, oral consent was obtained directly by the researcher after a clear explanation of the study's purpose, procedures, and their role. This approach was adopted due to the participants' minor status, ensuring they could understand and express willingness in an age-appropriate manner. The researcher documented oral consent details, including specific dates from December 1 to 31, 2023, and key content in a standardized record using a pre-approved script to ensure consistency. Concurrently, signed informed consent was obtained from all parents, who received comprehensive information about the study's scope, data usage, and consent for anonymized data publication. Parental consent forms were signed between December 1 and 31, 2023, fulfilling all regulatory requirements for informed consent. Both oral and written consent processes were completed within the same timeframe to maintain procedural rigor, with dates clearly recorded to ensure traceability and compliance.

Additional information

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