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EMPIRICAL RESEARCH

Dynamic Processes of Parent–Adolescent Conflict and Warmth in Chinese Families: Differences between Mothers and Fathers

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Abstract

Parent-adolescent relationships are shaped by daily interactions that include both warmth and conflict, yet most research has focused on aggregate or long-term patterns rather than their day-to-day fluctuations. Guided by family systems theory, this study examined how mothers and fathers distinctly contribute to daily parent-adolescent warmth and conflict, as well as how these interactions vary across families. The sample consisted of 307 Chinese adolescents ($M_{age} = 13.02$ years, $SD = 0.762$ years; 49.51% girls). Participants reported their daily perceptions of warmth and conflict with both their mothers and fathers over a 10-day period. Dynamic structural equation modeling showed significant autoregressive effects for mother- and father-adolescent warmth and conflict. Cross-lagged analyses revealed that higher levels of mother-adolescent conflict, higher levels of father-adolescent warmth, and lower levels of father-adolescent conflict predicted increased mother-adolescent warmth the following day. Additionally, greater father-adolescent conflict predicted greater mother-adolescent conflict the next day. Within-family effects varied in both direction and magnitude across families and some lagged effects were moderated by adolescent age and family income. Overall, these findings emphasize the importance of considering parent gender and family-level variations when examining daily family dynamics. They also suggest that maternal warmth may be especially sensitive to the family's daily relational experiences, highlighting the need for parenting practices and interventions that acknowledge and address this responsiveness.

Keywords Conflict · Warmth · Parent-adolescent interactions · Family systems · Dynamic structural equation modelling

Introduction

Parent-child interactions are among the most proximal and direct influence on adolescent development (Bronfenbrenner & Morris, 1998). A large body of research has shown that warmth and conflict, two distinct aspects of parent-adolescent interactions, are associated with multiple dimensions of adolescent adjustment, including emotional well-being, academic performance, and interpersonal functioning (Boele et al., 2020; Harold & Sellers, 2018; Pinquart, 2017). However, much of this work has predominantly focused on the aggregate values (averages) or long-term effects (across months or years) of parent-adolescent warmth and conflict, their day-to-day variations and interplay are less understood (Keijsers et al., 2022). Moreover, family systems theory emphasizes that families consist of multiple subsystems, such as those between mothers and adolescents, and fathers and adolescents, each with its own dynamics (Cox & Paley, 1997). Parenting roles specific to mothers and fathers are evident in mother-adolescent and father-adolescent general interactions (Gryczkowski et al., 2010; Yaffe, 2023); however, comparisons of dynamic interactions between mothers and

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fathers and their teens have been largely unexplored. Thus, this study examined the dynamic processes of parent-adolescent warmth and conflict to explore the roles of mothers and fathers in daily interactions with adolescents and the heterogeneity of parent-adolescent interactions across families in China.

Different Roles of Mothers and Fathers in Chinese Parent-Adolescent Interactions

The different roles of mothers and fathers in the family have long been discussed (Yaffe, 2023). Early research in Western contexts found significant differences between mother-child and father-child relationships, with these differences becoming more pronounced during the transition to adolescence (Collins & Russell, 1991). While some studies have reported similar levels of warmth between mothers and fathers (e.g., Brouillard et al., 2019 in Canadian families; Newland et al., 2013 in American families), other evidence indicates notable differences. For example, mother-adolescent relationships are characterized by both higher levels of warmth and conflict compared to those between fathers and adolescents in American families (Fagan, 2022; Timmons & Margolin, 2015). This may be due to the fact that mothers typically spend more time with their adolescents (Gryczkowski et al., 2010) and take on more responsibility for their daily care and discipline (Phares et al., 2009), which provides more opportunities for mothers to express warmth and engage in conflict with their adolescents.

Within Chinese families, the patterns of mother-adolescent and father-adolescent interaction may be more complex than those in Western cultures. Shaped by Confucian ideals of filial piety and respect for parents, the traditional parenting roles in many Chinese families can be described as "strict father, kind mother" (Shek, 2005). Traditionally, fathers are viewed as authoritative figures who focus on discipline. As a result, they tend to display more conflict and less warmth in their interactions with children, with the goal of correcting inappropriate behaviors (Ji et al., 2017). In contrast, mothers are generally responsible for attending to children's daily needs, and thus, tend to show more warmth and concern to their children (Chang et al., 2011).

Meanwhile, rapid economic development and sociocultural changes have contributed to shifts in cultural values about parenting (Luo et al., 2021; Way et al., 2013), narrowing the gap between maternal and paternal roles (Luo et al., 2021; Xu et al., 2018), possibly due to the rise in educational levels and employment opportunities for Chinese women. Fathers today are more involved in child-rearing (Li, 2020). For instance, a four-wave longitudinal study beginning when children were in 4th grade found that fathers increased both supportive and unsupportive parenting behaviors over time (Jiang et al., 2024).

An even more interesting phenomenon is the emerging trend of "tiger mother, panda father," which contrasts with the traditional "strict father, kind mother" dynamic (Xie & Li, 2019). In this newer configuration, mothers are more likely to assume the primary role in teaching and training their children. They may set higher behavioral standards and enforce them through strict control and direct commands. Indeed, recent research shows that Chinese mothers not only demonstrate more warmth (Xu et al., 2018) but also more hostile and punitive behaviors than fathers when parenting their children (Xie & Li, 2019). Taken together, these findings suggest that, under the influence of China's historical cultural traditions and contemporary social changes, mother-adolescent and father-adolescent interaction patterns may differ in modern Chinese families.

Daily Dynamics of Mother- and Father-Adolescent Warmth and Conflict

Previous studies have mainly analyzed the differences between mothers and fathers at the aggregate level (i.e., differences in mean values between parents), rather than fluctuations in parent-child warmth and conflict over time in everyday life (i.e., differences in dynamic processes between parents). Since changes in parent-adolescent warmth and conflict are associated with adolescents' daily adaptation and well-being (Boele et al., 2020; Bülow et al., 2022), exploring parental differences only on macro time scales may undermine a deeper understanding of how mother-adolescent and father-adolescent warmth and conflict unfold on micro time scales (i.e., from day to day), and how mothers and fathers differ in their dynamic interactions with their children.

Of the work that has used diary or ecological momentary assessment data to examine the dynamic processes of parent-adolescent warmth and conflict (Bülow et al., 2022; Sears et al., 2016), most have not differentiated between mother-adolescent and father-adolescent interactions (Bülow et al., 2022; Janssen et al., 2021), or have focused on mother-child interactions (Mastrotheodoros et al., 2022). Even when some studies collected data on both mother-child and father-child conflict and/or warmth, they combined the data into an overall measure of parent-child interaction (Robles et al., 2016; Sears et al., 2016) or analyzed them in separate models, precluding an understanding of the transactional processes involved in parent-child interaction (Chung et al., 2009; Janssen et al., 2023).

According to family systems theory (Cox & Paley, 1997), the mother-adolescent and father-adolescent dyads are important and distinct subsystems within family dynamics. An important dynamic characteristic of parent-

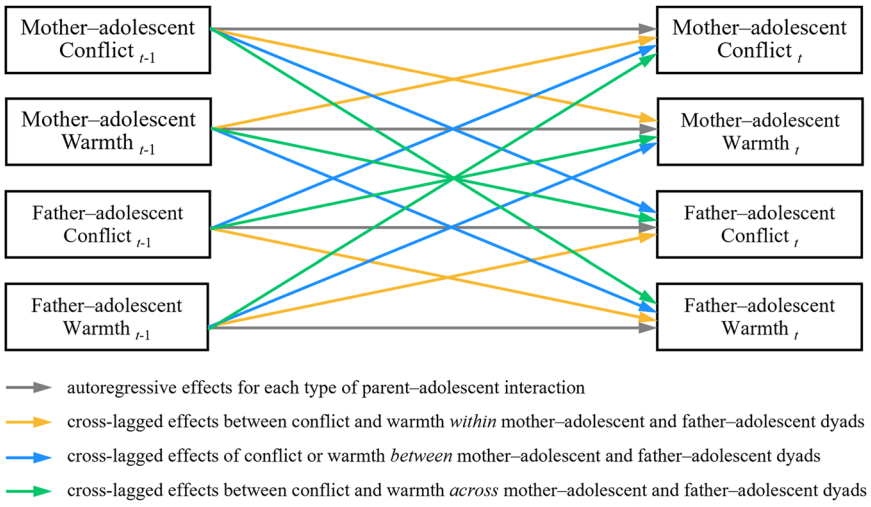

Fig. 1 Autoregressive and cross-lagged effects of warmth and conflict in mother-adolescent and father-adolescent interactions

adolescent interactions in these family subsystems is the carry-over effect (i.e., inertia) from one day to the next, which can be quantified by autoregressive effects. Previous research found significant positive autoregressive effects of mother-child and father-child relationship quality across days (Gao & Cummings, 2019), suggesting that changes in both mother-adolescent and father-adolescent subsystems tend to persist. This study also found that autoregressive effects of mother-child and father-child relationships were of similar strength; however, other studies showed that adolescents' perceived relationship satisfaction with their fathers had stronger autoregressive effects across days than with their mothers (Van Doorn et al., 2009). In addition to differences between mother-adolescent and father-adolescent subsystems, there are also differences among types of interactions within a parent-adolescent subsystem. For example, some studies found significant but weak autoregressive effects of maternal warmth (Mastrotheodoros et al., 2022; Wu et al., 2023), while nonsignificant autoregressive effects of mother-adolescent conflict (Wu et al., 2023). These results suggest that warmth and conflict in the mother-adolescent and father-adolescent subsystems may be characterized by different dynamics.

In addition to *dynamic characteristics (i.e., autoregressive effects)* of warmth and conflict in mother-adolescent and father-adolescent subsystems, there are also *dynamic interactions (i.e., cross-lagged effects)* within and between these two subsystems (Cox & Paley, 1997). Specifically, there are three types of possible reciprocal effects among mother-adolescent and father-adolescent warmth and conflict: (a) cross-lagged effects between warmth and conflict *within* mother-adolescent or father-adolescent dyads, (b) cross-lagged effects of conflict or warmth *between* mother-adolescent and father-adolescent dyads, and (c) cross-lagged effects between warmth and conflict *across* mother-adolescent and father-adolescent dyads (see Fig. 1 for a depiction of the possible reciprocal effects).

Within mother- or father-adolescent dyads, cross-lagged effects between warmth and conflict suggest that one type of parent-adolescent interaction (conflict/warmth) may subsequently influence the other. Previous research found that higher same-day conflict than average levels were associated with less parent-adolescent warmth than usual (Bai et al., 2017). Using a daily diary approach, teen anxiety was associated with same-day use of parent psychological aggression, father (not mother) psychological aggression was associated with next-day teen anxiety, and teen anxiety was related to next-day use of psychological aggression by both mothers and fathers (Quan et al., 2024).

Though less work has examined dynamic relations among parent-child interactions, longitudinal studies have identified a reciprocal relationship between mother- and father-child warmth (Daniel et al., 2016; Schofield et al., 2009) and conflict (Xie et al., 2021). Directionality has not been determined in these studies, but some research suggests that mothers are the primary nurturers of their children, and fathers typically mimic mothers' parenting practices (Hawkins et al., 1993). For example, researchers found that mothers' involvement was a strong predictor of fathers' subsequent involvement, but the reverse effect was small and nonsignificant (Pleck & Hofferth, 2008). However, particularly under the influence of Chinese Confucian patriarchy, fathers maintain authority and dominance in most Chinese families (Santos & Harrell, 2017). In one study, father-child conflict positively predicted mother-child conflict nine months later, whereas mother-child conflict did not significantly predict subsequent father-child conflict (Zhang & Chen, 2010), supporting the influence of fathers. Given the inconsistent theoretical and empirical evidence, it remains unclear whether one parent's interactions with adolescents are more influenced by the other parent.

In addition, the cross-lagged effects *between* different types of interactions (i.e., warmth and conflict) *across* mother-adolescent and father-adolescent dyads are understudied. Theoretically, the dynamic interplay between family subsystems can be characterized by both spillover and compensatory effects (Cox & Paley, 1997). On the one hand, spillover effects presume that emotions and behaviors can permeate from one relationship to another. For example, an adolescent's high levels of warmth with their mother can positively impact their interactions with father, potentially leading to enhanced warmth and decreased conflict in the father-adolescent relationship. On the other hand, compensatory effects occur when conflict in one parent-adolescent relationship prompts an increase in warmth in another, or vice versa. For example, an adolescent who experiences conflict with their father may seek comfort and support from their mother, which can enhance warmth in the mother-adolescent relationship.

Heterogeneity of Parent-Adolescent Interactions Across Families

Family systems theory stresses that each family is a unique system with different dynamic characteristics (Cox & Paley, 1997; Kunnen et al., 2019). Thus, parent-adolescent dynamic interactions may differ not only between mothers and fathers within a family, but also across families. Most studies of heterogeneity in family dynamics have focused on differences in the *direction* of within-family effects. Some studies identified different types or patterns of family dynamic processes based on the direction and statistical significance (i.e., negatively significant, positively significant, and nonsignificant) of a family-specific effect (Mastrotheodoros et al., 2022) or different combinations of multiple family-specific effects (Boele et al., 2023). Other studies calculated the percentage of families that have the same direction as the average within-family effect to examine whether there were uniform, universal or unique effects in within-family processes (Bülow et al., 2022). However, few studies have examined the *magnitude* of differences, which can allow for enhanced interpretations of the degree of variation between families.

The inclusion of moderators can help to explain heterogeneity of within-family processes of parent-adolescent interactions. To date, studies have explored adolescent characteristics, particularly their demographic factors (e.g., gender, and age), and family characteristics (e.g., family income). For example, boys have lower rates of change in mother-child closeness and conflict from middle childhood to adolescence compared to girls; however, a child's gender does not significantly predict the rate of change in father-child closeness and conflict (Xie et al., 2021). There were no significant effects of child's ethnicity, family income, or father presence on the rates of changes in mother-child and father-child closeness and conflict (Xie et al., 2021). Other work has found mixed results for the influence of demographic factors on parent-adolescent warmth and conflict (Bülow et al., 2022; Chung et al., 2009; Timmons & Margolin, 2015). Future work is needed to help explicate the conditions under which demographic variables may relate to the dynamic processes of parent-adolescent warmth and conflict.

Current Study

Although previous research underscores the importance of parent-adolescent warmth and conflict, it has primarily focused on broad, aggregate measures over extended periods, often overlooking the distinct daily dynamics within mother-adolescent and father-adolescent subsystems. Moreover, the heterogeneity of these interactions across different families and the conditions under which demographic factors moderate these processes remain largely unexplored. To address these gaps, the current study examines the daily dynamics of warmth and conflict in Chinese parent-adolescent relationships, simultaneously considering the unique roles of mothers and fathers, as well as family-level variations. At the within-family level (see Fig. 1), the study estimated (a) autoregressive effects (i.e., carry-over effects or inertia) for each type of parent-adolescent interaction, (b) cross-lagged effects between warmth and conflict *within* mother-adolescent or father-adolescent dyads, (c) cross-lagged effects of warmth or conflict *between* mother-adolescent and father-adolescent dyads, and (d) cross-lagged effects between warmth and conflict *across* mother-adolescent and father-adolescent dyads. At the between-family level, the universality of the direction of each within-family effect across families and the differences in its magnitude were further examined. It was hypothesized that there would be a positive autoregressive effect for each type of parent-adolescent interaction (Hypothesis 1). In addition, positive cross-lagged effects of conflict or warmth between mother-adolescent and father-adolescent dyads were expected (Hypothesis 2). Given mixed findings in the extant literature, no specific hypotheses were proposed regarding the cross-lagged effects between warmth and conflict both within dyads (Hypothesis 3) and across dyads (Hypothesis 4). Finally, heterogeneity in both the direction and magnitude of all within-family effects was expected (Hypothesis 5). Demographic variables relevant to parent-adolescent interactions were also included (i.e., adolescent gender and age, and family income); however, due to mixed results from previous work, no specific hypotheses were put forth.

Methods

Participants

The initial sample included 315 seventh-grade adolescents from a public middle school in a city in Northeast China. Eight participants were excluded from the analysis: seven had more than 50% missing values in all study variables on parent-adolescent interactions and one reported no interaction with parents during the study. The final sample included 307 adolescents (49.51% girls; 11–15 years; $M_{age} = 13.02$ years, $SD = 0.76$). The majority of the sample was of Chinese Han ethnicity (96.5%), while a minority was of Manchu (2.6%), Hui (0.3%), Mongol (0.3%), and Korean (0.3%). Regarding parents' educational attainment, 42.5% had completed middle school, 23.1% had completed high school, and 24.1% had earned a bachelor's degree. An additional 6.5% had not completed middle school. Regarding annual household income, the majority of families (76.3%) earned less than 72,000 RMB (approximately 10,300 USD), which was lower than the local average annual household income (i.e., 77,363 RMB; approximately 11,000 USD) for the area in which the school is located (Heilongjiang Bureau of Statistics, 2020). About 18.8% of the families earned between 72,000 and 120,000 RMB annually, with an additional 3.1 and 1.7% reported annual incomes between 120,000 and 240,000 RMB and above 240,000 RMB (i.e., high income level), respectively.

Procedure

All study procedures and materials were approved by the university's ethics committee. First, parents provided informed consent for their children's participation on the online survey platform Qualtrics, and adolescents gave their informed consent in person at school. Then, research assistants visited the school to distribute questionnaire packets, which included items on family demographics. They also provided adolescents with detailed instructions to ensure that they fully understood the daily procedures and items. Following these preparatory steps, adolescents completed a daily diary each evening before bedtime over a two-week period (10 consecutive school days, Monday through Friday for two weeks), reporting on their warmth and conflict with their parents. All adolescents in the study lived full-time with their parents, as the school did not provide dormitories, and the local enrollment policies required students to attend schools near their homes. This arrangement provided greater opportunities for parent-adolescent interactions during school days. For the 10-day period, research assistants visited the school each day to hand out that day's diary entries and collect the previous day's completed entries, ensuring that the participants had followed the instructions. Each adolescent received the daily diary entry form 10 min before school dismissal and was asked to complete it at home before going to sleep (at approximately 9 PM), recording their interactions with their parents. The next morning, they brought the completed diaries back to school, where the research assistants collected them. Each daily entry took about 5 min to complete. Of the total possible number of daily diary entries ($3070 = 307$ participants × 10 days), adolescents completed 2856 daily entries, achieving a high compliance rate of 93.03%.

Measures

Parent-Adolescent Warmth and Conflict

Adolescents reported their daily warmth and conflict with their mothers and fathers separately. Items were based on the Youth Everyday Social Interaction and Mood scales (Repetti, 1996) and previous diary studies (Robles et al., 2016; Sears et al., 2016). Mother-adolescent and father-adolescent warmth was measured by three items, respectively (i.e., "I had fun with my [Mom/Dad] today", "My [Mom/Dad] and I got along well today", and "My [Mom/Dad] gave me love and attention today"). Mother-adolescent and father-adolescent conflict was measured by three items, respectively (i.e., "My [Mom/Dad] got mad at me today", "I was angry at my [Mom/Dad] today", and "My [Mom/Dad] punished me today"). Participants were asked to rate how much they agreed with the description of each item from 1 (not at all) to 4 (very much). The total scores of adolescents' reports on the interactions with their mothers and fathers was calculated separately.

To test the reliability of adolescent-reported warmth and conflict, a multilevel confirmatory factor model was established for mother-adolescent warmth, father-adolescent warmth, mother-adolescent conflict, and father-adolescent conflict, respectively. Based on these models, between- and within-person reliabilities were estimated by calculating McDonald's ω (Geldhof et al., 2014), which indicated excellent reliability ($\omega = 0.990$ for mother-adolescent warmth, $\omega = 0.995$ for father-adolescent warmth, $\omega = 0.937$ for mother-adolescent conflict, and $\omega = 0.966$ for father-adolescent conflict at the between-person level; $\omega = 0.877$ for mother-adolescent warmth, $\omega = 0.929$ for father-adolescent warmth, $\omega = 0.830$ for mother-adolescent conflict, and $\omega = 0.844$ for father-adolescent conflict at the within-person level).

Demographic and Family-Related Information

Adolescents reported their gender (0 = female, 1 = male) and age. Parents reported monthly household income (from

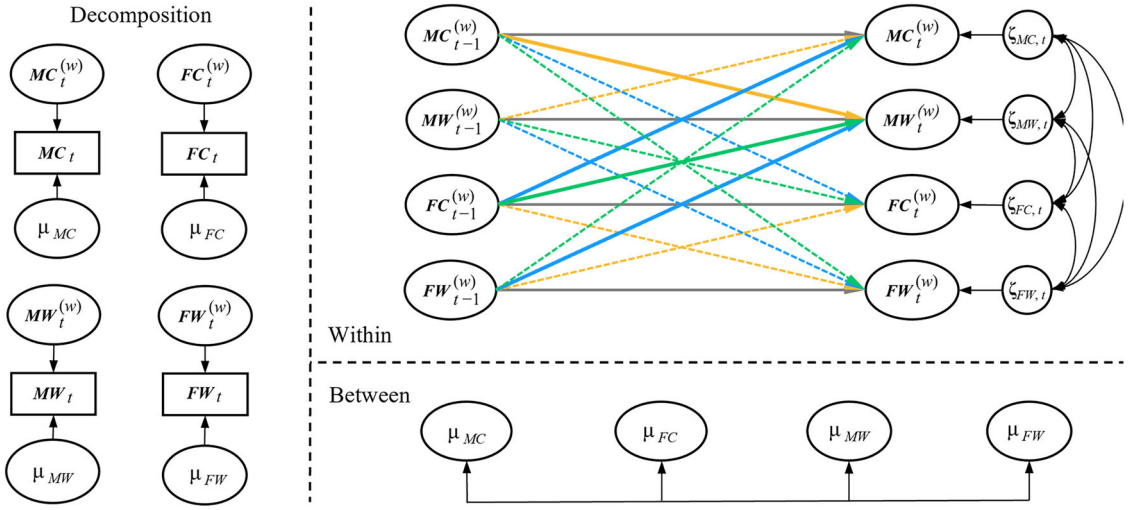

Fig. 2 dynamic structural equation model of warmth and conflict in mother-adolescent and father-adolescent interactions. *Note*: MC Mother-adolescent Conflict, MW Mother-adolescent Warmth, FC Father-adolescent Conflict, FW Father-adolescent Warmth. Solid lines indicate statistically significant standardized effects, while dashed lines indicate standardized effects that were estimated in the model but not statistically significant

1 = less than 2000 RMB to 10 = more than 20,000 RMB). Monthly household income was multiplied by twelve to estimate annual household income.

Data Analyses

Descriptive statistics and correlations were calculated in *R* version 4.2.2 using *psych* package (Revelle, 2017). To examine the within-family processes of parent-adolescent interactions and between-family differences, the dynamic structural equation modeling (DSEM, Asparouhov et al., 2018) was employed in M*plus* version 8.10. This approach distinguishes between-family components (family averages across all days) from within-family components (day-specific deviations from family averages) to more accurately capture within-family processes. It also allows for between-family variation in these within-family estimates, thus providing family-specific effects.

A visual presentation of the model is shown in Fig. 2. Observed scores of mother-adolescent warmth, father-adolescent warmth, mother-adolescent conflict, and father-adolescent conflict were first decomposed into between-family (i.e., latent mean of the variable) and within-family (i.e., the deviation of observed score from the latent mean) components. At the within-family level, random variances were allowed for all autoregressive and cross-lagged effects, and family-specific autoregressive and cross-lagged effects were estimated. Fixed effects of each autoregressive and cross-lagged effect were obtained by averaging family-specific effects across families. The variances and covariances of the within-family residuals of four variables were fixed to be equal for all families. At the between-family level, correlations between the random intercepts (i.e., latent means of all variables) were estimated.

The model parameters were estimated using a Bayesian estimator with noninformative priors and Markov chain Monte Carlo (MCMC) algorithm. Two Gibbs-sampler chains were used, with 5000 iterations each, 50% burn-in and a thinning value of 10 (Asparouhov et al., 2018). The model convergence was determined based on the potential scale reduction (PSR; Asparouhov & Muthén, 2010) and trace plots of parameters. The within-person standardization approach (Schuurman et al., 2016) was used to obtain standardized estimates.

The rates of missing data were low across key variables: 7.00% for mother-adolescent warmth, 7.07% for father-adolescent warmth, 6.91% for mother-adolescent conflict, and 6.91% for father-adolescent conflict. Little's (1988) test for missing completely at random (MCAR) was not significant, $\chi^2(20) = 27.17$, $p = 0.13$, indicating that the data met the pattern of MCAR. The missing values were subsequently addressed using a Kalman filter approach in M*plus* (Asparouhov et al., 2018; Kalman, 1960).

To explore within-family processes, the STDRESULTS command in the SAVE section in M*plus* was used to obtain family-specific standardized autoregressive and cross-lagged effects. First, the heterogeneity in each family-specific effect was examined by calculating the percentage of families with an effect that was the same sign as the fixed effect and the 95% heterogeneity interval (i.e., lower and upper bounds are the 2.5th and 97.5th percentiles of the distribution of the family-specific effect, respectively). Then, each family-specific effect was regressed on demographic and family-related factors (i.e., adolescent gender, adolescent age, and annual household

Table 1 Descriptive statistics and correlations among the four types of parent-adolescent interactions

		M (*SD* within, *SD* between)	ICC	Correlations			
				1	2	3	4
1	MC	3.979 (2.161, 1.641)	0.536	–	0.702***	0.055**	0.126***
2	FC	3.737 (1.943, 1.468)	0.523	0.830***	–	0.168***	0.182***
3	MW	7.282 (3.592, 2.912)	0.623	−0.031	0.004	–	0.738***
4	FW	6.950 (3.684, 3.050)	0.660	−0.051	0.038	0.878***	–

MC mother-adolescent conflict, *FC* father-adolescent conflict, *MW* mother-adolescent warmth, *FW* father-adolescent warmth, *ICC* intraclass correlation

Between-family correlations are presented below the diagonal, and within-family correlations are presented above the diagonal

** $p < 0.01$. *** $p < 0.001$

income) to test whether these variables explained differences across families.

Results

Descriptive Statistics

Descriptive statistics and correlations among four types of parent-adolescent interactions are shown in Table 1. The intraclass correlations for four types of parent-adolescent interactions ranged from 0.523 to 0.660, suggesting that approximately 60% of the variances were between-family. At the between-family level, mother-adolescent warmth and conflict were positively correlated with father-adolescent warmth and conflict, respectively. At the within-family level, all four types of parent-adolescent interactions were positively associated with one another, indicating that one days when adolescents experienced more of one type of interaction, they also tended to engage in more of the other types.

Within-Family Processes of Parent-Adolescent Interactions

The unstandardized and standardized estimates of the parameters in the dynamic structural equation model and their 95% credible intervals are shown in Table 2. Regarding the autoregressive effects, the four types of parent-adolescent interactions showed significant inertia (i.e., carryover effects) across days, that is specific types of interactions between parents and adolescents one day predicted more of the same types of interactions the next day. The inertia of father-adolescent warmth ($\varphi_{FWFW} = 0.215$, 95% Credible Interval (CI) [0.142, 0.285]) was approximately twice as large as the inertia of mother-adolescent warmth ($\varphi_{MWMW} = 0.125$, 95% CI [0.043, 0.200]), and the inertia of father-adolescent conflict ($\varphi_{FCFC} = 0.230$, 95% CI [0.169, 0.291]) was approximately three times as large as the inertia of mother-adolescent conflict ($\varphi_{MCMC} = 0.077$, 95% CI [0.014, 0.145]); thus, father-adolescent warmth and conflict between father and adolescents were more persistent from day to day than were mother-adolescent warmth and conflict.

Regarding the cross-lagged effects, father-adolescent warmth and conflict predicted more mother-adolescent warmth and conflict the next day, respectively ($\varphi_{FWMW} = 0.112$, 95% CI [0.035, 0.190]; $\varphi_{FCMC} = 0.142$, 95% CI [0.073, 0.210]), but not vice versa. Furthermore, mother-adolescent conflict predicted more mother-adolescent warmth the next day ($\varphi_{MCMW} = 0.082$, 95% CI [0.009, 0.154]), whereas father-adolescent conflict predicted less mother-adolescent warmth the next day ($\varphi_{FCMW} = -0.079$, 95% CI [−0.154, −0.007]). This suggested that mother-adolescent warmth was susceptible to the complex effects of mother-adolescent and father-adolescent interactions from the previous day.

The same-day associations between mother-adolescent warmth, father-adolescent warmth, mother-adolescent conflict, and father-adolescent conflict after controlling for lagged effects were all significant ($r = 0.081$–0.803, all $ps < 0.001$). Overall, the model explained 19.3, and 25.4, 20.8, and 23.6% of the variance in mother-adolescent warmth, father-adolescent warmth, mother-adolescent conflict, and father-adolescent conflict, respectively. Notably, some of the autoregressive and cross-lagged effects in parent-adolescent interactions had large random variances, suggesting that the within-family processes of parent-adolescent interactions differed across families. This inspired us to further explore family-specific effects.

Between-Family Differences of Within-Family Processes

For each family-specific effect, the degree of heterogeneity was first explored. Table 3 shows the percentage of families with an effect that was the same sign as the fixed effect (i.e., the effect of the average or typical family), and the 95% heterogeneity interval (95% HI) of each family-specific effect. Regarding the *direction* of family-specific effects, the majority of families (86.97–93.16%) had positive autoregressive effects

Table 2 Parameter estimation results of the dynamic structural equation model

Effects	Notations	Unstandardized estimates		Standardized estimates
		Fixed effects	Random variances	Fixed effects
Autoregressive effects				
$MC_{t-1} \rightarrow MC_t$	φ_{MCMC}	**0.078 [0.012, 0.148]**	0.041 [0.023, 0.065]	**0.077 [0.014, 0.145]**
$FC_{t-1} \rightarrow FC_t$	φ_{FCFC}	**0.234 [0.161, 0.307]**	0.096 [0.071, 0.127]	**0.230 [0.169, 0.291]**
$MW_{t-1} \rightarrow MW_t$	φ_{MWMW}	**0.126 [0.044, 0.208]**	0.046 [0.023, 0.071]	**0.125 [0.043, 0.200]**
$FW_{t-1} \rightarrow FW_t$	φ_{FWFW}	**0.214 [0.134, 0.291]**	0.077 [0.057, 0.101]	**0.215 [0.142, 0.285]**
Cross-lagged effects				
$MC_{t-1} \rightarrow FC_t$	φ_{MCFC}	0.061 [−0.006, 0.125]	0.046 [0.026, 0.071]	0.058 [−0.010, 0.118]
$MC_{t-1} \rightarrow MW_t$	φ_{MCMW}	**0.121 [0.003, 0.234]**	0.094 [0.041, 0.163]	**0.082 [0.009, 0.154]**
$MC_{t-1} \rightarrow FW_t$	φ_{MCFW}	0.005 [−0.110, 0.122]	0.085 [0.026, 0.163]	0.007 [−0.062, 0.077]
$FC_{t-1} \rightarrow MC_t$	φ_{FCMC}	**0.168 [0.083, 0.251]**	0.131 [0.091, 0.182]	**0.142 [0.073, 0.210]**
$FC_{t-1} \rightarrow MW_t$	φ_{FCMW}	−0.120 [−0.235, 0.005]	0.052 [0.006, 0.127]	**−0.079 [−0.154, −0.007]**
$FC_{t-1} \rightarrow FW_t$	φ_{FCFW}	−0.009 [−0.146, 0.125]	0.151 [0.084, 0.238]	−0.008 [−0.088, 0.061]
$MW_{t-1} \rightarrow MC_t$	φ_{MWMC}	−0.031 [−0.075, 0.011]	0.007 [0.002, 0.015]	−0.046 [−0.108, 0.013]
$MW_{t-1} \rightarrow FC_t$	φ_{MWFC}	−0.032 [−0.072, 0.007]	0.006 [0.002, 0.013]	−0.053 [−0.107, 0.008]
$MW_{t-1} \rightarrow FW_t$	φ_{MWFW}	0.067 [−0.007, 0.137]	0.019 [0.004, 0.042]	0.061 [−0.009, 0.133]
$FW_{t-1} \rightarrow MC_t$	φ_{FWMC}	0.013 [−0.006, 0.052]	0.002 [0.001, 0.007]	0.019 [−0.039, 0.074]
$FW_{t-1} \rightarrow FC_t$	φ_{FWFC}	0.027 [−0.011, 0.065]	0.002 [0.001, 0.006]	0.045 [−0.019, 0.100]
$FW_{t-1} \rightarrow MW_t$	φ_{FWMW}	**0.113 [0.035, 0.188]**	0.029 [0.010, 0.054]	**0.112 [0.035, 0.190]**

MC mother-adolescent conflict, *FC* father-adolescent conflict, *MW* mother-adolescent warmth, *FW* father-adolescent warmth

95% credible intervals (CIs) are in the brackets. Significant fixed effects (zero is not within the 95% CIs) are bolded

Table 3 Heterogeneity and potential of family-specific effects

Notations	Percentage (%)	95% HI	Adolescent gender			Adolescent age			Annual household income		
			B	SE	*p*	*B*	SE	*p*	*B*	SE	*p*
φ_{MCMC}	86.971	[−0.113, 0.288]	0.015	0.010	0.131	0.001	0.007	0.848	0.001	0.002	0.800
φ_{FCFC}	93.160	[−0.132, 0.684]	−0.006	0.020	0.779	−0.018	0.013	0.193	0.000	0.005	0.980
φ_{MWMW}	89.902	[−0.116, 0.356]	−0.008	0.012	0.514	−0.008	0.008	0.325	**−0.006**	**0.003**	**0.022**
φ_{FWFW}	91.857	[−0.087, 0.692]	−0.015	0.019	0.435	0.023	0.013	0.070	0.003	0.004	0.443
φ_{MCFC}	83.062	[−0.156, 0.292]	−0.007	0.011	0.555	0.003	0.007	0.677	−0.003	0.002	0.222
φ_{MCMW}	88.925	[−0.080, 0.284]	−0.014	0.011	0.212	0.002	0.007	0.834	0.000	0.002	0.970
φ_{MCFW}	66.775	[−0.184, 0.173]	0.001	0.009	0.946	−0.006	0.006	0.331	−0.001	0.002	0.514
φ_{FCMC}	87.622	[−0.264, 0.529]	0.026	0.020	0.204	0.012	0.013	0.379	−0.003	0.005	0.530
φ_{FCMW}	96.417	[−0.177, 0.016]	−0.009	0.006	0.125	−0.004	0.004	0.307	0.001	0.001	0.431
φ_{FCFW}	66.775	[−0.219, 0.223]	−0.009	0.012	0.432	0.005	0.008	0.503	0.000	0.003	0.883
φ_{MWMC}	92.508	[−0.168, 0.054]	−0.001	0.005	0.917	−0.002	0.003	0.582	0.001	0.001	0.535
φ_{MWFC}	92.182	[−0.150, 0.037]	0.002	0.005	0.739	−0.003	0.003	0.439	0.000	0.001	0.972
φ_{MWFW}	93.811	[−0.041, 0.150]	0.008	0.005	0.135	0.001	0.003	0.770	0.000	0.001	0.808
φ_{FWMC}	90.879	[−0.025, 0.064]	0.000	0.002	0.987	0.000	0.001	0.815	0.001	0.000	0.129
φ_{FWFC}	98.371	[−0.008, 0.102]	−0.001	0.003	0.683	**−0.003**	**0.002**	**0.047**	0.000	0.001	0.578
φ_{FWMW}	94.137	[−0.065, 0.224]	0.002	0.008	0.780	−0.002	0.005	0.766	−0.001	0.002	0.413

MC mother-adolescent conflict, *FC* father-adolescent conflict, *MW* mother-adolescent warmth, *FW* father-adolescent warmth

Percentage = percentage of families with a standardized effect that was the same sign as the fixed effect. 95% HI = 95% Heterogeneity Interval (lower and upper bounds are the 2.5th and 97.5th percentiles of the distribution of standardized family-specific effects, respectively). Results of significant regression coefficients are in bold

of parent-adolescent interactions, and most family-specific cross-lagged effects were in the same direction as the effects for the average family. However, the *magnitude* of these effects varied considerably across families. For the autoregressive effects, families at the high end of the distribution (i.e., 97.5th percentile) showed moderate positive autoregressive effects of mother-adolescent interactions and strong positive autoregressive effects of father-adolescent interactions. This suggests that the inertia of parent-adolescent interactions was two to three times larger in some families than in the average family. In contrast, there were some families at the low end of the distribution (i.e., 2.5th percentile) that showed small negative autoregressive effects. Similarly, the cross-lagged effects showed considerable variation in size across families. For example, while the lagged effect of father-adolescent conflict on mother-adolescent conflict (i.e., φ_{FCMC}) was significantly positive for the average family ($\varphi_{FCMC} = 0.142$), some families had a moderately negative effect ($\varphi_{FCMC} = -0.264$), while others had positive effects that was more than three times the effect for the average family ($\varphi_{FCMC} = 0.529$).

Next, the potential impact of adolescent gender and age and annual household income was explored (see Table 3). Adolescent age negatively predicted the lagged effect of father-adolescent warmth on father-adolescent conflict ($\beta = -0.114$, $p = 0.047$) and family income negatively predicted the inertia of mother-adolescent warmth ($\beta = -0.135$, $p = 0.022$). All family-specific effects were independent of adolescent gender.

Discussion

Parent-adolescent relationships are shaped by day-to-day fluctuations in interactions within and between mother-adolescent and father-adolescent subsystems. Guided by family systems theory (Cox & Paley, 1997; Kunnen et al., 2019), this study examined the dynamic interplay of warmth and conflict in these relationships. As predicted, day-to-day carry-over effects were identified for all types of parent-adolescent interactions. Also consistent with the hypotheses, the dynamic processes of parent-adolescent warmth and conflict differed between fathers and mothers and varied across families. Overall, these findings highlight the importance of considering both mother-adolescent and father-adolescent dyads when examining the dynamics of parent-adolescent interactions.

Within-Family Processes of Parent-Adolescent Interactions: Fathers Matter

For the autoregressive effects, as expected, both mother-adolescent and father-adolescent interactions displayed significant inertia (i.e., the persistence of warmth and conflict from one day to the next). Notably, the differences in the magnitude of these effects between mothers and fathers were greater than anticipated. In particular, the inertia of father-adolescent warmth and conflict were two and three times greater than that of mother-adolescent warmth and conflict, respectively. The finding that mother-adolescent dynamics tend to return quickly to average levels of warmth and conflict is consistent with prior work (Mastrotheodoros et al., 2022; Wu et al., 2023). As primary caregivers, mothers and their adolescents may have ample opportunities to experience both positive and negative moments, leading them to perceive these interactions as inherently transient.

In contrast, because fathers may spend comparatively less time managing warmth and conflict, their interactions with adolescents could carry greater weight, making these experiences more salient and enduring. Extant literature on Chinese fathers supports the idea that their influence can be more persistent. For instance, Quan et al. (2024) found that while both mother and father psychological aggression was associated with adolescent anxiety on the same day, only father psychological aggression carried over to predict adolescent anxiety on the following day. Research from Western contexts further suggests that fathers tend to discourage emotional expression and respond less supportively to their children's negative emotions than mothers (Shewark & Blandon, 2015), although it remains unclear whether these findings apply to Chinese fathers. Further investigation is needed to clarify the unique role of father-adolescent interactions in Chinese families.

For the cross-lagged effects between warmth and conflict *within* mother-adolescent or father-adolescent dyads, significant lagged-day associations were found only between warmth and conflict within mother-adolescent subsystems. Specifically, mother-adolescent conflict increased mother-adolescent warmth the next day. Within mother-adolescent dyads, the positive predictive effect of conflict on warmth may reflect the greater regulatory and adaptive capacity of mother-adolescent subsystems. Mothers may have used more warmth following conflict to diffuse tension and maintain the relationship. Mothers are more involved in their adolescents' parenting across both Western and Chinese cultures (Gryczkowski et al., 2010; Li & Lamb, 2015), which not only provides mothers with more opportunities to adjust their relationships with their children, but may also facilitate the restoration of harmony with their children more quickly.

With respect to the cross-lagged effects of warmth or conflict *between* mother-adolescent and father-adolescent dyads, results indicated that higher levels of warmth and conflict between fathers and adolescents were followed by higher levels of warmth and conflict between mothers and

adolescents, respectively. This suggests that fathers may play a particularly influential role in shaping the emotional climate of Chinese parent-adolescent relationships. This finding aligns with prior research showing that father-child tension—but not mother-child tension—predicted next-day marital tension (Almeida et al., 1999), and that fathers' constructive and destructive conflict behaviors forecasted mothers' destructive conflict behaviors in the subsequent year, but not vice versa (Cheung et al., 2016). Similarly, father-child relationship satisfaction was found to predict both fathers' and mothers' coparental cooperation as well as mothers' coparental conflict two months later, whereas mother-child relationship satisfaction did not predict either parent's coparental cooperation or conflict (Peltz et al., 2018). A possible explanation for these findings is that Chinese mothers, who are generally expected to be the primary caregivers and nurturers, have clear societal expectations that help them define their family roles. These clear role expectations may enhance their ability to regulate their own emotions and maintain psychological and behavioral boundaries with other family members (Stevenson et al., 2014). In contrast, the roles of Chinese fathers are less clearly delineated, making it more difficult for them to compartmentalize their emotions and behaviors. As a result, the fathers' emotional states and interactions may spill over into other family subsystems—such as the mother-adolescent relationship—thereby influencing the overall family dynamics (Almeida et al., 1999).

For the cross-lagged effects between warmth and conflict *across* mother-adolescent and father-adolescent dyads, only a weak adverse effect of father-adolescent conflict on mother-adolescent warmth was found, suggesting a spillover effect of fathers' conflicts with adolescents to maternal warmth in family dynamics (Sears et al., 2016). Previous research also found evidence for fathers' influences on mother-adolescent subsystems. For example, Lim (2024) found that fathers' work-family conflict predicted less maternal warmth, while mothers' work-family conflict was not predictive of paternal warmth. The greater impact of fathers' negative experiences and feelings on mothers may be due to the fact that women are more empathetic to the emotions of others, especially significant others (e.g., family members), and are more able to be aware of their conflict experiences and to feel the pain of others (Yucel & Latshaw, 2020). In the context of Chinese collectivist culture, people are more closely related and interdependent, especially among family members (Li et al., 2006). Therefore, mothers' expressions of warmth may be more easily influenced by the negative experiences and feelings of fathers in the family.

More importantly, when considering all lagged effects on maternal warmth, it was found to be predicted by all types of parent-adolescent interactions in this study (i.e., warmth and conflict between both fathers and adolescents, and mothers and adolescents). This suggests that mothers, particularly regarding their warmth, are more susceptible to prior parent-adolescent interactions. Previous research has underscored the importance of adolescents' perceived warmth from parents (Bülow et al., 2022; Pinquart, 2017), especially from their mothers (Leung Ling et al., 2020). In the present study, mother-adolescent warmth was influenced by various interactions of the previous day. These findings highlight that maternal warmth may be especially responsive to the family's daily relational experiences, underscoring the need to consider this susceptibility in parenting practices and interventions.

Between-Family Differences in Parent-Adolescent Interactions: Families Vary

As anticipated, the within-family estimates had varying degrees of between-family variation. Some families had parent-adolescent subsystems that were more strongly interdependent (i.e., two or more times stronger than the average effect) and some parent-adolescent subsystems even showed a different dynamic pattern (i.e., reverse effects). Overall, however, the direction of the effects remained the same for most families. This was particularly true for those family-specific effects that had significant average effects, with 86–96% of families having the same dynamic pattern as the typical family. This suggests that family-specific effects in parent-adolescent interactions show greater variations in magnitude and greater universality in direction. Such analyses of qualitative and quantitative differences in within-family processes contribute to a better understanding of the dynamics of mother-adolescent and father-adolescent warmth and conflict in families.

The vast majority of within-family effects in parent-adolescent interactions were not predicted by adolescent age or family income. Only the lagged effect of father-adolescent warmth on conflict (though nonsignificant on average) was negatively predicted by adolescent age, and the autoregressive effect of maternal warmth was negatively predicted by family income. Thus, for the more than 98% of families with a positive lagged effect of father-adolescent warmth on conflict, the effect was weaker in families with older adolescents. It could be that older teens have had more opportunities for interaction with fathers so that their daily experiences could have less impact on later interactions.

For the nearly 90% of families with a positive autoregressive effect of maternal warmth, the effect was stronger in families with lower income. For the remaining 10% of families with a negative autoregressive effect of maternal warmth (i.e., anti-persistence or back-and-forth shifting around the average levels of maternal warmth), the effect

was stronger in families with higher income. It could be that mothers in families with lower household incomes experience stronger bonds with their children, as they rely more heavily on each other for emotional support, leading to greater persistence in warmth day-to-day. In contrast, mothers in families with relatively high incomes may not exhibit the same level of dependency. In such families, mothers might offer a different type of support that encourages independence and a broader range of emotional expressions, which can result in more variability in warmth (Conger et al., 2010). Additionally, greater academic pressure in families with relatively high incomes could contribute to lower persistence and greater variability in maternal warmth. As academic pressure is a critical source of both conflict and harsh parenting in Chinese families (Jiang et al., 2022; Kim et al., 2013), mothers in relatively high-income families may place greater academic demands on their children, which could lead to more fluctuating expressions of warmth.

It is important to note that the sample in this study predominantly consisted of families with low SES (76.3% of families had annual incomes below the regional average, and 65.6% of parents had education levels below a bachelor's degree). Thus, our findings suggest that in relatively impoverished families in Northeast China, adolescents tend to experience more intense and sustained warmth with mothers in daily interactions, whereas in families with higher incomes, these interactions may exhibit greater daily variability. However, whether this pattern can generalize to all Chinese families requires further investigation, especially given that the majority of studies on Chinese families have been conducted in highly metropolitan areas (e.g., Beijing, Shanghai, Hong Kong; Luo et al., 2021; Jiang et al., 2024).

None of the effects in parent-adolescent interactions varied by adolescents' gender. Adolescents in this study grew up in the context of China's one-child policy (implemented from 1979 to 2015), which promotes child gender equality (Lee, 2012), and thus boys and girls may have been treated more similarly than during other time periods. Another possible explanation for the limited number of significant moderating effects is that each unique family system is shaped by the interactions of factors from various sources (Boele et al., 2024; Bronfenbrenner, 2005). Thus, future research may need to comprehensively consider multiple factors at different levels (e.g., individual, family, and contextual characteristics) to explore whether and how these factors and their interplay influence the dynamic processes of warmth and conflict in parent-adolescent interactions.

Limitations and Future Directions

There are several limitations of this study that should be noted. First, the results of this study (e.g., within-family estimates) cannot be directly generalized to denser time scales. Given that mother-adolescent and father-adolescent interactions may fluctuate and interplay over several hours within a day, future research could collect ecological momentary assessment data (i.e., multiple assessments within a day) to examine the processes of warmth and conflict within families. Second, parent-adolescent warmth and conflict were reported by adolescents, and thus the results may be influenced by adolescents' subjective perceptions. Since there may be differences in adolescents' and parents' perceptions of their interactions (Janssen et al., 2021), future research could further explore whether the dynamic processes of parent-adolescent warmth and conflict differ between parents' and adolescents' perspectives. Third, to facilitate survey administration in classrooms, this study collected daily entries exclusively on weekdays. However, this approach may exclude important variability, as weekends typically offer more opportunities for parent-adolescent interactions, fostering both warmth and potential conflicts. Future research should consider collecting data on both weekday and weekend parent-adolescent interactions to gain a more comprehensive understanding of the daily dynamics of warmth and conflict across different times of the week. Finally, the relations among study variables may also have been influenced by other factors that were not assessed in this study. For instance, employment status of parents may impact parent-adolescent warmth and conflict patterns. Future work can explore demographic and other factors that may influence the nature of parent-adolescent relationships in the Chinese cultural context.

Conclusion

Parent-adolescent relationships are shaped by daily interactions involving both warmth and conflict within and between mother-adolescent and father-adolescent subsystems. However, prior research has largely focused on aggregate or long-term measures of warmth and conflict, leaving daily fluctuations in these interactions—and the distinct roles of mothers and fathers—relatively unexplored. Guided by family systems theory, this study addressed these gaps by examining how maternal and paternal warmth and conflict unfold and influence one another from day to day, as well as how these processes vary across Chinese families. Using dynamic structural equation modeling (DSEM), significant autoregressive effects were identified. Cross-lagged analyses revealed that heightened mother-adolescent conflict, increased father-adolescent warmth, and reduced father-adolescent conflict each predicted greater maternal warmth on the following day, while greater father-adolescent conflict predicted greater mother-adolescent conflict the next day. It was also found that the direction

and magnitude of these effects varied across families, with some lagged-associations moderated by adolescent age and family income. Taken together, the findings underscore the importance of considering both parental gender and family-specific differences when examining family dynamics, and highlight that maternal warmth may be especially sensitive to daily relational fluctuations within Chinese adolescent families.

Authors' Contributions X.L. performed the statistical analysis, participated in the interpretation of the data, and draft the manuscript; H.W. participated in the design and coordination of the study, interpretation of the data, and revised the manuscript; J.X. participated in the design of the study and the interpretation of the data; H.L. performed the statistical analysis and participated in the interpretation of the data; C.S. conceived of the study and helped to draft the manuscript; Z.R.H. conceived of the study, participated in its design and coordination, and helped to draft the manuscript. All authors read and approved the final manuscript.

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

Compliance with Ethical Standards

Conflict of Interest The authors report no conflict of interests.

Ethical Approval This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Faculty of Psychology, Beijing Normal University (Date. July 14, 2021/No. 202107140039).

Informed Consent Informed consent was obtained from the adolescents and their parents.

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