

Article

Parental Emotional Symptoms as a Statistical Mediator Between ADHD Symptoms and Behavior Problems: A Cross-Sectional Study in China

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Highlights

What are the main findings?

- Parental emotional symptoms as a statistically plausible mediator between children's ADHD symptoms and behavioral problems in China. While child sex did not play a significant moderating role in the pathway, a gender-specific pattern was found for peer problems, with the indirect association observed only in boys.

What are the implications of the main findings?

- Supporting parental mental health can be considered in the intervention strategies for children with ADHD symptoms.

Abstract

Background: Children with Attention Deficit Hyperactivity Disorder (ADHD) often face behavioral challenges, which may be exacerbated through bidirectional parent–child interactions. Sex differences and cultural context may further shape this pathway. This study aims to examine these relationships among children's ADHD symptoms, behavioral problems, and parental emotions (anxiety and depression) within China, testing whether parental emotions serve as a mediator and exploring potential differences across child sex. **Methods:** A path analysis was conducted among children's ADHD symptoms, children's behavioral problems, and parental emotional symptoms. Children's ADHD symptoms were measured using the Swanson, Nolan, and Pelham version IV scale-parent form (SNAP-IV), while the Strengths and Difficulties Questionnaire (SDQ) assessed behavioral problems. Parental emotional symptoms were measured with the Patient Health Questionnaire-9 (PHQ-9) and Generalized Anxiety Disorder-7 (GAD-7) scales. All questionnaires are in Chinese. **Results:** The direct, indirect, and total associations of children's ADHD symptoms on behavioral problems were significant in all models. In the full model, the indirect association, defined through parental emotional symptoms, was estimated at 0.206 (95% CI:



Academic Editors: Yi Song and Diego Gomez-Baya

Received: 14 November 2025

Revised: 8 February 2026

Accepted: 27 February 2026

Published: 5 March 2026

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0.157–0.262). The indirect pathway constituted 27.3% of the total association. **Conclusions:** Parental emotional symptoms are associated with both children's ADHD symptoms and their behavioral problems, indicating a potential pathway warranting further investigation. Child sex does not play a significant moderating role in the path, but an indirect association from ADHD symptoms to peer problems is observed in boys, not girls.

Keywords: ADHD; problem behavior; mental health; self-report; latent class analysis; structural equation modeling

1. Introduction

Attention deficit hyperactivity disorder (ADHD) is a prevalent neurodevelopmental disorder characterized by inattention, hyperactivity, and impulsivity, with a global prevalence of 5.29% [1,2]. The diagnosis is more common in boys than girls, with a ratio of roughly 2–2.5:1 [3,4]. In China alone, an estimated 21.99 million individuals were affected in 2019, accompanied by rising incidence rates and disability-adjusted life years (DALYs) since 1990 [5]. ADHD poses substantial challenges not only to the diagnosed individuals, but also to their families and society, making it a critical public health concern [1,2,6,7].

Children with ADHD are about three times more likely to exhibit comorbid emotional symptoms, behavioral issues, and peer relationship difficulties than their peers [8]. While the impact of these comorbidities on well-being is well documented, the complex family dynamics characterizing these associations remain incompletely understood [9]. Sameroff's transactional model provides a robust framework for conceptualizing these interrelations, emphasizing the continuous, reciprocal interactions between a child and their environment [10,11]. Although the model describes developmental processes over time, it effectively highlights the necessity of examining child and parent factors simultaneously. Within this framework, parental emotional symptoms may serve as a key factor associated with child outcomes. Specifically, bidirectional parent–child interactions suggest that ADHD symptoms can elevate parenting stress and exacerbate parental anxiety and depression [12–19], which in turn may potentially worsen behavioral issues in children [20–22]. However, prior studies have examined these associations in isolation, leaving a fragmented understanding of how these factors operate conjointly within the family system. This isolationist approach fails to capture how parental emotional symptoms may function as a connective pathway linking child ADHD symptoms to broader behavioral outcomes. Consequently, there is a paucity of research that integrates these factors into a cohesive framework to explicitly examine the extent to which parental emotions account for the association between ADHD symptoms and child behavioral problems.

This potential integrated pathway may be further nuanced by child sex and cultural context. Biological and socialization differences suggest potential sex differences. Girls with ADHD often present with more inattentive symptoms, whereas boys display more hyperactive-impulsive behaviors [23]. Moreover, parental perceptions are subject to sex-based bias, in which parents tend to overestimate hyperactivity and impulsivity symptoms in boys but underestimate them in girls [24]. Maternal guidance and concern are also reported to be higher for boys with ADHD than for girls with the disorder [25]. Culturally, parenting norms emphasize academic achievement and behavioral discipline, which can lead to increased stress for parents of children with ADHD [26]. Moreover, cultural stigmas associated with behavioral disorders may intensify parents' feelings of shame and self-blame, thereby compounding their emotional burden [27].

To address the need for a systemic perspective, this study utilizes cross-sectional data collected during the COVID-19 pandemic to examine the relationships among chil-

dren's ADHD symptoms, behavioral problems, and parental emotions in a Chinese context. Informed by the transaction model as a heuristic framework, we adopt a path analysis framework to examine these variables not as isolated correlates, but as components of an integrated system. We explicitly interpret all paths as correlational rather than causal, acknowledging that our cross-sectional design captures a static 'snapshot' of these associations rather than the dynamic, reciprocal processes. Specifically, we hypothesize that (1) parental emotional symptoms (anxiety and depression) serve as a statistical partial mediator in the association between children's ADHD symptoms and their behavioral problems; and (2) child sex plays a moderating role in the pathway. By exploring these potential mechanisms, the study aims to provide preliminary insights that could inform the emotional regulation components of future family-based interventions.

2. Materials and Methods

2.1. Study Population and Data Collection Procedure

This cross-sectional study was conducted among students in grades 2 to 5 at a primary school in Hubei Province, China, from June to July in 2020. Participants were recruited from the Tongji Mental Health Cohort Study using convenience sampling. Data collection was administered entirely online via the WJX platform (<http://www.wjx.cn>, accessed on 15 August 2020). Parents completed a comprehensive digital questionnaire covering demographics, parental mental health, child's ADHD symptoms, and child's behavioral difficulties in one continuous session, with an estimated completion time of 20–40 min.

A total of 2710 parents of these students were invited to complete the questionnaire, yielding 2425 valid responses. The effective response rate is 89.5%. All participants provided electronic informed consent, and confidentiality was strictly assured. This study protocol was approved by the Ethics Committee of Tongji Medical College, Huazhong University of Science and Technology ([2020] S062).

2.2. Demographic Information

Demographic information collected included the child's sex, child's age, parental education level, and family income. Parental education level was recorded using five levels: "junior high school or below," "high school," "associate degree," "undergraduate degree," and "postgraduate degree or above." Family annual income was collected in six tiers (in RMB): <¥50,000; ¥50,000–100,000; ¥100,000–150,000; ¥150,000–200,000; ¥200,000–300,000; and ≥¥300,000.

2.3. Instrument

2.3.1. Parental Mental Health Symptoms

Parental depressive symptoms were assessed using the Patients' Health Questionnaire-9 (PHQ-9) [28], a 9-item self-report scale rated symptom frequency on a 4-point Likert scale (0–3). Total scores range from 0 to 27, with higher scores indicating greater depression severity. The severity categories are defined as: no (0–4), mild (5–9), moderate (10–14), and severe (15–27). The Chinese version of the PHQ-9 has demonstrated good reliability and validity [29], with a Cronbach's α coefficient of 0.842 in the present study.

Parental anxiety symptoms were evaluated using the Generalized Anxiety Disorder scale-7 item (GAD-7) [30], a 7-item instrument utilizing a 4-point Likert scale (0–3). The severity categories are defined as: no (0–4), mild (5–9), moderate (10–14), and severe (15–21). The Chinese version of GAD-7 has demonstrated good reliability and validity [31], with a Cronbach's α coefficient of 0.878 in the present study.

2.3.2. Children's ADHD Symptoms

Children's ADHD symptoms were measured using the Swanson, Nolan, and Pelham version IV scale-parent Form (SNAP-IV) [32]. The 26-item scale assesses symptoms on a 4-point Likert scale (0–3), and comprises three distinct subscales: inattention, hyperactivity/impulsivity, and oppositional defiant disorder. Elevated scores on the inattention and hyperactivity/impulsivity subscales, along with the overall total score, indicate more severe ADHD symptoms. For screening purposes, a child is considered to exhibit ADHD symptoms if they score 2 or 3 on six or more items in either the inattention or hyperactivity/impulsivity subscales. Cronbach's α coefficient was 0.938 in the present study.

2.3.3. Children's Behavioral Difficulties

The Strengths and Difficulties Questionnaire (SDQ) for parents, a 25-item behavioral screening questionnaire, was used to evaluate a wide range of behavioral dimensions in children [33]. The 25 SDQ items are divided into 5 subscales: emotional symptoms, conduct problems, hyperactivity/inattention, peer problems, and prosocial behaviors. Each item is rated on a 3-point Likert scale (0–2). The first four scales are summed to generate a total difficulties score, with higher scores indicating greater behavioral difficulties. The prosocial behaviors scale is conceptually distinct from psychological problems; therefore, this scale was not included in the follow-up analysis. Cronbach's α coefficient was 0.741 in the present study.

2.4. Statistical Analysis

2.4.1. Descriptive Statistics

Descriptive statistics were used to summarize participants' characteristics. Categorical variables are presented as frequencies and percentages (%), while continuous variables are reported as mean $\pm$ standard deviation (SD) for normally distributed data or median (interquartile ranges; IQR) for non-normally distributed data (reported as P_{50} [P_{25} , P_{75}]). Students' *t*-tests, Mann–Whitney U tests, and Pearson's chi-squared tests were employed to compare demographic characteristics, parental mental health problems, and children's behavioral difficulties between those with and without ADHD symptoms. In addition, the association among the variables was assessed through Spearman bivariate correlation analysis.

To facilitate group comparisons, given the uneven sample size, parental educational level was dichotomized into "high school or less" and "beyond high school." Family income was consolidated into three tiers: <¥100,000, ¥100,000–200,000, and >¥200,000 (equivalent to approximately <\$14,500, \$14,500–29,000, or >\$29,000/year, based on the 2020 average exchange rate of 1 USD = ¥6.8974). The original distributions of these variables are provided in Table S1.

2.4.2. Path Analysis

Structural equation modeling (SEM) was employed to examine associative pathways among children's ADHD symptoms, parental emotional symptoms, and behavioral problems, adjusting for sex, age, parental education level, and family income. Separate models were stratified by sex to explore potential sex differences.

Children's ADHD symptoms were modeled as a latent variable, with the hyperactivity/impulsivity and inattention subscales of the SNAP-IV serving as observed variables. Parental emotional symptoms were modeled as another latent variable, with depression and anxiety symptoms as observed variables. Children's behavioral problems were modeled as a separate latent variable, with emotional symptoms, conduct problems, and peer problems from the SDQ serving as observed variables. To avoid redundancy and ensure accurate

representation of the hypothesized relationships, the hyperactivity/inattention subscale of SDQ was excluded from the latent variable construction for children's behavioral problems.

Path analysis was performed using Children's ADHD symptoms as the independent variable, children's behavioral problems as the dependent variable, and parental emotional symptoms as the mediator. Given the cross-sectional nature of the data, it is crucial to clarify the terminology used in this report. Terms such as mediator and indirect association are used strictly in their statistical sense to describe the partitioning of variance within the specified path analysis model. These terms refer to the mathematical operation of the statistical model and do not imply temporal precedence, causality, or confirmed biological mechanisms.

The multi-group invariance test was conducted to assess the possible moderating role of sex. Chi-squared tests were used to compare the unconstrained, measurement weights, and structural weights models. Invariance is supported if $p > 0.05$ for the χ^2 difference test [34] or the changes in fit indices ($\Delta CFI < 0.01$, $\Delta RMSEA < 0.015$) [35]. Finally, critical ratios for differences were further employed to statistically compare specific regression paths between boys and girls.

Missing data for covariates (parental educational level and family income) were handled using multiple imputations (5 datasets) via the mice package in R. Imputation diagnostics, including trace plots, density plots, and strip plots, are presented in Figure S1.

2.4.3. Common Method Bias Test

Potential common method bias was assessed using Harman's single-factor test [36] and the unmeasured latent method construct (ULMC) [37]. Harman's test indicated that the first factor from an unrotated exploratory factor analysis accounted for 20.66% of the total variance, which is below the critical threshold of 40% [38] (see Table S2 for details). The ULMC results indicated that, compared with a single-factor model, the improvement in model fit is limited after introducing an unmeasured common method factor ($\Delta\chi^2/df = 1.022$, $\Delta CFI = 0.027$, $\Delta RMSEA = 0.004$; see Table S3 for details). These results suggest that common method bias didn't substantially confound the findings in the current study.

2.4.4. Sensitivity Analyses

In sensitivity analysis, a series of sensitivity analyses were conducted to assess the robustness of the findings: (1) modeling SDQ subdomains (emotional problems, conduct problems, and peer problems) as separate observed variables in the path analysis; (2) comparing the primary model to one that included the SDQ hyperactivity/inattention subscale; (3) testing the model separately within the ADHD-symptom-positive and negative subgroups (due to the sample size in the ADHD-positive group, a simplified specification was adopted: the SDQ subscale scores (emotional problems, conduct problems, peer problems) were used as observed variables); and (4) re-evaluated the model with different sets of confounders to assess the impact of covariates, including before and after imputation.

2.4.5. Statistical Software

The bootstrapping method, involving 1000 iterations, was employed to generate bias-corrected 95% confidence intervals for the association coefficients. For imputed data, coefficient sizes were pooled according to Rubin's rules. The criterion for statistical significance was set at $p < 0.05$. SPSS 26.0, Amos 28.0, and R 4.4.1 software were used for data analysis.

This study was not pre-registered. The primary analyses (structural equation modeling examining associations among ADHD symptoms, parental emotions, and child behavior)

were planned a priori. Sensitivity analyses (e.g., sex-stratified models, subdomain-specific effects) were exploratory and conducted after initial data inspection.

3. Results

3.1. Descriptive Characteristics of the Participants

The descriptive characteristics of the participants are summarized in Table 1. A total of 2425 students were included in the study, comprising 1338 boys (55.2%) and 1087 girls (44.8%). The average age of the children was 10.84 ± 1.75 years. Regarding parental education, 30.8% (529) of fathers and 27.8% (477) of mothers had attained an education level beyond high school, whereas 1187 fathers (69.2%) and 1239 mothers (72.2%) had a high school education or less. Family income distribution showed 15.0% of families (257) reported less than \$14,500 annually, 66.5% (1141) earned between \$14,500 and \$29,000, and 18.5% (318) had an income of \$29,000 or more.

Table 1. Demographic characteristics of the participants, categorized by ADHD symptoms group ($n = 2425$).

Characteristic	Total Mean $\pm$ SD/ n (%)	ADHD Symptoms Group		t/χ^2	p -Value
		Yes ($n = 116$) Mean $\pm$ SD/ n (%)	No ($n = 2309$) Mean $\pm$ SD/ n (%)		
Age (years)	10.84 ± 1.75	10.70 ± 1.69	10.85 ± 1.75	0.360	0.387
Sex				5.269	0.022
Boys	1338 (55.2%)	76 (65.5%)	1262 (54.7%)		
Girls	1087 (44.8%)	40 (34.5%)	1047 (45.3%)		
Father's education level				0.178	0.673
High school or less	1187 (69.2%)	55 (67.1%)	1132 (69.3%)		
Beyond high school	529 (30.8%)	27 (32.9%)	502 (30.7%)		
Mother's education level				2.142	0.143
High school or less	1239 (72.2%)	65 (79.3%)	1174 (71.8%)		
Beyond high school	477 (27.8%)	17 (20.7%)	460 (28.2%)		
Family income (Dollars/Year)				3.468	0.177
<14,500	257 (15.0%)	12 (14.6%)	245 (15.0%)		
14,500–29,000	1141 (66.5%)	61 (74.4%)	1080 (66.1%)		
$\geq 29,000$	318 (18.5%)	9 (11.0%)	309 (18.9%)		

In this study, 4.78% (116) of the children screened positive for ADHD symptoms. Children with ADHD symptoms had a mean age of 10.70 ± 1.69 years, and 65.5% (76) were boys. Among these children, 32.9% of fathers and 20.7% of mothers had education beyond high school, while 74.4% belonged to families with an annual income of more than \$14,500. Comparisons between children with and without ADHD symptoms revealed no significant differences in age, family income, or parental education between children with and without ADHD symptoms (all $p > 0.05$). However, a significant sex difference was observed ($p = 0.022$), with a higher proportion of boys (65.5%) in the ADHD symptoms group compared to the non-ADHD symptoms group (54.7%).

3.2. Associations Among Children's ADHD Symptoms, Parental Emotional Symptoms, and Children's Behavioral Problems

Table 2 shows that children who screened positive for ADHD symptoms had higher levels of behavioral problems compared to their peers without ADHD symptoms. Their SDQ scores were higher for emotional symptoms (3.05 ± 1.91 vs. 1.55 ± 1.59 , $p < 0.001$),

conduct problems (3.08 ± 1.46 vs. 1.65 ± 1.24 , $p < 0.001$), and peer problems (2.78 ± 1.49 vs. 2.33 ± 1.44 , $p = 0.001$). Regarding parental emotional symptoms, parents of children with ADHD symptoms reported significantly higher levels of both anxiety symptoms (5.97 ± 4.56 vs. 2.50 ± 2.99 , $p < 0.001$) and depression symptoms (5.84 ± 5.15 vs. 1.92 ± 2.97 , $p < 0.001$).

Table 2. Associations among parental emotional symptoms, children’s behavioral problems, and ADHD symptoms ($n = 2425$).

Variable	Total Mean $\pm$ SD/P ₅₀ (P ₂₅ , P ₇₅)	ADHD Symptoms Group		<i>t/U</i>	<i>p</i> -Value
		Yes (<i>n</i> = 116) Mean $\pm$ SD/P ₅₀ (P ₂₅ , P ₇₅)	No (<i>n</i> = 2309) Mean $\pm$ SD/P ₅₀ (P ₂₅ , P ₇₅)		
Parental emotional symptoms					
Anxiety symptoms ^a	2 (0, 4)	5 (3, 8.75)	1 (0, 4)	−9.090	<0.001
Depression symptoms ^a	1 (0, 3)	5 (1, 9)	1 (0, 3)	−9.583	<0.001
Children’s behavioral problems					
Emotional symptoms ^a	1 (0, 2)	3 (1.25, 4)	1 (0, 2)	−8.509	<0.001
Conduct problems ^b	1.72 $\pm$ 1.29	3.08 $\pm$ 1.46	1.65 $\pm$ 1.24	−10.329	<0.001
Peer problems ^b	2.35 $\pm$ 1.44	2.78 $\pm$ 1.49	2.33 $\pm$ 1.44	−3.247	0.001

^a: Mann–Whitney U test was used. ^b: *t* test was used.

Table S4 further illustrates that children’s ADHD symptoms were significantly correlated with both parental emotional symptoms and children’s behavioral problems (r ranged from 0.113 to 0.669, all $p < 0.001$). Additionally, parental emotional symptoms were strongly associated with children’s behavioral issues. The correlation analysis preliminarily supported the relationships among the study variables in the proposed model.

3.3. Path Analysis and Coefficients Estimate

Figure 1 illustrates the hypothesized associative pathways among variables, with the regression coefficients displayed. As shown in Table S5, the full and sex-stratified models fit were adequate.

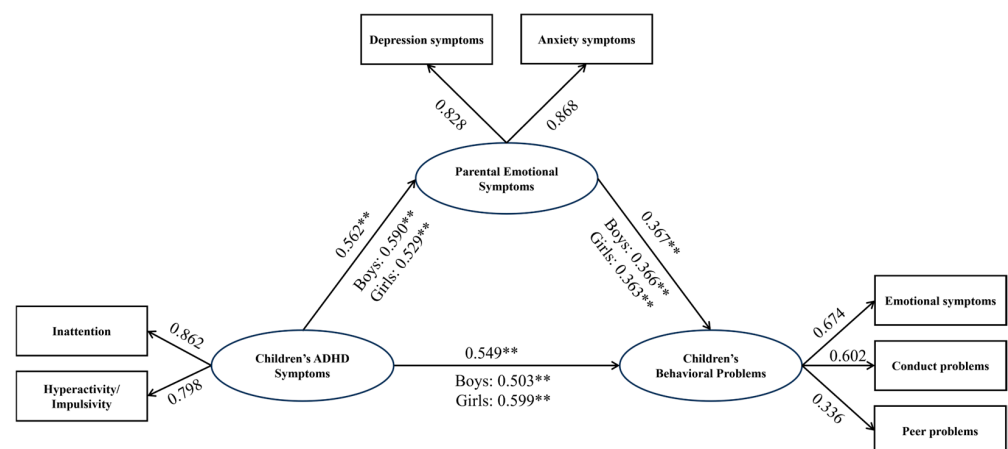


Figure 1. Path analysis among parental emotional symptoms, children’s ADHD symptoms, and behavioral problems. Note: Standardized structural equation model (full model and sex-stratified model). Adjusted for sex (in the full model), age, parental education level, and family income. **: p -value < 0.01 .

As depicted in Table 3, children's ADHD symptoms demonstrated robust cross-sectional associations with behavioral problems across all models, with standardized coefficients of $\beta = 0.549$ ($p < 0.01$) in the full sample, $\beta = 0.503$ ($p < 0.01$) in boys, and $\beta = 0.599$ ($p < 0.01$) in girls. Similarly, the relationship between children's ADHD symptoms and parental emotional symptoms was significant in the full and sex-stratified models (β is 0.562 in the full model, 0.590 in boys, and 0.529 in girls, all $p < 0.01$). Moreover, parental emotional symptoms showed consistent positive associations with children's behavioral problems (β ranged from 0.363 to 0.367 across the three models, all $p < 0.01$).

Table 3. Path analysis among parental emotional symptoms, children's ADHD symptoms, and behavioral problems.

Path	β ^a	SE ^b	95%CI ^c		<i>p</i> -Value
			Lower	Upper	
Full model (<i>n</i> = 2425) ^d					
ADHD symptoms → Behavioral problems	0.549	0.044	0.463	0.627	0.004
ADHD symptoms → Parental emotional symptoms	0.562	0.027	0.506	0.614	0.002
Parental emotional symptoms → Behavioral problems	0.367	0.044	0.287	0.459	0.002
Boys (<i>n</i> = 1338) ^e					
ADHD symptoms → Behavioral problems	0.503	0.058	0.383	0.612	0.002
ADHD symptoms → Parental emotional symptoms	0.590	0.029	0.531	0.648	0.002
Parental emotional symptoms → Behavioral problems	0.366	0.057	0.248	0.470	0.002
Girls (<i>n</i> = 1087) ^e					
ADHD symptoms → Behavioral problems	0.599	0.060	0.477	0.716	0.002
ADHD symptoms → Parental emotional symptoms	0.529	0.043	0.435	0.609	0.003
Parental emotional symptoms → Behavioral problems	0.363	0.069	0.217	0.499	0.003

^a: Standardized point estimate. ^b: Bootstrap standard error. ^c: Bias-corrected confidence interval. ^d: Adjusted for sex, age, parental education level, and family income. ^e: Adjusted for age, parental education level, and family income.

Table 4 summarizes indirect associations via parental emotional symptoms. The direct, indirect, and total association of children's ADHD symptoms on behavioral problems were significant in the full model, the boys model, and the girls model. In the full model, the indirect pathway from ADHD symptoms to behavioral problems was 0.206 (95% CI: 0.157–0.262), statistically represented 27.3% of the total association. Similar patterns emerged in sex-stratified analyses, where the indirect pathway statistically represented 30.0% of the total association in boys and 24.3% in girls. The multiple-group measurement invariance test suggests potential sex differences in the model's structural paths (structural weight invariance was rejected, $p < 0.001$ and $\Delta CFI > 0.01$; see Table S6). However, pairwise parameter comparisons confirmed that no significant moderation effects were found for the hypothesized paths (Z-scores of -0.01 , 0.198 , and 1.248 , all $|Z| < 1.96$). Therefore, sex did not significantly moderate the core indirect associations in this model.

3.4. Sensitivity Analysis

To explore subdomain-specific associations, emotional symptoms, conduct problems, and peer relationships were analyzed as separate observational variables, as shown in Figure S2 and Table S5. In the full model, indirect associations via parental emotional symptoms were statistically significant for all three subdomains (all $p < 0.01$). Sex-stratified analyses revealed that emotional and conduct problems showed significant indirect associations in both boys and girls ($p < 0.01$). Notably, for peer relationship, the indirect association was significant in boys ($p = 0.002$) but not in girls ($p = 0.082$). Measurement invariance testing further indicated that the model for peer problems was equivalent across sex, suggesting no significant moderation in these structural paths (Table S6).

Table 4. Standardized direct, indirect, and total association.

Mediator: Parental Emotional Symptoms	β ^a	SE ^b	Bootstrapping		<i>p</i> -Value	Statistical Indirect Proportion
			95% CI ^c			
			Lower	Upper		
Full model (<i>n</i> = 2425) ^d						27.3%
Total association	0.755	0.031	0.690	0.811	0.004	
Direct association	0.549	0.044	0.463	0.627	0.004	
Indirect association	0.206	0.027	0.157	0.262	0.002	
Boys (<i>n</i> = 1338) ^e						30.0%
Total association	0.719	0.045	0.623	0.801	0.003	
Direct association	0.503	0.058	0.383	0.612	0.002	
Indirect association	0.216	0.034	0.146	0.278	0.002	
Girls (<i>n</i> = 1087) ^e						24.3%
Total association	0.791	0.036	0.715	0.861	0.002	
Direct association	0.599	0.060	0.477	0.716	0.002	
Indirect association	0.192	0.042	0.115	0.276	0.003	

^a: Standardized point estimate. ^b: Bootstrap standard error. ^c: Bias-corrected confidence interval. ^d: Adjusted for sex, age, parental education level, and family income. ^e: Adjusted for age, parental education level, and family income. Total association: ADHD symptoms → Behavioral problems. Direct association: ADHD symptoms → Behavioral Problems. Indirect association: ADHD symptoms → Parental emotional symptoms → Behavioral problems.

Second, an alternative model specification was examined by including the SDQ hyperactivity/inattention subscale within the latent variable for children's behavioral problems (Figure S2 and Table S7). Despite the potential for conceptual overlap, the indirect association remained statistically significant ($\beta = 0.121$, indirect proportion = 13.7%). Third, a simplified path model with observed SDQ scores as the independent variable was tested (Table S7). The total and indirect association coefficients are lower than in the primary latent variable model (e.g., total $\beta = 0.546$ vs. 0.755, indirect $\beta = 0.153$ vs. 0.206), but the statistical indirect proportion is stable (28% vs. 27.3%). Within the ADHD-symptom-positive subgroup, the indirect association remained significant, with $\beta = 0.069$ (indirect proportion = 16.1%). Finally, analyses adjusting for different sets of covariates also showed the statistical significance of the indirect association (β ranged from 0.179 to 0.214). Across all tested models, the indirect pathway statistically represented 22.6–29.6% of the total association in the full sample (see Table S8).

In summary, the findings suggest that the hypothesized relationship was robust across different model specifications, outcome operationalizations, subgroups, and covariate adjustments.

4. Discussion

The primary aim of this study was to examine the relationships among child ADHD symptoms, parental emotions, and child behavioral problems within a Chinese context, informed by the transactional model as a heuristic framework. A key finding is that parental emotional symptoms serve as a significant statistical mediator in this association. Path analysis showed that the indirect association via parental emotional symptoms statistically represented 27.3% of the total association between ADHD symptoms and behavioral problems, which underscores that parental emotional well-being is a prominent component of the shared variance in this family system. This suggests that supporting parental mental health might be a relevant aspect of comprehensive care, although causal inferences are limited by our cross-sectional design.

4.1. Parental Emotional Symptoms as a Potential Mediating Mechanism

The observed indirect association is consistent with the theoretical expectations of the transactional model, which posits that child characteristics and parental functioning influence one another [11]. In terms of the impact on parents, high ADHD symptom severity in children is often associated with behavioral dysregulation and noncompliance, which may contribute to elevated parental stress, anxiety, and depression [39–41]. This distress might be further amplified by affiliate stigma and economic burdens associated with managing the disorder [42–45]. Additionally, healthcare expenses and caregiving demands may also impose financial strain and potential income loss on parents. These challenges might have been further intensified during the COVID-19 pandemic, when many parents experienced heightened stress, burnout, and anger, alongside diminished social support [46,47]. Pandemic-related disruptions in children's routines were also significantly associated with increased caregiver stress [47], thereby contributing to a vicious cycle of emotional exhaustion and reduced coping capacity. It is also important to recognize that since ADHD symptoms were assessed via parent-report, parental emotional distress may itself influence the perception and endorsement of child symptoms. However, regardless of whether these reports reflect objective behavior or subjective perception, the association represents a meaningful burden within the family system.

Furthermore, compromised parental mental health may be linked to difficulties in parenting competence, potentially worsening children's behavioral problems. According to the model, parents who may feel overwhelmed by anxiety or depression may struggle to provide the consistent emotional support, warmth, and responsiveness that children with elevated ADHD symptoms require [12,13,18,48]. Parental emotional symptoms, such as helplessness, irritability, and withdrawal, can hinder implementation of positive parenting strategies, thereby potentially exacerbating the child's behavioral problems [12]. Although our data cannot capture the real-time dynamics of these reciprocal processes, the observed pathway underscores the vital interdependence of child and parent well-being, suggesting that effective intervention may require an integrated focus on both.

4.2. Sex-Specific Patterns in Associations

Regarding child sex, our formal multi-group invariance tests indicated that the structural pathways were equivalent across boys and girls for both the overall model and the subdomain models. This suggests that, statistically, sex does not significantly moderate the mechanism of family transmission. However, exploratory analyses within subdomains revealed a nuanced pattern of significance: the indirect path from ADHD symptoms to peer problems via parental emotional symptoms reached statistical significance in boys but did not in girls. Given the confirmed invariance, this discrepancy implies a difference in statistical significance thresholds rather than a fundamental difference in the underlying mechanism. Nevertheless, from a sex-informed perspective, this pattern warrants attention. Girls with ADHD often present with inattentive symptoms that are less disruptive [23] and are frequently under-recognized by parents and teachers [24]. In contrast, hyperactive/impulsive behaviors in boys may be somewhat more tolerated [4,24,49]. Societal expectations also dictate that girls should exhibit greater compliance, emotional restraint, and social grace [42]. Thus, girls with ADHD symptoms may face more rigorous scrutiny from peers, and their greater investment in interpersonal relationships may exacerbate difficulties in peer functioning [50,51]. Consequently, while the indirect pathway appears structurally universal, the difference in peer problems may be more pronounced in boys within this sample.

4.3. The Role of Cultural Context

While specific cultural constructs were not empirically measured in this study, the Chinese cultural context provides a critical backdrop for interpreting these associations. Currently, only about 10% of children with ADHD in China receive a formal diagnosis or treatment [9], compared to roughly three-quarters of children with ADHD in the United States who receive behavioral intervention or medication [52]. The lower awareness of ADHD in China means that parents often lack a neurodevelopmental framework to understand their children's challenges [53]. Furthermore, traditional Chinese cultural values emphasize compliance, self-discipline, and focused behavior, as well as a strong emphasis on academic achievement in children [27,54]. Within such a context, it is plausible that behavioral problems are more frequently interpreted as a result of poor parenting or inadequate discipline, in which parents often face social stigma [27,55,56]. This cultural lens offers a theoretical explanation for the association between child ADHD symptoms and parental emotional distress observed in our sample.

4.4. Limitations

This study has several limitations. First, the cross-sectional design cannot establish the temporal sequence of variables or causality. We therefore emphasize that the observed indirect associations reflect statistical patterns rather than causal pathways. Second, the reliance on single-informant parent reports for all focal constructs is a key limitation that may introduce shared method variance and reporting biases. Although we applied statistical controls, these cannot fully substitute for multi-informant designs. Future studies should incorporate multi-informant data (e.g., teacher reports) to validate these findings. Third, ADHD symptoms were reported by parents rather than a clinical diagnosis, and the sample size of the ADHD symptoms group was relatively small. Fourth, cultural factors were not objectively measured. The interpretations, while grounded in prior literature, remain speculative and highlight the need for future research that directly measures cultural factors (e.g., stigma, parenting values) to examine their specific roles. Fifth, the study was conducted in a single primary school, which may restrict the generalizability of the results. Although this school served a diverse urban population with broad socioeconomic status (Table S1), caution is warranted when extrapolating these results to other contexts. Finally, there may be unmeasured confounding factors, such as parental histories of other psychopathologies.

5. Conclusions

In conclusion, our study suggests that parental emotional symptoms serve as a statistical mediator linking children's ADHD symptoms and behavioral problems within a Chinese sample. These results underscore the importance of addressing parental mental health as a potential component of intervention strategies aimed at mitigating behavioral difficulties associated with ADHD. Additionally, while child sex did not act as a statistical moderator in this pathway, sex-specific patterns in peer problems suggest the value of a sex-informed perspective.

Future research employing longitudinal designs is necessary to establish temporal precedence and causality. Furthermore, integrating multi-informant assessments, clinical diagnoses, and direct measures of cultural factors will be essential to deepen the understanding of these transactional family processes and to inform more tailored support strategies.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/future4010010/s1>, Figure S1: Strip (A), trace (B), and density

(C) strip plots from multiple imputation; Figure S2: Standardized structural equation model (full model and sex-stratified model); Figure S3: Standardized structural equation model (hyperactivity/inattention within the children's behavioral problems latent variable); Table S1: Demographic characteristics of the participants, categorized by ADHD symptoms group ($n = 2425$); Table S2: Total variance explained by unrotated exploratory factor analysis; Table S3: Model fit comparison between the single-factor model and the addition of a common method factor model; Table S4: Spearman correlations among children's ADHD symptoms, parental emotional symptoms, and children's behavioral problems ($n = 2425$); Table S5: Summary of full and sex-stratified models fit; Table S6: Tests of multiple-group measurement invariance by sex; Table S7: Path analysis in various models and subgroups; Table S8: Path analysis, adjusting for different confounding factors.

Author Contributions: Formal analysis: J.T. and J.Z.; investigation: J.Z., X.W., T.W., X.L., Z.X., L.Y. and R.S.; resources: L.Y. and R.S.; writing—original draft: J.T. and J.Z.; writing—review & editing: J.T., J.Z., X.W., T.W., X.L., Z.X., L.Y. and R.S.; supervision: L.Y. and R.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Tongji Medical College, Huazhong University of Science and Technology (approval code: [2020] S062, approval date: 26 March 2020).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The authors will supply the relevant data in response to reasonable requests.

Acknowledgments: We extend our heartfelt gratitude to all the parents of students who took part in the survey.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

ADHD	Attention Deficit Hyperactivity Disorder
CI	Confidence Interval
DALYs	Disability-adjusted Life Years
GAD-7	Generalized Anxiety Disorder-7
PHQ-9	Patient Health Questionnaire-9
SDQ	Strengths and Difficulties Questionnaire
SE	Standard Error
SEM	Structural Equation Modeling
SNAP-IV	Swanson, Nolan, and Pelham Version IV

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