



Paternal parenting stress, parenting styles, and early childhood development: Examining the key role of parent-child relationships[☆]

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ABSTRACT

Early childhood development lays the foundation for the physical, emotional, and intellectual health of children during middle childhood, adolescence, and adulthood. This study explores the mechanisms through which paternal parenting stress may be associated with early childhood development. Methods: A nine-month cross-timepoint phased measurement design was employed, involving 289 children ($M_{age} = 62.54$ months, $SD_{age} = 6.978$ months) and their fathers. Results: No evidence was found to suggest that paternal parenting stress directly predicts early childhood development. Similarly, the mediating effects of paternal authoritative and authoritarian parenting styles in this relationship were not significant. However, parent-child relationships were found to mediate the association between paternal parenting stress and early childhood development. The findings indicate that increased paternal parenting stress is associated with a tendency toward less favorable paternal parenting styles, which may indirectly affect early childhood development. Parent-child relationships emerge as a critical factor in this process, addressing a research gap and contributing to the refinement of the parenting stress model.

Early childhood development refers to the developmental process from conception to age eight, during which children begin to acquire a range of physical, cognitive, language, social, and emotional skills. It is regarded as the most critical stage of life, as it directly impacts individual and societal economic, health, and social outcomes (Heckman, 2012). Research indicates that not fully developing one's potential during early childhood can result in diminished abilities later in life (Alam et al., 2022). Moreover, the status of early childhood development directly impacts the quality and efficiency of future workers, the quality of national life, as well as social equity, stability, and development (Lu et al., 2016). Therefore, attention to early childhood development is crucial for the long-term benefits of individuals and society.

Ecological systems theory emphasizes that the family is the primary proximal environment promoting early childhood development (Bronfenbrenner & Morris, 2007), playing an indispensable role in children's early development. For example, Tran et al. (2017) highlight that effective parental caregiving includes active engagement, cognitive

stimulation, sensitive responsiveness, provision of educational materials, and the avoidance of severe punishment, all critical for child development. Furthermore, Britto et al. (2017) note that children raised in environments marked by parental neglect or abuse, and severe family distress, often encounter challenges in parent-child relationships, leading to unhealthy behavioral patterns that jeopardize their healthy development.

In summary, parents hold indispensable roles in the development of early childhood. However, past research has mainly focused on mothers, neglecting the importance of fathers in the parenting process (Bahrami et al., 2018; Menon et al., 2020). In fact, fathers occupy distinct roles within the family dynamic. Evidence suggests that fathers are more likely to focus on preparing children for future challenges and tend to have a keen awareness of their children's long-term behavioral development trajectories (McKinney & Renk, 2008). However, fathers face significant challenges in fulfilling this role, one of which is parenting stress. Parenting stress is a critical variable influencing fathers' parenting

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styles and their impact on children. According to Abidin's Parenting Stress Theory, parenting stress can influence parents' perception and coping strategies regarding caregiving tasks, consequently directly impacting their parenting behaviors and the quality of parent-child relationships, thereby affecting children's development (Abidin, 1992). Therefore, this study aims to explore the influence of paternal parenting stress on early childhood development, and to delve into the roles of parenting styles and parent-child relationships in this process.

1. Parenting stress and early childhood development

Parental pressure is defined as the psychological stress that arises from the disparity between a parent's perceived childcare responsibilities and their available resources (Östberg, 1999). This pressure adversely affects parents' psychological well-being and the quality of their marital relationships (Dong et al., 2022; Rollè et al., 2017), thereby hindering their ability to employ optimal parenting practices. Studies have shown that parenting stress can also have a negative impact on children's development. For example, parenting stress can lead to internalizing and externalizing problem behaviors in children (Rodríguez et al., 2019) and affect children's executive functions (De Cock et al., 2017).

In addition, parental stress is believed to influence both parenting and child development (Holly et al., 2019). Paternal parenting stress often stems from challenges of the paternal role, including the perception of one's own expectations and sense of responsibility as a father, as well as feelings of family status and external pressure (Baldwin et al., 2018). Research indicates that both fathers and mothers experience comparable levels of parenting stress, and this stress impacts children's behavior in ways similar to that observed in mothers (Liu & Wang, 2015). The presence of parenting stress often hinders fathers' ability to effectively respond to their children's needs and challenges. This may result in fathers lacking patience and attention in parent-child interactions, thereby affecting positive interaction and communication with their children (Lee et al., 2018).

1.1. Parenting stress, parenting styles, and early childhood development

Parenting style encompasses the attitudes, emotions, and behaviors that parents exhibit while raising their children. This includes specific actions taken by parents in fulfilling their duties, as well as nonverbal cues in parent-child interactions, such as gestures, tone of voice, and emotional expressions (Darling & Steinberg, 2017). Researchers have classified the parenting styles of parents into three types: authoritative, authoritarian, and permissive. Among these, authoritative parenting is characterized by high responsiveness and high demands, authoritarian parenting by low responsiveness and high demands, and permissive parenting by high responsiveness and low demands (Baumrind, 1967). Research has shown that parents adopting the authoritative style are more likely to establish warm relationships with their children and contribute to positive psychological and behavioral development in their offspring (Washington, 2024). In contrast, authoritarian and permissive parenting styles are associated with negative developmental outcomes, such as aggression and anxiety (Lei et al., 2018).

Abidin et al. (1992) argued that parenting stress can directly or indirectly influence parental parenting behaviors, which are specific manifestations of parenting style (Darling & Steinberg, 2017). Indeed, evidence suggests that parenting stress was significantly and positively correlated with authoritarian parenting and was negatively correlated with authoritative parenting (Carapito et al., 2018). Therefore, elevated levels of parenting stress frequently result in parents adopting more authoritarian and negative approaches to parenting. Moreover, compared to mothers, fathers are more susceptible to the effects of stress, which makes their mental health and family functions more susceptible to impact, making it difficult to effectively fulfill their parenting responsibilities (Cummings et al., 2010; Sihan et al., 2023).

Inappropriate parenting styles can lead to maladaptation in children and hinder their social development (Chen et al., 2024). This suggests that paternal parenting stress indirectly predicts early childhood development via the parenting style employed.

1.2. Parenting stress, parent-child relationship, and early childhood development

Parent-child relationships are a special bond in which everyone is personally involved (Popov & Ilesanmi, 2015). According to Troll and Fingerman (1996), parent-child relationships are inherently unique because their intimacy surpasses that of other types of relationships, such as partners, family, and friends. Research has shown that positive parent-child relationships are linked to a range of beneficial outcomes in child development (Smetana & Rote, 2019), while poor development of parent-child relationships constitutes a significant practical foundation for the emergence of problem behaviors in children (Orellana et al., 2021).

In addition, research has established a close link between parenting stress and parent-child relationships. The quality of parenting directly impacts these relationships, which in turn influences children's well-being and development. (Feinberg & Kan, 2008). According to the spillover effect of family systems theory, emotions or behaviors in one subsystem of the family can affect other subsystems (Erel & Burman, 1995). This indicates that parenting stress on the parent subsystem may affect other subsystems, such as the parent-child subsystem. For example, research indicates that significant parenting stress in fathers often reduces their engagement in parenting activities (Liu et al., 2022), which can result in increased communication and interaction issues with their children (Ponnet et al., 2013). This reduction in paternal involvement may also lead to more frequent parent-child conflicts, adversely affecting the development of parent-child relationships (Garcia et al., 2017).

The quality of parent-child relationships directly influences the survival and development of young children (Thompson, 2008). Improving its quality can effectively regulate parents' emotional functioning, thereby positively impacting their mental health (Huber et al., 2016). In addition, Feinberg (2003) points out in his parent-child relationship ecological model that parent-child relationships can directly or indirectly influence children's adaptation. Furthermore, compared to children with poor parent-child relationships, children with good parent-child relationships have higher social abilities (Saral & Acar, 2021). Moreover, parent-child relationships also have a certain predictive effect on an individual's social emotions (Lang et al., 2020). Therefore, parent-child relationships play a positive role in promoting early childhood development.

2. Parenting styles and parent-child relationships

The interaction between parents and children is not only a process of upbringing but also a platform for emotional communication and relationship building (Vu et al., 2015). Therefore, different parenting styles can also have varying effects on parent-child relationships. Research indicates that parents who adopt an authoritative parenting style typically establish gentle and clear guidelines. This approach encourages children to think independently, develop independence, while providing necessary guidance and support, thus promoting stability and harmony in parent-child relationships (Aloia & Warren, 2019; Lanjekar et al., 2022). Conversely, authoritarian parents may be more inclined to emphasize authority and control, potentially overstepping into their children's lives, restricting their freedom and independent development. Moreover, this parenting style is associated with higher conflict frequencies (Sorkhabi & Middaugh, 2014), which can easily lead to conflicts and contradictions between parents and children. Children may feel constrained and disrespected, ultimately resulting in estrangement and disharmony in the parent-child relationship (Liu et al., 2022).

3. The current study

Research on the impact of parenting stress on child development has primarily focused on the relationship between maternal parenting stress and children's social development or problem behaviors (Menon et al., 2020; Qian et al., 2021). However, fathers also play a unique and important role in shaping children's social and emotional health and development (Cabrera et al., 2014). Studies have shown that fathers' negative emotional symptoms are negatively associated with parent-child relationship quality and children's healthy development (Ramchandani et al., 2005). Nevertheless, existing research has largely concentrated on maternal parenting stress, overlooking the distinct influence of fathers in parenting.

Based on the parenting stress theory, this study examines how paternal parenting stress, parenting styles, and parent-child relationships jointly influence early childhood development. Therefore, this study proposes the following hypotheses:

H1. Paternal parenting stress is significantly negatively correlated with early childhood development.

H2a. Authoritative parenting mediates the relationship between paternal parenting stress and early childhood development.

H2b. Authoritarian parenting mediates the relationship between paternal parenting stress and early childhood development.

H3. Parent-child relationship mediates the relationship between paternal parenting stress and early childhood development.

H4a. Authoritative parenting and parent-child relationship serve as a serial mediation pathway between paternal parenting stress and early childhood development.

H4b. Authoritarian parenting and parent-child relationship serve as a serial mediation pathway between paternal parenting stress and early childhood development.

Based on the literature review and theoretical hypotheses, the theoretical framework of this study is depicted in Fig. 1.

4. Methods

4.1. Participants

This study randomly selected two kindergartens located in Shanghai,

China. The target population of this study consisted of kindergarten children and their parents in the Hongkou District of Shanghai. First, the complete list of registered kindergartens in the district was obtained from the Hongkou District Education Bureau. Subsequently, two kindergartens were randomly selected from the list as the study sample using a computer-generated random number table. All children attending these kindergartens and their parents were invited to participate in the survey. This study employed a phased measurement design across multiple time points. Data collection was conducted in two waves: from April to May 2022 (T1), fathers of the children were given the Parenting Stress Index Short Form (PSI-SF), the Parenting Styles and Dimensions Questionnaire (PSDQ), and the Parent-Child Relationship Scale. From January to February 2023 (T2), mothers of the children were provided with the Early Human Capability Index (eHCI).

Responses with insufficient completion time, consistent selection of a single fixed option, or data that did not align with the age suitability of the measurement tools were excluded. A total of 329 valid questionnaires were obtained from the first wave of data collection, and 289 from the second wave. Pairwise matching was conducted between the two waves, resulting in 289 successfully matched data points. The 40 cases where child and father data were not successfully matched were considered as attrition. Little's MCAR test revealed that the attrition was completely random ($\chi^2 = 69.108$, $df = 103$, $p = 0.996$) (Little, 1988).

The final analysis included data from 289 children and their fathers, with children's mean age being 62.54 months ($SD = 6.978$). There were 148 girls and 141 boys. Demographic information is presented in Table 1. This study obtained ethical approval from the institutional review board of the corresponding author's institution, following the guidelines of the Helsinki Declaration. In addition, informed consent was obtained from each child's father and guardian.

Table 1
Demographic Characteristics of the Study Participants ($N = 289$).

Variables		Frequency	Percentages
Child's Age	42–47 months	1	0.35 %
	48–53 months	30	10.38 %
	54–60 months	101	34.95 %
	61–66 months	59	20.42 %
	67–72 months	98	33.91 %
Child's Gender	Girls	148	51.21 %
	Boys	141	48.79 %

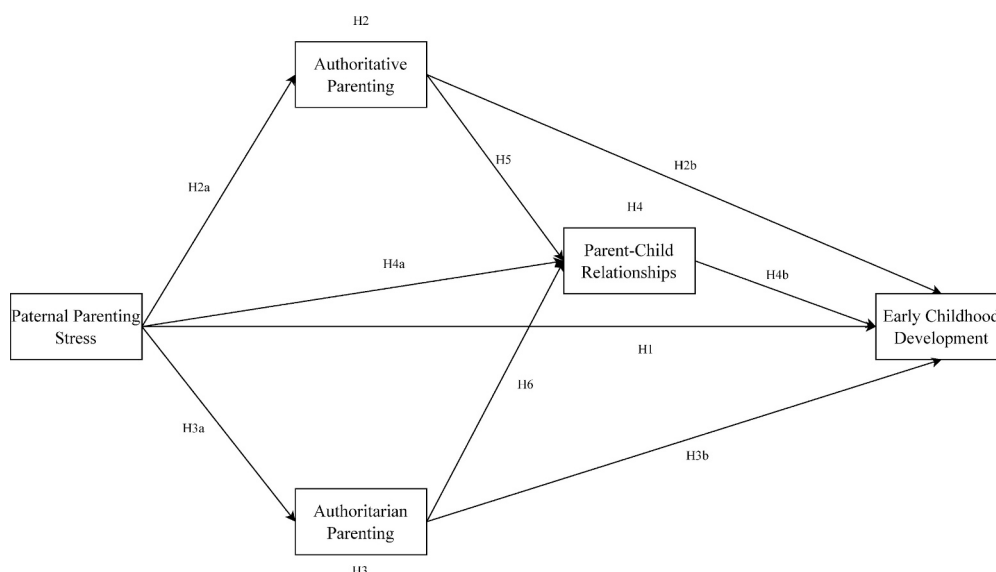


Fig. 1. Theoretical framework of this study.

4.2. Measurement

Parenting Stress Index Short Form (PSI-SF), developed by Abidin (1995), was utilized to assess paternal parenting stress. This measurement tool has been extensively employed in the research domain in China (Wang et al., 2023). Comprising 36 items, such as “Takes a long time for child to get used to new things,” respondents rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Higher scores on this scale indicate higher levels of parenting stress. Within the framework of this study, the Cronbach's α coefficient for paternal parenting stress was computed to be 0.927.

Parenting Styles and Dimensions Questionnaire (PSDQ), developed by Robinson et al. (2001), was employed to assess paternal parenting styles. The Chinese version of this measurement tool was translated by Wu et al. (2002) and has been widely utilized in China (Wu et al., 2002). Consisting of 26 items encompassing authoritative and authoritarian parenting styles, respondents rated statements like “Aware of problems or concerns about child in school” on a 5-point Likert scale (1 = never, 5 = always). This scale demonstrated high internal reliability in this sample, with Cronbach's α coefficients of 0.884 for paternal authoritative parenting style and 0.827 for paternal authoritarian parenting style.

Parent-Child Relationship Scale, developed by Driscoll and Pianta (1992), was used to evaluate the relationship between fathers and their children. This scale has been widely adopted in Chinese research (Wang et al., 2024). Comprising 30 items, including statements like “When I praise my child, he/she beams with pride,” respondents rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Originally containing intimacy, conflict, and dependence dimensions, due to the low reliability of the dependence dimension in previous studies, this survey utilized the conflict and intimacy dimensions as commonly done (Driscoll & Pianta, 1992). Higher scores on this scale indicate better parent-child relationships. In this study, the Cronbach's α coefficient for this scale was found to be 0.753.

Early Human Capability Index (eHCI), developed by Sincovich et al. (2019), was used to assess early childhood development. The Chinese version of this scale was translated and validated by Zhao et al. (2020) and has been extensively used in studies involving Chinese children (Zhang et al., 2021). Consisting of 62 items reported by the child's parents, caregivers, or teachers, including questions like “Is the child easily impatient?” each item scored on a binary scale (1 = already able/yes, 0 = not yet able/no). Higher scores on this scale indicate better early childhood development. In this study, the Cronbach's α coefficient for this scale was calculated to be 0.808.

4.3. Statistical methods and analytical approach

SPSS 22.0 and Mplus 8.3 were used for statistical analysis in this study. SPSS 22.0 was employed for assessing the reliability and validity of measurement tools, testing common method bias, conducting descriptive statistics, and analyzing the correlations between variables. Mplus 8.3 was used for constructing and evaluating structural equation models.

In this study, children's age (Woodhead, 2009), gender (Cobb-Clark & Moschion, 2017), and socioeconomic status (SES) (Letourneau et al., 2013) were considered as control variables. Gender was encoded using dummy variables (0 = female, 1 = male).

5. Results

To begin with, in order to avoid common method bias, this study conducted a Harman single-factor analysis, revealing that there are a total of 41 eigenvalues >1 common factors. The first factor explains 11.560 % of the variance, which falls below the critical threshold of 40 %. Consequently, this study does not suffer from severe common method bias (Podsakoff et al., 2003).

The Pearson correlation analysis results for each variable in this

study are presented in Table 2. The results indicated that paternal parenting stress was negatively correlated with authoritative parenting style, parent-child relationship and early childhood development, was positively correlated with authoritarian parenting style. Authoritative parenting style is significantly negatively correlated with authoritarian parenting style, significantly positively correlated with parent-child relationship and early childhood development. Authoritarian parenting style is significantly negatively correlated with parent-child relationship and early childhood development. Parent-child relationship is significantly positively correlated with early childhood development.

Subsequently, this study conducted a fit test on the model. The results indicate that the proposed model fits well. Specific indicators are as follows: $ML\chi^2 = 21.808$, $df = 9$, $\chi^2/df = 2.423$, CFI = 0.962, TLI = 0.908, RMSEA = 0.070, SRMR = 0.048. The results are presented in Table 3.

Bootstrap resampling method was employed 5000 times in this study. The findings indicate no evidence that paternal parenting stress significantly negatively predicts early childhood development ($\beta = -0.062$, $p = 0.370$), and thus H1 is not supported. Paternal parenting stress significantly negatively predicts authoritative parenting style ($\beta = -0.261$, $p < 0.001$), supporting H2a. However, no evidence was found that authoritative parenting style significantly positively predicts early childhood development ($\beta = 0.153$, $p = 0.111$), so H2b is not supported. Paternal parenting stress significantly positively predicts authoritarian parenting style ($\beta = 0.402$, $p < 0.001$), confirming H3a. Similarly, no evidence was found that authoritarian parenting style significantly negatively predicts early childhood development ($\beta = 0.011$, $p = 0.862$), and thus H3b is not supported. Paternal parenting stress significantly negatively predicts the parent-child relationship ($\beta = -0.438$, $p < 0.001$), supporting H4a. The parent-child relationship significantly positively predicts early childhood development ($\beta = 0.177$, $p < 0.05$), confirming H4b. Paternal authoritative parenting style significantly positively predicts the parent-child relationship ($\beta = 0.310$, $p < 0.001$), supporting H5. Finally, paternal authoritarian parenting style significantly negatively predicts the parent-child relationship ($\beta = -0.190$, $p < 0.001$), supporting H6. The results are presented in Table 4.

The indirect paths in this study are displayed in Table 5. Authoritative parenting style does not mediate between paternal parenting stress and early childhood development ($\beta = -0.008$, $p = 0.091$), with a 95 % confidence interval of $[-0.017, 0.001]$, containing 0, therefore not supporting H2. Similarly, authoritarian parenting style does not mediate between paternal parenting stress and early childhood development ($\beta = 0.001$, $p = 0.865$), with a 95 % confidence interval of $[-0.009, 0.011]$, containing 0, hence not supporting H3. However, parent-child relationship mediates between paternal parenting stress and early childhood development ($\beta = -0.015$, $p < 0.05$), with a 95 % confidence interval of $[-0.029, -0.002]$, not containing 0, therefore supporting H4. The structural equation modeling results of this study are shown in Fig. 2.

6. Discussion

6.1. Parenting stress and early childhood development

The study found no significant association between paternal parenting stress and early childhood development. This result aligns with the findings of Lee et al. (2018), supporting the primary caregiver effect theory, which emphasizes the crucial role of the primary caregiver in children's development (Pan et al., 2024). In most families, mothers are typically the primary caregivers, while fathers' involvement in parenting is relatively limited. As a result, the influence of fathers' parenting stress on children's development may be minimal. Additionally, fathers often bear multiple roles within the family, such as being the breadwinner, a husband, and a father. These multifaceted responsibilities can lead to role overload (Duxbury & Halinski, 2014). The stress associated with role overload may reduce the time and energy fathers can devote to parenting, thereby weakening the direct impact of

Table 2

Means, standard deviations, and correlations of the variables (N = 289).

Variables	M	SD	1	2	3	4	5	6	7	8
1. Child's Age	62.54	6.978	1							
2. Child's Gender	0.488	0.5007	−0.017	1						
3. SES (Socioeconomic Status)	−0.0051	1.01011	−0.043	0.062	1					
4. Parenting Stress	1.63255	0.43727	−0.018	0.151*	−0.082	1				
5. Authoritative Parenting Style	4.3024	0.49429	−0.021	−0.138*	0.185**	−0.261**	1			
6. Authoritarian Parenting Style	1.7084	0.461299	0.043	0.181**	−0.037	0.402**	−0.293**	1		
7. Parent-Child Relationship	4.2987	0.30909	0.070	−0.120*	0.130*	−0.595**	0.480**	−0.456**	1	
8. Early Childhood Development	0.88263	0.086108	0.283**	−0.048	0.078	−0.210**	0.250**	−0.128*	0.304**	1

Note:

* $p < 0.05$,** $p < 0.01$.**Table 3**

Fit indices of the model.

Fit indices	Recommended threshold	Scores
ML χ^2	–	21.808
Df	–	9
χ^2/df	$1 < \chi^2/\text{df} < 3$	2.423
CFI	> 0.9	0.962
TLI	> 0.9	0.908
RMSEA	< 0.08	0.070
SRMR	< 0.08	0.048

parenting stress on children's development. Furthermore, from the perspective of gender socialization theory, men are often expected to suppress emotional expression during the socialization process. Particularly in stressful situations, men tend to adopt avoidant coping strategies (Flynn et al., 2010). Such strategies may lead fathers to suppress overt negative emotions when dealing with parenting stress, thereby diminishing its potential impact on children's development.

6.2. Parenting stress, parenting styles, and early childhood development

This study found that paternal parenting styles did not mediate the relationship between paternal parenting stress and early childhood development. This result can be explained by the “buffering hypothesis” within attachment configuration theory. According to this theory, in families with inconsistent attachment patterns, children typically prefer to interact with the parent with whom they have a secure attachment and are less likely to engage with the parent with whom they share an insecure attachment (Dagan & Sagi-Schwartz, 2018). If the attachment

relationship between the father and the child is relatively insecure, children may be more inclined to seek comfort and support from their mother. A single secure attachment relationship can shield children from the negative impacts of insecure relationships on their development (Dagan & Sagi-Schwartz, 2018), which may partially mitigate the adverse effects of paternal parenting stress and authoritarian parenting on children.

Furthermore, attachment configuration theory suggests that establishing a secure attachment with one parent provides significant psychological benefits for children, but forming a second secure attachment with the other parent does not offer additional advantages (Dagan & Sagi-Schwartz, 2018). This mechanism may explain why paternal parenting styles did not serve as a significant mediator in the relationship between paternal parenting stress and early childhood development.

6.3. Parenting stress, parent-child relationships, and early childhood development

This study found that parent-child relationships play a mediating role between paternal parenting stress and early childhood development, with paternal parenting stress significantly negatively predicting parent-child relationships and parent-child relationships significantly positively predicting early childhood development. According to the spillover effect of family system theory, the emotions or behaviors of various subsystems in the family influence each other (Erel & Burman, 1995). This implies that parenting stress in the parental subsystem can affect other subsystems, such as the parent-child subsystem. Fathers under high parenting stress often face many problems in interacting and communicating with their children. For example, parenting stress may

Table 4

The direct effect of the research paths and research model hypothesis analysis.

DV	IV	Std. Est.	S.E.	Est./S.E.	P-Value	R ²	Hypo and Path
Early Childhood Development	Parent-Child Relationship	0.177	0.075	2.342	0.019	0.178	H4b: Parent-Child Relationship → Early Childhood Development
	Authoritative Parenting Style	0.153	0.096	1.596	0.111		H2b: Authoritative Parenting Style → Early Childhood Development
	Authoritarian Parenting Style	0.011	0.063	0.173	0.862		H3b: Authoritarian Parenting Style → Early Childhood Development
	Parenting Stress	−0.062	0.069	−0.897	0.370		H1: Parenting Stress → Early Childhood Development
Authoritative Parenting Style	Parenting Stress	−0.261	0.072	−3.653	***	0.068	H2a: Parenting Stress → Authoritative Parenting Style
Authoritarian Parenting Style	Parenting Stress	0.402	0.055	7.352	***	0.162	H3a: Parenting Stress → Authoritarian Parenting Style
Parent-Child Relationship	Authoritative Parenting Style	0.310	0.049	6.379	***	0.496	H5: Authoritative Parenting Style → Parent-Child Relationship
	Authoritarian Parenting Style	−0.190	0.045	−4.209	***		H6: Authoritarian Parenting Style → Parent-Child Relationship
	Parenting Stress	−0.438	0.043	−10.202	***		H4a: Parenting Stress → Parent-Child Relationship

Note:

*** $p < 0.001$.

Table 5

The indirect effect of the research paths.

Path	Std. Est.	S.E.	Est./S. E.	P-Value	Boot LLCI	Boot ULCI
H2: Parenting Stress → Authoritative Parenting Style → Early Childhood Development	−0.008	0.005	−1.688	0.091	−0.017	0.001
H3: Parenting Stress → Authoritarian Parenting Style → Early Childhood Development	0.001	0.005	0.170	0.865	−0.009	0.011
H4: Parenting Stress → Parent-Child Relationship → Early Childhood Development	−0.015	0.007	−2.235	0.025	−0.029	−0.002

lead to emotional fluctuations in fathers, making it difficult for them to remain calm and rational when interacting with their children, and may then adopt inappropriate or harsh methods, exacerbating tension and conflict between parents and children (Garcia et al., 2017). The parent-child relationship is closely related to children's emotions, emotions, behavioral performance, and cognitive patterns (Lanjekar et al., 2022). Therefore, the tension in parent-child relationships will inevitably have a significant impact on the early development of children.

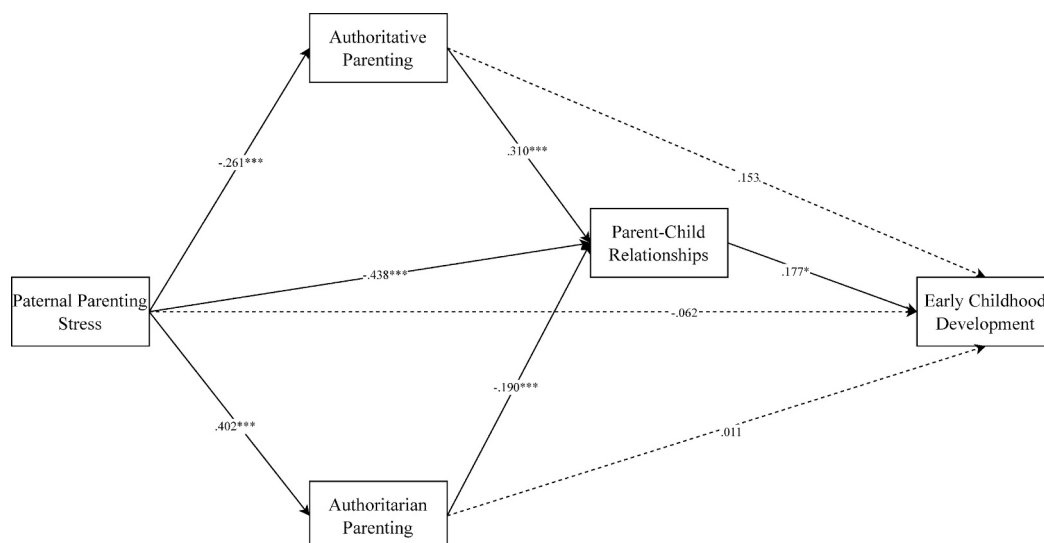
6.4. The chain-mediated effect of parenting styles and parent-child relationships

This study also found that paternal parenting stress is associated with parent-child relationships through its influence on authoritative and authoritarian parenting styles, which, in turn, are linked to early childhood development. According to the perspective of the parenting pressure model, paternal parenting stress can directly predict their

parenting style (Hadjicharalambous & Demetriou, 2021). Fathers with high parenting pressure tend to adopt negative parenting styles, which are not conducive to establishing positive parent-child relationships. For example, parents with authoritarian parenting styles often exhibit high demands and low responses (Fonseca et al., 2020), lack sensitivity to their children's needs and opinions, excessive control, and often tend to use punitive measures to obtain their children's obedience. This approach can easily lead to parent-child conflicts, hinder the development of positive parent-child relationships, and threaten the early childhood development. In contrast, parents with authoritative parenting styles can focus on and accept their children's opinions and individual characteristics, and have reasonable expectations for their children, which helps establish positive parent-child relationships (Aloia & Warren, 2019), and promotes early childhood development (Lamb & Lewis, 2013). Paternal parenting stress is associated with early childhood development, with parenting styles and parent-child relationships serving as mediating factors in this connection.

6.5. Theoretical contributions

This study made the following theoretical contributions in examining the association between paternal parenting stress and early childhood development. Firstly, by conducting in-depth research on the relationship between parental parenting stress and early childhood development, we have enriched the theoretical framework of existing parenting stress models (Abidin, 1992). Traditionally, research has mainly focused on the impact of maternal parenting stress on children (Larkin & Otis, 2019), while our research has shifted the focus to fathers, providing a new perspective for a comprehensive understanding of parenting stress models. Secondly, research has found a correlation between paternal parenting stress and parenting style, which does not directly predict early childhood development, highlighting the mediating role of parent-child relationships between parenting stress and children's behavior. This discovery emphasizes the special role of fathers in families and the importance of parent-child relationships in children's development. Therefore, this study enriches our understanding of the dynamics of family parenting, providing important theoretical support for promoting paternal involvement in family parenting, optimizing parent-child relationships, and developing more effective family intervention plans.

**Fig. 2.** The result of structural equation model of this study.

6.6. Practical contributions

The results of this study provide important insights for family education practice. Firstly, it is important to fully recognize the impact of paternal parenting stress on parent-child relationships and the family atmosphere. Parenting stress may lead to negative behaviors such as indifference and estrangement from fathers, which not only predicts their parenting style but also hinders the healthy development of parent-child relationships. Therefore, the maintenance of marital relationships should be emphasized in families, creating a warm family environment to alleviate paternal parenting stress (Johnson & Simpson, 2013), and promote early development of children. Secondly, this study found that father's authoritative parenting style is associated with positive outcomes in children, indicating that father's parenting style is significantly associated with children's behavioral development. In contrast, authoritarian parenting styles may lead to more externalized behavioral problems in children (Carapito et al., 2018). Fathers can participate in family education and training to help establish authoritative parenting styles. In addition, a good parent-child relationship helps cultivate a child's emotional regulation ability and adaptability (Carapito et al., 2018). Therefore, fathers should spend more time with their children to strengthen the connection and communication between them.

6.7. Research limitations and future prospects

Firstly, the research adopts a phased measurement design across multiple time points. Future studies could consider employing longitudinal tracking to gain a deeper understanding of the long-term effects of paternal parenting stress on early childhood development. Secondly, this study examines the impact of parenting style and parent-child relationships on early childhood development but does not account for other potential influencing factors, such as marital conflict, childhood trauma, socioeconomic status, and work-family conflict. These factors may also exacerbate paternal parenting stress, thereby affecting parent-child interactions and early childhood development. Future research could include these variables for further exploration. Thirdly, the study takes a holistic perspective on early childhood development, but the Early Human Capability Index (eHCI) may have limitations in its ability to precisely measure specific developmental domains. Future studies could focus on particular aspects of child development to examine their relationship with parental stress, thereby deepening our understanding of specific domains. Lastly, we acknowledge that the generalizability of this study's findings may be limited due to the sampling scope. We recommend expanding the sample size in future research to validate the results.

7. Conclusion

This study explores the associations among paternal parenting stress, parenting styles, parent-child relationships, and early childhood development. It was found that paternal parenting stress was positively associated with their authoritarian parenting style but was not directly linked to early childhood development. Additionally, the study highlights the parent-child relationship as a key factor in the connection between parenting stress and early childhood development. These findings deepen our understanding of parenting stress models and offer a scientific basis for practical interventions aimed at promoting early childhood development from a paternal perspective.

CRediT authorship contribution statement

Baocheng Pan: Software, Methodology, Conceptualization. **Jiaxuan Miao:** Writing – original draft, Visualization. **Youli Wang:** Writing – review & editing, Software. **Chengli Zhao:** Visualization, Investigation. **Yizhao Gong:** Writing – review & editing, Writing – original draft. **Bowen Xiao:** Writing – original draft. **Yan Li:** Methodology, Funding

acquisition, Formal analysis, Conceptualization.

Ethics approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the Helsinki declaration. This study was approved by the Scientific Research Ethics Committee of Shanghai Normal University.

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Declaration of competing interest

None.

Data availability

The datasets used or analyzed during the current study are available from the corresponding author upon reasonable request.

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