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Perceived Family Functioning, Family Resilience, and Multidimensional Sleep Problems Among Chinese Children and Adolescents With Cancer: The Indirect Association of Depression and Anxiety

Zhe Li¹  | Chaoran Hu²  | Lijia Yao³ | Yifei Wang¹  | Zhuoyu Yang¹ | Xiaoning Wang⁴  | Xin Ni¹

¹National Center for Pediatric Cancer Surveillance, National Center for Children's Health, Beijing Children's Hospital, Capital Medical University, Beijing, China | ²State Key Laboratory of Media Convergence and Communication, Communication University of China, Beijing, China | ³Department of Pediatric Cancer Surveillance Project, Beijing To You PrimeKid Nexus Technologies Co. Ltd., Beijing, China | ⁴School of Data Science and Media Intelligence, Communication University of China, Beijing, China

Correspondence: Xiaoning Wang (sdwangxiaoning@cuc.edu.cn) | Xin Ni (ncpcs@bch.com.cn)

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ABSTRACT

Background: Multidimensional sleep problems are prevalent among children and adolescents with cancer. Although perceived family functioning and family resilience are known to be associated with sleep problems, the contributions of depression and anxiety remain unquantified.

Aims: To examine associations of perceived family functioning and family resilience with multidimensional sleep problems and quantify indirect associations through depression and anxiety among Chinese children and adolescents undergoing active cancer treatment.

Methods: This cross-sectional study used baseline data from 518 patients aged 7 to <18 years in the Chinese Childhood Cancer Survivorship Wellbeing Cohort. Perceived family functioning and family resilience were assessed using the Family APGAR Questionnaire and Family Hardiness Index, respectively. Depression and anxiety were measured using the pediatric PROMIS scales, and multidimensional sleep problems were assessed using the BEARS Sleep Screening Scale. A mutually adjusted, multiple-predictor parallel mediation model used 5000 bootstrap resamples and adjusted for sociodemographic and clinical covariates. A parallel indirect-association sensitivity analysis with the BEARS summed score modeled as a Poisson count outcome was performed.

Results: Perceived family functioning was negatively correlated with anxiety ($r = -0.341$), depression ($r = -0.355$), and sleep problems ($r = -0.240$), and family resilience was negatively correlated with anxiety ($r = -0.283$), depression ($r = -0.311$), and sleep problems ($r = -0.222$; all $p < 0.001$). After depression and anxiety were included, perceived family functioning remained directly associated with fewer sleep problems ($B = -0.061$, $p < 0.05$), with a significant total indirect association ($B = -0.048$, bias-corrected 95% bootstrap CI: -0.071 to -0.028). Family resilience showed a nonsignificant direct association but a significant total indirect association ($B = -0.010$, bias-corrected 95% bootstrap CI: -0.016 to -0.004).

Conclusions: Depression and anxiety showed significant indirect associations between family protective factors and sleep problems. Interventions addressing family dynamics and psychological distress may improve sleep outcomes.

Zhe Li and Chaoran Hu contributed equally.

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1 | Introduction

Multidimensional sleep problems, affecting 40%–80% of children and adolescents with cancer, are highly prevalent and persistent, adversely impacting treatment adherence and quality of life [1–3]. These problems may persist into long-term survivorship, with at least 20% of survivors showing greater inattention and poorer executive function than population norms, underscoring the need to identify modifiable risk factors [4, 5].

While disease progression and treatment-related factors are well-established contributors to sleep disturbances [6–8], emerging evidence from a biopsychosocial perspective highlights family protective factors as critical yet underexplored determinants of sleep problems [9, 10]. Family systems theory posits that well-functioning families—characterized by effective communication, emotional responsiveness, and adaptive problem-solving [11]—can foster children's and adolescents' emotional security and self-regulation, thereby promoting sleep health [12]. Conversely, the immense stress of a cancer diagnosis can disrupt these family processes [13–16].

From a family systems perspective, family protective factors broadly refer to relational and adaptive resources within the family system that may buffer the adverse effects of illness and treatment [17, 18]. In the present study, this term is used as an overarching conceptual framework rather than as a single measured construct. We focused on two theoretically distinct but complementary family-related predictors: perceived family functioning and family resilience [19, 20]. Perceived family functioning refers to the child's or adolescent's subjective appraisal of day-to-day family processes, including adaptation, partnership, growth, affection, and resolve [21]. It therefore primarily captures perceived relational and affective functioning within the family [22]. Family resilience, in contrast, refers to the family's capacity to maintain commitment, perceived control, and adaptive coping when confronted with sustained stress and adversity [23]. Although both constructs may operate as protective family resources, they are not interchangeable and do not encompass all dimensions of the family system.

Pediatric cancer may disrupt both everyday family relationships and the family's capacity to adapt to prolonged illness and treatment-related demands [24, 25]. Previous studies have linked parenting practices, family routines, and family relationship processes with sleep-related problems in children and adolescents [14–16]. However, much of the existing evidence has focused on isolated family variables, specific diagnostic or survivorship populations, or individual sleep symptoms [26]. Evidence remains limited regarding the simultaneous associations of perceived family functioning and family resilience with multidimensional sleep problems among children and adolescents undergoing active cancer treatment.

A diagnosis of cancer during childhood and adolescence constitutes a profound traumatic stressor, frequently inducing persistent psychological distress [27]. Nearly 25%–40% of patients experience clinical levels of depression and anxiety [28, 29], which exhibit robust bidirectional relationships with

sleep disruption [6, 9, 30]. While psychological interventions exist, their primarily individual focus may limit their efficacy by overlooking the family context [31]. Importantly, family protective factors are increasingly recognized as resources that may mitigate treatment-related distress and reduce vulnerability to depression and anxiety [32]. However, the mediating roles of depression and anxiety in the associations between family protective factors and sleep problems have not been empirically examined within a comprehensive pediatric oncology model.

This study aimed to simultaneously examine the associations of perceived family functioning and family resilience with multidimensional sleep problems, including their indirect associations through depression and anxiety among Chinese children and adolescents with cancer.

2 | Methods

2.1 | Study Design and Data Source

In this cross-sectional analysis, we used baseline data from the Chinese Childhood Cancer Survivorship Wellbeing Cohort (CCCS-WC) to examine the associations of perceived family functioning and family resilience with sleep problems, including their indirect associations through depression and anxiety, among Chinese children and adolescents with cancer. The CCCS-WC is an ongoing prospective, multicenter cohort study established by the National Center for Pediatric Cancer Surveillance in 2021. The cohort enrolls patients aged 7 to <18 years who have been diagnosed with all cancers, nonmalignant tumors, or dynamic undetermined or unknown tumors of the CNS and reproductive system. The standardized follow-up protocol consists of four time points: (1) T0, a baseline assessment conducted post-diagnosis during active treatment; (2) T1, follow-up at 3 months after baseline (± 1 month window) during ongoing treatment; (3) T2, follow-up at 6 months after T1 while the patient remains under therapeutic management; and (4) T3, follow-up at 12 months after T2 following treatment completion. Annual assessments are subsequently conducted during survivorship (± 2 months window). Standardized electronic self-report questionnaires are administered at each time point to evaluate psychological symptom levels (including depression and anxiety), social adaptation functioning, and quality of life.

Participants were eligible for the present analysis if they met the following criteria: (1) a pathologically confirmed diagnosis of all cancers, nonmalignant tumors, or dynamic undetermined or unknown tumors of the CNS and reproductive system; (2) intellectual and cognitive functioning sufficient to understand and complete the study assessments; and (3) physical capability and willingness to comply with the study procedures. Participants were excluded if they had (1) a communication disorder, brain metastases, impaired consciousness, a psychiatric disorder, or other major chronic comorbidities; or (2) residence outside the 31 provinces of mainland China or non-Chinese citizenship. Written informed consent was obtained from the parent or legal guardian of each participant before enrollment.

2.2 | Demographic Variables and Classification

For the present study, we included all participants in the CCCS-WC who completed the T0 before January 1, 2025. We extracted a standardized set of variables, including sex, age at diagnosis, type of cancer, place of residence, monthly household income (defined as the combined after-tax disposable income of both parents), parental educational attainment, parental marital status, date of diagnosis, and date of T0. In addition, we retrieved each participant's scale scores for perceived family functioning, family resilience, depression, anxiety, and sleep problems.

Variables were categorized for descriptive presentation and covariate adjustment based on clinical interpretability, the distribution of the data, and the need to avoid sparse subgroups. Guided by the World Health Organization (WHO) recommendations regarding stages of adolescence and considering the sample distribution, participants were categorized into two age groups: 7 to 14 and 15 to <18 years. According to the International Classification of Childhood Cancer, Third Edition (ICCC-3), cancer type was classified into three categories: leukemia, lymphoma, and solid tumors (ICCC-3 diagnostic groups III–XI) (Table S1). The interval from diagnosis to T0 was categorized into three groups: <180, 180–365, and >365 days. Place of residence was classified as rural or urban according to Regulations on the Division of Urban and Rural Areas for Statistics issued by the National Bureau of Statistics of China in 2008 [33]. Monthly household income was dichotomized using a threshold of twice the national average monthly disposable income of Chinese residents (13,771.34 CNY), as reported by the National Bureau of Statistics of China in 2025 [34]. Participants with a monthly household income greater than 13,771.34 CNY were classified as belonging to the high-income group, while those with an income below this threshold were classified as belonging to the low-income group. Parental educational attainment was grouped into four levels: primary school, junior high school, senior high school, and university or above. Parental marital status was categorized as married or divorced.

2.3 | Instruments

2.3.1 | Measurement of Perceived Family Functioning and Family Resilience

Perceived family functioning was assessed using the Family Adaptation, Partnership, Growth, Affection, and Resolve (Family APGAR) Questionnaire, which measures a participant's satisfaction with family functioning during cancer treatment. The total score represents the patient's perceived level of family functioning. The Family APGAR questionnaire comprises five items representing adaptation, partnership, growth, affection, and resolve [35]. Each item is rated on a 3-point scale (0 = "Hardly ever," 1 = "Some of the time," 2 = "Almost always"), yielding a total score ranging from 0 to 10, with higher scores indicating better perceived family functioning. Total scores are categorized as follows: 7–10,

highly functional; 4–6, moderately dysfunctional; and 0–3, severely dysfunctional. In this study, the perceived family functioning scale was used with a Cronbach's alpha of 0.80 and McDonald's omega of 0.81.

Family resilience was assessed using the Family Hardiness Index (FHI) [36], which evaluates a family's capacity to remain committed and adapt when facing stress and adversity during a family member's cancer treatment. The FHI comprises three dimensions: commitment, control, and challenge. The scale consists of 20 items, each rated on a 4-point Likert scale ranging from 1 ("Never") to 4 ("Always"). Item scores are summed to produce a total score, with higher scores indicating greater resilience. In this study, the family resilience scale was used with a Cronbach's alpha of 0.83 and a McDonald's omega of 0.82.

Considering participants' cognitive limitations, participants aged ≥ 12 years completed the questionnaires independently, while those younger than 12 years received assistance from trained research staff to ensure that they understood the questions before providing their responses.

2.3.2 | Measurement of Depression and Anxiety

Depression and anxiety were assessed using the Chinese version of the Pediatric Patient-Reported Outcomes Measurement Information System (C-Ped-PROMIS) [37]. All participants were within the validated age range of the Chinese Pediatric PROMIS depression and anxiety measures. Each scale comprises eight items rated on a 5-point scale ranging from 1 ("Never") to 5 ("Almost always"), with higher scores indicating more severe symptoms. Raw scores for each completed scale were converted to standardized PROMIS *T*-scores (mean = 50, SD = 10) [38, 39]. *T*-scores were interpreted as follows: ≤ 30 , very low symptom levels; > 30 to ≤ 40 , low symptom levels; > 40 to < 60 , medium symptom levels; ≥ 60 to < 70 , high symptom levels; and ≥ 70 , very high symptom levels. In this study, the depression scale showed a Cronbach's alpha and McDonald's omega of 0.82, and the anxiety scale showed values of 0.87 for both coefficients.

2.3.3 | Measurement of Sleep Problems

Sleep problems were assessed using the BEARS Sleep Screening Scale [40], which screens five domains: bedtime issues (B), excessive daytime sleepiness (E), night awakenings (A), regularity and duration of sleep (R), and snoring (S). Each domain was coded as a binary variable ("Yes" = 1; "No" = 0). A summed score ranging from 0 to 5 was calculated across each of the five domains. Similar quantitative operationalizations of BEARS responses have been used for analytic purposes in previous studies [41]. The summed score was interpreted as the number of sleep-problem domains endorsed and therefore reflected the breadth of multidimensional sleep problems assessed by BEARS. Higher scores indicated problems in a greater number of sleep domains.

2.4 | Data Analysis

Clinical and sociodemographic characteristics were summarized for the full sample using descriptive statistics. Categorical variables were presented as frequencies and percentages, and continuous variables as means with standard deviations. Descriptive analyses were based on available cases. All 518 participants had complete data for the variables included in the primary mediation and sensitivity analyses; therefore, no imputation was performed. *T*-tests were used to examine mean differences across age groups, sex, monthly household income, place of residence, and parental marital status. ANOVA tests were used to assess mean differences across categories of parental educational attainment, type of cancer, and duration from diagnosis to T0. Bivariate correlations between family protective factors (perceived family functioning and family resilience), psychological symptoms (depression and anxiety), and sleep problems were examined using Pearson correlation analysis.

To determine whether perceived family functioning and family resilience were associated with depression, anxiety, and sleep problems after accounting for their shared variance, we conducted a mutually adjusted, multiple-predictor parallel mediation analysis. Multicollinearity between the two family-related predictors was assessed before model estimation; the variance inflation factor was 1.22. Following the multiple-predictor procedure described by Hayes, which allows for the estimation of a mediation model with statistical controls by executing PROCESS *k* times—each time placing one predictor as the focal independent variable and the remaining *k* – 1 predictors as covariates—the model was estimated in two complementary runs [42]. In the first run, perceived family functioning was specified as the focal predictor, and family resilience was included as a covariate. In the second run, the roles were reversed, with family resilience specified as the focal predictor and perceived family functioning included as a covariate. In both runs, the nonfocal family-related predictor was included in the equations for both mediators and in the sleep-problem equation. Mathematically, all resulting paths, direct, and indirect effects will be the same as if the two family-related predictors had all been estimated simultaneously. Therefore, the two family-related predictors were mutually adjusted throughout the mediation analysis, and depression and anxiety were modeled as parallel mediators.

For each focal predictor (perceived family functioning and family resilience), the following paths were estimated according to Baron and Kenny's procedure: (a) its associations with depression and anxiety; (b) the associations of depression and anxiety with sleep problems, with adjustment for both family-related predictors; (c) its direct association with sleep problems after adjustment for both mediators; and (d) its total association with sleep problems [43]. All regression models were adjusted for covariates selected based on previous literature and clinical relevance: age group, sex, monthly household income, type of cancer, and duration from diagnosis to T0 [3, 44]. Specifically, household income and time since diagnosis were included because they may influence family dynamics and financial resources, thereby potentially affecting family functioning [13]. Predictor-specific indirect

associations were evaluated using 5000 bootstrap resamples and bias-corrected 95% confidence intervals. An indirect association was considered statistically significant when its bias-corrected 95% bootstrap confidence interval did not include zero. All statistical tests were two-tailed, and $p < 0.05$ was used for supplementary interpretation.

As a sensitivity analysis, we conducted a parallel indirect-association analysis in which the summed BEARS score was modeled as a Poisson count outcome with a log link because it represented the number of endorsed sleep-problem domains, ranging from 0 to 5. Depression and anxiety were retained as continuous parallel mediators. Perceived family functioning and family resilience were entered simultaneously in both mediator models and the outcome model, with adjustment for age group, sex, monthly household income, cancer type, and duration from diagnosis to T0. Specific indirect associations were estimated as the products of the corresponding predictor-to-mediator and mediator-to-outcome coefficients on the log expected-count scale. The total indirect association for each family-related predictor was calculated as the sum of its two specific indirect associations. Bias-corrected 95% confidence intervals were obtained using 5000 nonparametric bootstrap resamples. Overdispersion was evaluated using the Pearson chi-square-to-degrees-of-freedom ratio. All statistical analyses were conducted using the R programming language.

3 | Results

3.1 | Sample Characteristics

This study included 518 children and adolescents undergoing active cancer treatment, including 448 (86.5%) children aged 7–14 years and 70 (13.5%) adolescents aged 15 to <18 years; 301 boys (58.1%) and 217 girls (41.9%). The maximum age of the sample was 17.13 years. Overall, 315 participants (60.8%) were recruited within 180 days of diagnosis, whereas 203 (39.2%) completed it after a longer interval. Cancer types included leukemia ($n = 258$, 49.8%), lymphomas ($n = 100$, 19.3%), and solid tumors ($n = 160$, 30.9%; Table 1).

3.2 | Levels of Family Protective Factors, Psychological Symptoms, and Sleep Problems

Significant differences were observed in both perceived family functioning and family resilience scores across subgroups defined by parental educational attainment and marital status ($p < 0.05$). Participants whose fathers had higher educational attainment reported significantly higher perceived family functioning scores than those whose fathers had lower educational attainment. Family resilience scores were significantly higher among participants with greater paternal or maternal educational attainment ($p < 0.05$). Regarding psychological symptoms, only parents' marital status showed significant differences in depression and anxiety scores, whereas parental educational attainment was associated with differences in depression scores ($p < 0.05$). Participants with divorced parents reported significantly higher depression and anxiety scores than those with married parents ($p < 0.05$), suggesting greater psychological vulnerability among children and adolescents with cancer from divorced families. Additionally,

TABLE 1 | Sociodemographic characteristics and baseline measures of the participants.

Categorical variables	Overall sample (<i>n</i> %)	Family protective factors, mean (SD)			Psychological symptoms, mean (SD)			Sleep problems		
		Perceived family functioning	<i>p</i>	Family resilience	<i>p</i>	Depression	Anxiety	<i>p</i>	Mean (SD)	<i>p</i>
Age groups										
7–14	448 (86.5)	8.07 (1.99)	0.615	61.51 (6.62)	0.538	50.74 (7.26)	47.77 (8.75)	0.192	1.44 (1.24)	0.892
15 to <18	70 (13.5)	8.21 (2.20)	—	62.03 (6.47)	—	52.11 (8.24)	48.33 (10.20)	—	1.41 (1.20)	—
Sex										
Boy	301 (58.1)	8.01 (2.03)	0.293	61.40 (6.40)	0.468	51.41 (7.11)	48.30 (8.89)	0.085	1.48 (1.25)	0.315
Girl	217 (41.9)	8.20 (2.01)	—	61.83 (6.87)	—	50.26 (7.76)	47.21 (9.01)	—	1.37 (1.21)	—
Monthly household income										
Low income	309 (59.7)	7.99 (2.03)	0.175	61.30 (6.43)	0.248	51.35 (7.25)	48.25 (8.97)	0.117	1.52 (1.25)	0.037
High income	209 (40.3)	8.24 (2.00)	—	62.00 (6.84)	—	50.30 (7.60)	47.24 (8.91)	—	1.30 (1.19)	—
Father's educational attainment										
Primary school	56 (10.8)	8.02 (2.04)	0.044	60.46 (7.07)	0.025	53.18 (7.81)	49.77 (9.75)	0.004	1.55 (1.16)	0.101
Junior high school	167 (32.2)	7.87 (2.14)	—	60.70 (6.43)	—	51.56 (7.10)	48.46 (8.88)	—	1.59 (1.26)	—
Senior high school	110 (21.2)	7.91 (2.13)	—	61.74 (6.13)	—	51.20 (7.42)	47.38 (8.89)	—	1.37 (1.26)	—
University or above	185 (35.7)	8.43 (1.81)	—	62.63 (6.75)	—	49.51 (7.33)	46.98 (8.73)	—	1.19 (1.20)	—
Mother's educational attainment										
Primary school	58 (11.2)	7.78 (2.18)	0.065	59.45 (6.08)	0.005	54.47 (6.89)	49.53 (9.17)	<0.001	1.52 (1.14)	0.140
Junior high school	182 (35.1)	7.93 (2.10)	—	60.93 (6.68)	—	51.09 (7.49)	48.04 (9.40)	—	1.50 (1.23)	—
Senior high school	96 (18.5)	8.00 (1.98)	—	62.28 (6.12)	—	50.55 (7.29)	48.20 (7.87)	—	1.57 (1.36)	—
University or above	182 (35.1)	8.41 (1.88)	—	62.55 (6.74)	—	49.83 (7.24)	46.92 (8.91)	—	1.26 (1.19)	—

(Continues)

TABLE 1 | (Continued)

Categorical variables	Overall sample (<i>n</i> %)	Family protective factors, mean (SD)			Psychological symptoms, mean (SD)			Sleep problems		
		Perceived family functioning	<i>p</i>	Family resilience	<i>p</i>	Depression	Anxiety	<i>p</i>	Mean (SD)	<i>p</i>
Place of residence										
Urban	212 (40.9)	8.16 (1.99)	0.177	62.41 (7.07)	0.063	50.55 (7.47)	48.09 (8.68)	0.576	1.49 (1.35)	0.783
Rural	208 (40.2)	7.98 (2.07)	—	61.19 (6.32)	—	50.96 (7.52)	47.49 (9.16)	—	1.46 (1.16)	—
Missing	98 (18.9)									
Parents' marital status										
Married	478 (92.3)	8.15 (1.99)	0.045	61.79 (6.55)	0.021	50.66 (7.37)	47.61 (8.96)	0.006	1.42 (1.23)	0.310
Divorced	40 (7.7)	7.38 (2.32)	—	59.15 (6.72)	—	54.08 (7.12)	50.68 (8.37)	—	1.63 (1.23)	—
Type of cancer										
Leukemias	258 (49.8)	8.08 (2.01)	0.862	61.53 (6.60)	0.226	50.68 (7.46)	47.41 (8.93)	0.104	1.42 (1.20)	0.591
Lymphomas	100 (19.3)	8.19 (1.88)	—	62.52 (6.42)	—	50.02 (7.74)	47.56 (8.90)	—	1.35 (1.16)	—
Solid tumors	160 (30.9)	8.06 (2.13)	—	61.08 (6.69)	—	51.89 (7.03)	48.73 (9.00)	—	1.51 (1.32)	—
Duration since diagnosis (days)										
<180	315 (60.8)	8.18 (2.03)	0.263	61.82 (6.87)	0.550	50.80 (7.35)	47.56 (8.86)	0.871	1.48 (1.24)	0.435
180–365	104 (20.1)	8.12 (2.17)	—	61.40 (6.52)	—	51.02 (8.24)	47.88 (9.46)	—	1.40 (1.20)	—
> 365	99 (19.1)	7.81 (1.81)	—	61.02 (5.75)	—	51.23 (6.69)	48.70 (8.70)	—	1.30 (1.24)	—

Note: *p* values were calculated using independent-samples *t*-test for comparisons between two groups and one-way analysis of variance (ANOVA) for comparisons among three or more groups.

TABLE 2 | Correlations among study variables.

Variable	Perceived family functioning	Family resilience	Depression	Anxiety	Sleep problems
Perceived family functioning	1				
Family resilience	0.427*	1			
Depression	−0.355*	−0.311*	1		
Anxiety	−0.341*	−0.283*	0.665*	1	
Sleep problems	−0.240*	−0.222*	0.314*	0.309*	1

* $p < 0.001$.

participants from low-income families also reported significantly more sleep problems ($p < 0.05$; Table 1).

3.3 | Association Among Family Protective Factors, Psychological Symptoms, and Sleep Problems

Pearson correlation analyses showed significant associations among family protective factors, psychological symptoms, and sleep problems ($p < 0.001$; Table 2). Perceived family functioning was positively correlated with family resilience ($r = 0.427$, $p < 0.001$). Both family-related protective factors showed moderate negative correlations with anxiety (perceived family functioning: $r = -0.341$; family resilience: $r = -0.283$) and depression (perceived family functioning: $r = -0.355$; family resilience: $r = -0.311$, $p < 0.001$). Depression and anxiety were strongly positively correlated ($r = 0.665$, $p < 0.001$). Sleep problems showed small-to-moderate positive correlations with anxiety ($r = 0.309$, $p < 0.001$) and depression ($r = 0.314$, $p < 0.001$) and negative correlations with family protective factors (perceived family functioning: $r = -0.240$; family resilience: $r = -0.222$, $p < 0.001$).

3.4 | Indirect Association of Depression and Anxiety Between Family Protective Factors and Sleep Problems

Most covariates were not significantly associated with the primary pathways ($p > 0.05$); however, all prespecified covariates were retained on the basis of clinical and theoretical considerations. A notable exception was the duration since diagnosis (< 180 days), which emerged as a significant covariate for sleep problems ($p < 0.05$).

In the mutually adjusted models without depression and anxiety, better perceived family functioning ($B = -0.109$, $p < 0.001$) and greater family resilience ($B = -0.026$, $p = 0.003$) were each associated with fewer endorsed sleep-problem domains. These coefficients represent predictor-specific conditional total associations, adjusted for the other family-related predictor and the prespecified covariates. After depression and anxiety were included as parallel mediators, the corresponding direct associations remained statistically significant for perceived family functioning ($B = -0.061$, $p < 0.05$), but not for family resilience ($B = -0.017$, $p > 0.05$). After adjustment for family resilience, perceived family functioning was negatively associated with depression ($B = -0.989$, 95% CI: -1.310

to -0.668 ; $p < 0.001$) and anxiety ($B = -1.174$, 95% CI: -1.569 to -0.779 ; $p < 0.001$). After adjustment for perceived family functioning, family resilience was also negatively associated with depression ($B = -0.211$, 95% CI: -0.309 to -0.112 ; $p < 0.001$) and anxiety ($B = -0.223$, 95% CI: -0.344 to -0.102 ; $p < 0.001$). These findings suggest that greater perceived family functioning or family resilience corresponded to fewer depressive and anxiety symptoms. In both models, depression and anxiety were positively associated with sleep problems ($p < 0.05$), suggesting that higher depression and anxiety scores were associated with more endorsed sleep-problem domains (Table 3; Figure 1).

3.5 | Bootstrap Tests of the Mediation Models

Bootstrap analyses showed statistically significant indirect associations through depression and anxiety for both perceived family functioning and family resilience. Total, direct, and indirect associations were reported as unstandardized coefficients. Bias-corrected bootstrap confidence intervals were used for the indirect associations, whereas conventional model-based confidence intervals were reported for the conditional total and direct associations. These coefficients represent the estimated change in the number of endorsed sleep-problem domains associated with a one-point increase in the corresponding family protective factor score.

Perceived family functioning remained negatively associated with sleep problems after adjustment for family resilience and the prespecified covariates (conditional total association: $B = -0.109$, 95% CI: -0.165 to -0.053). A one-point increase in perceived family functioning score was associated with an estimated 0.109 fewer endorsed sleep-problem domains. After depression and anxiety were included, the direct association remained statistically significant ($B = -0.061$, 95% CI: -0.118 to -0.004). The total indirect association was -0.048 (bias-corrected 95% bootstrap CI: -0.071 to -0.028). The specific indirect associations through depression ($B = -0.024$, bias-corrected 95% bootstrap CI: -0.045 to -0.005) and anxiety ($B = -0.025$, bias-corrected 95% bootstrap CI: -0.046 to -0.006) were also statistically significant.

Family resilience was also negatively associated with sleep problems after adjustment for perceived family functioning and the prespecified covariates (conditional total association: $B = -0.026$, 95% CI: -0.044 to -0.010). A one-point higher family resilience score was associated with an estimated 0.026

TABLE 3 | Mutually adjusted parallel mediation model of perceived family functioning, family resilience, psychological symptoms, and sleep problems.

Variable	Sleep problems	Depression	Anxiety	Sleep problems
Perceived family functioning	−0.109*** (−0.165, −0.053)	−0.989*** (−1.310, −0.668)	−1.174*** (−1.569, −0.779)	−0.061* (−0.118, −0.004)
Family resilience	−0.026** (−0.044, −0.010)	−0.211*** (−0.309, −0.112)	−0.223*** (−0.344, −0.102)	−0.017 (−0.034, 0.0004)
Age group	0.019 (−0.282, 0.319)	1.600 (−0.118, 3.319)	0.759 (−1.354, 2.872)	−0.035 (−0.328, 0.257)
Sex	0.090 (−0.122, 0.302)	1.062 (−0.151, 2.275)	0.929 (−0.563, 2.420)	0.045 (−0.161, 0.252)
Monthly household income	−0.215* (−0.427, −0.003)	−0.772 (−1.983, 0.440)	−0.644 (−2.134, 0.847)	−0.183 (−0.389, 0.023)
Leukemias, myeloproliferative, and myelodysplastic diseases	0.040 (−0.237, 0.316)	0.441 (−1.140, 2.023)	−0.483 (−2.428, 1.462)	0.039 (−0.229, 0.308)
Solid tumors	0.175 (−0.131, 0.481)	1.854* (0.104, 3.604)	0.909 (−1.243, 3.062)	0.112 (−0.186, 0.410)
Duration since diagnosis (<180 days)	0.297* (0.023, 0.572)	0.512 (−1.057, 2.083)	−0.264 (−2.195, 1.667)	0.291* (0.024, 0.557)
Duration since diagnosis (180–365 days)	0.214 (−0.119, 0.547)	0.649 (−1.255, 2.552)	−0.032 (−2.372, 2.309)	0.200 (−0.123, 0.522)
Depression				0.024* (0.005, 0.042)
Anxiety				0.021** (0.006, 0.036)
Constant	3.67*** (2.630, 4.711)	70.149*** (64.199, 76.098)	70.801*** (64.483, 78.118)	0.517 (−0.956, 1.990)
Observations	518	518	518	518
R-squared	0.091	0.177	0.148	0.150

Note: Values are unstandardized regression coefficients (*B*), with 95% confidence intervals shown in parentheses. Perceived family functioning and family resilience were entered simultaneously in all mediator and outcome models. All tests were two-sided.

**p* < 0.05.

***p* < 0.01.

****p* < 0.001.

fewer endorsed sleep-problem domains. After depression and anxiety were included, the direct association was attenuated and was not statistically significant ($B = -0.017$, 95% CI: -0.034 to 0.0004). The total indirect association remained statistically significant ($B = -0.010$, bias-corrected 95% bootstrap CI: -0.016 to -0.004), as did the specific indirect associations through depression ($B = -0.005$, bias-corrected 95% bootstrap CI: -0.010 to -0.001) and anxiety ($B = -0.005$, bias-corrected 95% bootstrap CI: -0.009 to -0.001) (Tables 4 and 5).

3.6 | Sensitivity Analysis

When the summed BEARS score was modeled as a Poisson count outcome, the parallel indirect-association sensitivity analysis yielded a pattern consistent with that observed in the

primary linear analysis. In the Poisson outcome model, depression ($B = 0.018$, 95% robust CI: 0.004 – 0.033 , $p < 0.05$) and anxiety ($B = 0.015$, 95% robust CI: 0.004 – 0.026 , $p < 0.01$) were positively associated with the expected number of endorsed sleep-problem domains. For perceived family functioning, the specific indirect association through depression was $B = -0.018$ (bias-corrected 95% bootstrap CI: -0.035 to -0.004), and that through anxiety was $B = -0.018$ (bias-corrected 95% bootstrap CI: -0.035 to -0.005). The total indirect association was $B = -0.036$ (bias-corrected 95% bootstrap CI: -0.056 to -0.022). For family resilience, the specific indirect associations through depression and anxiety were $B = -0.004$ (bias-corrected 95% bootstrap CI: -0.009 to -0.001) and $B = -0.003$ (bias-corrected 95% bootstrap CI: -0.008 to -0.001), respectively, with a total indirect association of $B = -0.007$ (bias-corrected 95% bootstrap CI: -0.013 to -0.004).

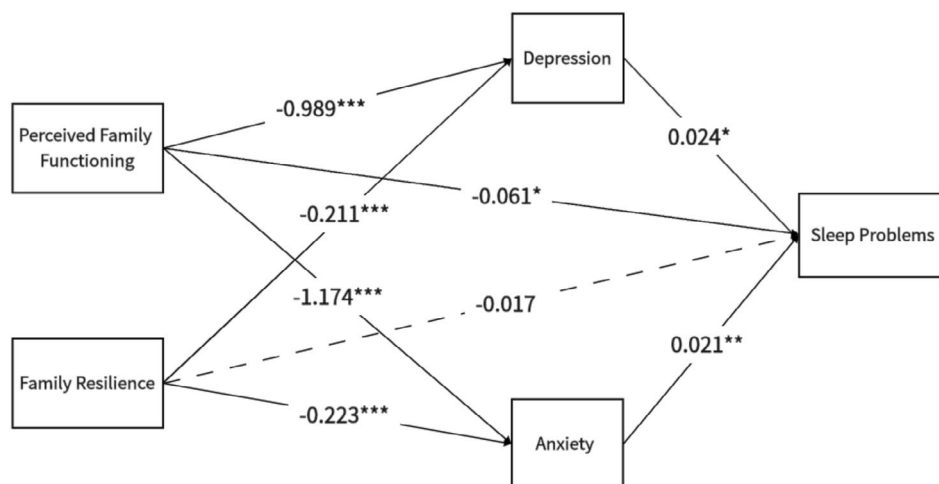


FIGURE 1 | The mediation model of psychological symptoms in the association between family protective factors (perceived family functioning and family resilience) and sleep problems. Values shown on the paths are unstandardized regression coefficients (*B*). Solid lines represent statistically significant associations, whereas the dashed line represents a nonsignificant association. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

TABLE 4 | Total, direct, and indirect associations for perceived family functioning.

	<i>B</i>	SE	LLCI	ULCI	Effect size
Indirect effect	-0.048	0.011	-0.071	-0.028	44.18%
Depressed symptoms	-0.024	0.010	-0.045	-0.005	21.54%
Anxiety symptoms	-0.025	0.010	-0.046	-0.006	22.64%
Direct effect	-0.061	0.029	-0.118	-0.004	55.91%
Total effect	-0.109	0.029	-0.165	-0.053	

Note: *B* represents the unstandardized association estimate. For specific and total indirect associations, standard errors and bias-corrected 95% bootstrap confidence intervals were obtained using 5000 bootstrap resamples. For direct and total associations, standard errors and 95% confidence intervals were model-based estimates from the corresponding regression models.

Abbreviations: LLCI, lower limit of the confidence interval; ULCI, upper limit of the confidence interval.

TABLE 5 | Total, direct, and indirect associations for family resilience.

	<i>B</i>	SE	LLCI	ULCI	Effect size
Indirect effect	-0.010	0.003	-0.016	-0.004	36.88%
Depressed symptoms	-0.005	0.002	-0.010	-0.001	19.01%
Anxiety symptoms	-0.005	0.002	-0.009	-0.001	17.87%
Direct effect	-0.017	0.009	-0.034	0.0004	/
Total effect	-0.026	0.009	-0.044	-0.010	

Note: *B* represents the unstandardized association estimate. For specific and total indirect associations, standard errors and bias-corrected 95% bootstrap confidence intervals were obtained using 5000 bootstrap resamples. For direct and total associations, standard errors and 95% confidence intervals were model-based estimates from the corresponding regression models.

Abbreviations: LLCI, lower limit of the confidence interval; ULCI, upper limit of the confidence interval.

Thus, all specific and total indirect associations were directionally consistent with the primary analysis, and all bias-corrected 95% bootstrap confidence intervals excluded zero. The Pearson chi-square-to-degrees-of-freedom ratio was 0.966, indicating no substantial overdispersion. These findings supported the robustness of the indirect-association pattern when the BEARS summary score was modeled according to its count structure (Table S2).

4 | Discussion

To our knowledge, this is the first study to examine the interrelationships among family protective factors, psychological symptoms, and multidimensional sleep problems in children and adolescents with cancer. We observed a pattern of cross-sectional associations in which better perceived family functioning and greater family resilience were associated with

fewer sleep problems, both directly in the regression models and indirectly through depression and anxiety. These psychological symptoms showed statistically significant indirect associations and partially accounted for the observed associations. In the mutually adjusted mediation models, depression and anxiety jointly accounted for 44.2% of the conditional total association between perceived family functioning and sleep problems and 36.9% of the corresponding association for family resilience. After depression and anxiety were included in the mutually adjusted models, the direct association remained statistically significant for perceived family functioning but was attenuated and no longer statistically significant for family resilience. This pattern provides preliminary insight into the potentially distinct roles of relational, adaptive, and psychological factors in family–sleep relationships among children and adolescents undergoing cancer treatment. The Poisson-based parallel indirect-association sensitivity analysis further yielded a pattern consistent with the primary linear model: the specific indirect associations through depression and anxiety, as well as the total indirect associations, remained statistically supported for both perceived family functioning and family resilience. Although the direct association of perceived family functioning with sleep problems was attenuated to borderline statistical significance in the Poisson outcome model, the specific and total indirect associations remained statistically supported. This suggests that the indirect-association pattern was more robust to outcome-model specification than the direct pathway.

This study examined two key dimensions of family protective factors—perceived family functioning and family resilience, revealing distinct association patterns that may be obscured by global measures. We found that perceived family functioning and family resilience were related to different parental characteristics. Specifically, paternal education level was uniquely associated with perceived family functioning, a relationship potentially explained by fathers' roles in leveraging resources and navigating healthcare systems, as suggested in models of parental efficacy [45]. In contrast, family resilience was associated with broader parental education and the stability afforded by a married-parent structure. In our sample, children and adolescents generally reported relatively favorable perceived family functioning and family resilience. This pattern may be consistent with previous evidence suggesting that families of children and adolescents with cancer may mobilize substantial emotional and practical support during treatment [46, 47]. Previous studies have also reported relatively high resilience among families of pediatric patients compared with families of adult patients [48], possibly reflecting the concentration of caregiving and emotional support around the child. Collectively, this evidence suggests that socioeconomic resources and relational stability jointly form the foundation of a family's adaptive capacity. Distinguishing the specific associations of parental characteristics with perceived family functioning and family resilience provides a crucial basis for developing targeted interventions—for instance, strengthening practical support in families with lower paternal education while enhancing communication and adaptive skills in families experiencing marital instability to foster resilience.

Our findings suggest that better perceived family functioning was associated with fewer sleep problems, with significant

indirect associations through lower depression and anxiety scores. The remaining direct association suggests that perceived family functioning may also be related to sleep through pathways not captured by these psychological symptoms. A supportive and well-functioning family provides emotional security and behavioral companionship, fostering a sense of safety and trust. When children and adolescents feel safe, the parasympathetic nervous system (PNS) can predominate, facilitating homeostatic functions such as relaxation and restoration that may support better sleep [49]. Concurrently, a significant proportion of the total effect may partially account for reducing depression and anxiety. This mechanism elucidates that emotional processes may be relevant to the association between perceived family functioning and sleep problems. Within the context of cancer treatment, high medical costs and illness-related uncertainty can exacerbate psychological distress in children and adolescents [29], making emotional support from family members particularly vital. Previous research suggests that perceived family functioning influences children's and adolescents' psychological pressure by bolstering their self-esteem and adaptability [50]. One possible explanation is that psychological stress activates the endocrine system via the hypothalamic–pituitary–adrenal (HPA) axis, triggering the secretion of stress hormones such as cortisol and adrenaline [51]. These hormones could heighten physiological arousal, leading to difficulty initiating sleep, elevated heart rate, and muscle tension [52]. Therefore, family-related support and lower psychological distress may be important factors associated with sleep problems. By quantifying these dual pathways, our findings provide preliminary support for evaluating family-focused approaches in future sleep-intervention research for children and adolescents with cancer.

Our analysis further revealed that depression and anxiety statistically accounted for a substantial proportion of the observed association between family resilience and sleep problems. After adjustment for perceived family functioning, greater family resilience remained independently associated with lower levels of depression and anxiety and with fewer sleep-problem domains at the conditional total-association level. This finding indicates that family resilience provides distinct information about the family's adaptive capacity under cancer-related adversity. After depression and anxiety were included in the model, however, the direct association between family resilience and sleep problems was attenuated and was no longer statistically significant, whereas the specific indirect associations through both psychological symptoms remained significant. As the FHI, family resilience reflects commitment, perceived control, and capacity to interpret and respond adaptively to stressful challenges. These resources may help families maintain stability, predictability, and a sense of psychological safety during prolonged cancer treatment [53, 54]. From a systems-dynamics perspective, greater family resilience may support collective coping and emotional regulation in the face of adversity [55]. Children and adolescents who perceive their families as more resilient may therefore also report fewer psychological symptoms [56], which may, in turn, be associated with fewer sleep difficulties and other sleep disturbances. Family resilience may therefore function as a relatively distal family-level protective resource whose association with sleep is expressed largely through the

psychological adaptation of children, adolescents, and their families.

The pattern observed in the primary mutually adjusted models further suggested that perceived family functioning may be more proximally related to daily sleep experiences, whereas family resilience may operate more indirectly. Perceived family functioning captures children's and adolescents' appraisals of routine family relationships, communication, affection, shared decision-making, and problem-solving. It may therefore be associated with sleep not only through psychological symptoms but also through more immediate factors, such as bedtime routines, emotional security, parent-child interactions before sleep, and the availability of practical caregiving [57, 58]. In contrast, family resilience may operate more distally by helping the family system to maintain collective coping and emotional regulation in response to cancer-related adversity, with its association with sleep reflected primarily through depression and anxiety [59, 60]. Taken together, perceived family functioning and family resilience appear to represent related but non-interchangeable family protective factors, suggesting that future family-based interventions may benefit from simultaneously addressing everyday relational functioning, adaptive coping with cancer-related stress, and the management of psychological distress.

By examining depression and anxiety concurrently, this study also delineates their specific indirect associations. The indirect associations through depression and anxiety accounted for 21.5% and 22.6%, respectively, of the conditional total association between perceived family functioning and sleep problems, and for 19.0% and 17.9%, respectively, of the corresponding association for family resilience. Notably, children and adolescents with cancer from divorced families reported significantly higher levels of both depression and anxiety compared to those from married families. This elevated distress may stem from factors such as emotional neglect, communication barriers, or external stressors within these family environments [61]. Familial adversities, including financial hardship, difficulties in adaptation, and insufficient emotional support, can foster feelings of helplessness and low self-esteem, which are core features of depression [52, 62]. In contrast, anxiety is often triggered by illness-related uncertainties, while the regulatory influence of family protective factors may remain relatively limited [63]. These findings suggest that depression and anxiety may partially explain the associations between family protective factors and sleep problems, whereas family structural adversity may be linked to poorer psychological well-being and sleep-related problems. These findings may therefore inform the development and evaluation of tiered family-based supportive-care strategies. For all families, integrated management of depression and anxiety may represent a key psychological component of efforts to improve sleep. For higher-risk families, including divorced or single-parent families, additional targeted support may be needed to foster a more stable emotional environment by strengthening family communication and expanding external support networks. These families may warrant particular attention in future supportive-care research and clinical assessment. Such tailored approaches may help promote sleep health among children and adolescents with cancer.

Our findings also suggested that the initial 180-day post-diagnosis period may warrant further attention in future longitudinal research and clinical monitoring, given its marginal association with sleep problems. During this early phase, the stress of cancer diagnosis and treatment may induce structural changes within the family system, disrupting established relationships and interaction patterns. Accordingly, this period may be a relevant time point for clinical assessment and supportive-care planning. Continuous monitoring of children's and adolescents' psychological well-being and the management of emerging sleep disturbances may be clinically useful. As psychological symptoms represent potentially modifiable clinical correlates, implementing integrated early interventions targeting mental health—including emotional regulation and the establishment of support groups—may help alleviate sleep-related problems.

4.1 | Study Limitations

While this study provides valuable insights, several limitations should be acknowledged. First, all primary variables were assessed at the same time point using patient-reported questionnaires. These measures may share reporting characteristics, including response style, negative affectivity, and social desirability, which could have inflated the observed associations. However, the Harman single-factor test indicated that common method bias was unlikely to be a major concern, as the first factor accounted for 34.54% of the total variance, below the 40% threshold. Second, the BEARS Sleep Screening Scale is a brief multidomain instrument that does not provide objective sleep parameters or diagnostic information regarding specific sleep disorders. Future studies should incorporate multi-informant and multimethod approaches, including parent- and clinician-reported family assessments, validated comprehensive sleep questionnaires, sleep diaries, actigraphy, and, where clinically indicated, polysomnography. Third, despite controlling for key covariates, detailed information on treatment regimens, treatment intensity, disease stage, relapse status, and caregiver-related characteristics was not comprehensively available. Residual confounding and unexamined heterogeneity therefore remain possible. Fourth, the cross-sectional design precludes causal inference, and the observed associations should be interpreted as correlational. Alternative explanations, including reverse or reciprocal associations among family-related functioning, psychological symptoms, and sleep problems, remain plausible. Finally, several sociodemographic and clinical variables were represented using relatively broad categories, which may not fully capture heterogeneity in socioeconomic circumstances, family structure, cancer characteristics, treatment burden, or disease course. Future longitudinal studies with larger samples and objective measures are warranted to clarify the temporal and potentially causal pathways linking perceived family functioning and family resilience with sleep problems.

4.2 | Clinical Implications

This study suggests potential avenues for exploring interventions to address sleep disturbances in children and adolescents with cancer. During active cancer treatment, oncologists and oncology nurses may consider routinely asking children and

adolescents about difficulties across key sleep domains. Given the observed associations of sleep problems with depression and anxiety, psychological screening may also be considered as part of comprehensive supportive care. Children and adolescents reporting multiple sleep-related concerns or elevated psychological symptoms may benefit from further assessment by psychologists or other mental health professionals, as clinically indicated. Future studies should develop and prospectively evaluate comprehensive intervention models that simultaneously strengthen everyday family functioning and family adaptive capacity. The initial phase of pediatric cancer treatment may be a clinically relevant period for assessing family needs, psychological symptoms, and sleep problems. A tiered support framework may be considered and should be evaluated in prospective studies, with foundational psychosocial support provided to all families and more intensive, structured interventions delivered to those at higher risk. When children and adolescents report less perceived family functioning or lower family resilience, healthcare teams may consider discussing family communication, emotional support, daily routines, treatment-related stress, and practical caregiving challenges. Social workers may be particularly well positioned to assist families experiencing financial strain, a caregiving burden, or limited external support, whereas psychologists may provide family-focused psychoeducation or communication-based support when appropriate.

5 | Conclusion

In this cross-sectional study, perceived family functioning and family resilience were each associated with the breadth of multidimensional sleep problems among Chinese children and adolescents undergoing active cancer treatment. Parallel indirect-association analyses showed statistically significant indirect associations through both depression and anxiety, and the same overall pattern was retained when the BEARS summary score was modeled as a Poisson count outcome. These findings suggest that family-related processes may represent relevant targets for future supportive-care research and intervention development. Future longitudinal and intervention studies should evaluate whether early, comprehensive family-based support strategies can improve family protective factors, psychological symptoms, and sleep problems.

Author Contributions

Zhe Li: conceptualization, methodology, software, data curation, investigation, validation, formal analysis, project administration, funding acquisition, writing – original draft, writing – review and editing, resources, supervision. **Chaoran Hu:** conceptualization, methodology, software, formal analysis, visualization, writing – original draft, data curation. **Lijia Yao:** investigation, data curation, project administration. **Yifei Wang:** writing – review and editing, investigation. **Zhuoyu Yang:** project administration, resources. **Xiaoning Wang:** methodology, writing – review and editing, software, conceptualization, funding acquisition. **Xin Ni:** writing – review and editing, project administration, resources, conceptualization, funding acquisition, supervision.

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Ethics Statement

The study was approved by the Ethics Committee of Beijing Children's Hospital, Capital Medical University, Beijing, China (approval number: [2021]-E-207-Y).

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

De-identified individual participant data from the National Center for Pediatric Cancer Surveillance's CCCS-WC database, together with the code used in this study, will be made available to members of the scientific and medical community for noncommercial purposes upon publication. Data requests may be submitted via email to ncpcs@bch.com.cn.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Table S1:** Abbreviated names for the 12 main cancer groups (based on ICC-3) in this study. **Table S2:** Poisson-based parallel indirect-association sensitivity analysis of perceived family functioning, family resilience, depression, anxiety, and sleep problems.