




# The Link Between Anxiety Severity and Irritability Among Anxious Youth: Evaluating the Mediating Role of Sleep Problems

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## Abstract

Although recent studies have linked pediatric anxiety to irritability, research has yet to examine the mechanisms through which youth anxiety may be associated with irritability. Importantly, sleep related problems (SRPs) have been associated with both child anxiety and irritability, but research has not considered whether the link between youth anxiety and irritability may be accounted for by SRPs. The present study investigated whether SRPs mediated the relationship between anxiety severity and irritability in a large sample of treatment-seeking anxious youth ( $N=435$ ; ages 7–19 years,  $M=12.7$ ; 55.1% female). Anxiety severity, SRPs and irritability showed significant pairwise associations, and the indirect effect of youth anxiety severity on irritability, via SRPs, was positive and significant. The present analysis is the first to examine youth anxiety, irritability, and SPRs in a single model in a sample of anxious youth, and provides preliminary evidence that SRPs partially mediate links between child anxiety and irritability.

**Keywords** Anxiety · Irritability · Youth · Sleep · Mediation

## Introduction

Anxiety disorders are the most prevalent class of mental disorders affecting children and adolescents, with approximately 12–25% of youth having met diagnostic criteria for an anxiety disorder in a given year [1, 2]. These disorders are traditionally characterized by excessive worry, fear, and/or panic, as well as avoidance and marked distress. Studies show anxiety disorders in youth are associated with significant academic, social, and family impairments [3]. When left untreated, anxiety disorders can persist and place affected

individuals at risk for mental and physical comorbidities, substance misuse, suicidality, and overall reduced quality of life [4–6]. Elucidating clinical presentation patterns and associated burdens among anxious youth is critical.

An emerging body of research has begun to link youth anxiety with irritability—a transdiagnostic clinical dimension characterized by excessive behavioral, cognitive, and affective reactivity to emotional stimuli and a low threshold for frustration or blocked goal attainment. Chronic irritability has been associated with a range of mental health problems and functional impairments and affects 3–5% of the population [7–13]. Although the majority of studies investigating links between irritability and child psychopathology have examined links to depression, bipolar disorder, and/or disruptive behavior disorders (DBD), an increasing literature is finding that child anxiety has unique associations with irritability [8, 13, 14]. Cornacchio et al., for example, documented a positive direct link between child anxiety severity and irritability in a large sample of youth with anxiety disorders, even after controlling for comorbid depression and oppositional defiant disorder [8]. Observed anxiety-irritability associations are robust across the anxiety disorders, as well as across child gender and age [8]. It has even been suggested that, due to observed associations between youth

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anxiety and irritability, and due to the unobservable nature of many anxiety symptoms, chronic irritability in children and adolescents may serve as a useful indicator that anxiety symptoms should be evaluated [8].

Despite observations of a link between youth anxiety and irritability, research has yet to clarify the mechanisms through which youth anxiety may be associated with irritability. Importantly, *sleep related problems (SRPs)* have been associated with both child anxiety [15–19] and irritability [18, 20–23], and may serve a key role in explaining the anxiety-irritability relationship. SRPs include difficulty initiating or maintaining sleep, bedtime resistance, night wakings, daytime sleepiness, and parasomnias [24], and are associated with inattention, impulsivity, academic performance impairments, and emotional dysregulation [18, 25]. General population studies estimate that SRPs affect about 25% of young children [26], and they are exceedingly more common among anxious youth. Across clinical samples of anxious youth, roughly 90% of youth with anxiety disorders have at least one SRP, over 80% have at least two SRPs, and roughly half have at least three SRPs [15, 26], that seem to remain consistent over time [27]. Daytime sleepiness presents differently in youth relative to adults. Instead of the yawning and drowsiness seen in adults, daytime sleepiness in youth often manifests in behavioral symptoms such as hyperactivity, low frustration tolerance, emotional reactivity, and irritability [9, 16, 28].

Much remains to be learned about complex links between youth anxiety, irritability, and SRPs. Despite observed associations between youth anxiety and irritability [8, 13, 14], between youth anxiety and SRPs [15–17, 19], and between SRPs and irritability [16, 20–23], to date, research has not considered whether the link between youth anxiety and irritability may be accounted for by SRPs. That is, the extent to which youth anxiety is associated with irritability in the absence of SRPs remains unclear.

The present study is the first, to our knowledge, to simultaneously examine youth anxiety severity, irritability, and SRPs in a single model in a sample of anxious youth. Specifically, we hypothesized that SRPs would mediate the association between anxiety severity and youth irritability, such that greater anxiety would be associated with elevated SRPs which in turn would be associated with increased irritability. Further, given the extent to which youth irritability and SRPs are also associated with disruptive behavior disorders, depression, gender, and age [13, 29, 30], we controlled for these factors in our analysis.

## Method

### Participants

Participants were 435 children between the ages of 7 and 19 years, and their parents, seeking assessment and/or treatment

for youth anxiety at one of two university-affiliated metropolitan outpatient clinics on the east coast of the United States. Children with active psychotic symptoms, suicidal or homicidal intent, more than two hospitalizations for serious psychiatric conditions within 5 years, or significant intellectual impairments were excluded. Youth currently taking psychotropic medications were required to be on a stable dose for at least 1 month. All youth participants met diagnostic criteria for a DSM-IV-TR anxiety disorder as assessed via semi-structured clinical interview. Table 1 presents an overview of the sociodemographic and clinical characteristics of the sample. There were slightly more females than males in the sample, the majority of participants were non-Hispanic Caucasian, and over one-third of the sample reported a household income of less than \$100,000. Generalized anxiety disorder (GAD) was the most common principal diagnosis in the sample, followed by social anxiety disorder (SocAD), obsessive-compulsive disorder (OCD), specific phobia, and panic disorder with or without agoraphobia. Additionally, 65.0% of the sample had at least one comorbid diagnosis. As represented in Table 1, the most common comorbid diagnoses in the sample were specific phobia, GAD, SocAD, depressive disorder, ADHD or other disruptive behavior disorder, SepAD, OCD, anxiety disorder not otherwise specified, learning disorder, and/or panic disorder with or without agoraphobia.

## Measures

### Child Diagnostic Profile and Anxiety Severity

The Anxiety Disorders Interview Schedule, Child and Parent Version (ADIS-IV-C/P) [31] is a semi-structured diagnostic interview administered to parents and children. The ADIS-IV-C/P assesses both internalizing and externalizing problems in accordance with the DSM-IV-TR, and is the most widely used diagnostic instrument to assess anxiety disorders in youth, with good reliability and validity [32]. After conducting the child and parent interview(s), the interviewer assigns a clinical severity rating (CSR) ranging from 0 to 8 for each assigned diagnosis, with CSRs  $\geq 4$  indicating that full diagnostic criteria have been met, and CSRs  $< 4$  indicating subclinical diagnostic presentations. Diagnostic profiles incorporate both parent and child interviews using the “or” rule, in which a diagnosis is considered present if either the parent or the child interview yields endorsement of sufficient symptoms for a diagnosis [33].

### Youth Sleep Problems

We assessed SRPs based on a composite score that, consistent with previous work in the clinical child literature examining youth sleep [34–37], incorporated endorsed items from

**Table 1** Sociodemographic and clinical characteristics of sample (N = 435)

	N	%	M	SD
Child age (years)			12.7	3.0
Sex				
Female	241	55.1		
Male	195	44.6		
Race/ethnicity				
Non-Hispanic Caucasian	362	93.0		
Ethnic/racial minority	27	7.0		
Annual household income				
≤ \$100,000	114	38.9		
> \$100,000	179	61.1		
Principal diagnosis				
Generalized anxiety disorder	122	28.0		
Social anxiety disorder	87	20.0		
Obsessive–compulsive disorder	63	14.5		
Specific phobia	59	13.6		
Panic disorder with or without agoraphobia	49	11.3		
Separation anxiety disorder	41	9.4		
Anxiety disorder NOS	36	8.3		
Selective mutism	7	1.6		
PTSD	4	0.9		
Mean # of comorbid diagnoses			1.2	1.2
Comorbid diagnosis				
Specific phobia	95	21.8		
Generalized anxiety disorder	90	20.1		
Social anxiety disorder	79	18.1		
Depressive disorder	55	12.6		
Separation anxiety disorder	36	8.3		
ADHD	32	7.4		
Obsessive–compulsive disorder	28	6.4		
Anxiety disorder NOS	22	5.1		
Learning disorder	20	4.6		
ODD or other disruptive behavior disorder	17	4.0		
Panic disorder with or without agoraphobia	14	3.2		
Elimination disorder	8	1.8		
Tic disorder	7	1.6		
Impulse control disorder	7	1.6		
Other	20	4.6		

the Child Behavior Checklist (CBCL) [38] and the Revised Child Anxiety and Depression Scale (RCADS) [39] that assess various forms and aspects of disrupted quality of sleep. The CBCL for ages 6–18, is a 120-item parent-report of youth emotional and behavior problems over the past 6 months. Items are rated on a 0 (not true) to 2 (very true or often true) scale. The CBCL is one of the most widely used measures of child psychopathology, and has demonstrated strong psychometric properties [38]. The RCADS is a 47-item youth self-report measure that asks youth to

rate symptoms of anxiety and depression on a 4-point Likert scale from 0 (never) to 3 (always). The RCADS has demonstrated good internal consistency [39]. Consistent with previous studies creating a composite SRP measure from across measures with different item scoring ranges [26, 35, 37], CBCL and RCADS sleep items with any endorsement > 0 were coded at “1.”

Correlation analyses and factor analysis were conducted to determine which sleep related items on the CBCL and RCADS should be retained in the final composite. Two sleep items from the CBCL were not included in the composite tally (“talks or walks in sleep”; “wets the bed”), as they demonstrated poor and non-significant correlations with the other sleep items (ranged from –0.07 to 0.2) and exceptionally low factor loadings (–0.005 and 0.064, respectively). The remaining items all showed significant correlations with the other sleep items, and acceptable factor loadings and yielded a composite tally of five CBCL sleep items and four RCADS sleep items: CBCL Sleep Item 54 (“overtired”); CBCL Sleep Item 76 (“sleeps less than most children”); CBCL Sleep Item 77 (“sleeps more than most children”); CBCL Sleep Item 100 (“trouble sleeping”); CBCL Sleep Item 47 (“nightmares”); RCADS Sleep Item 11 (“I have trouble sleeping”); RCADS Sleep Item 21 (“I am tired a lot”); RCADS Sleep Item 19 (“I have no energy for things”); and RCADS Sleep Item 45 (“I worry when I got to bed at night”). The scale demonstrated internal consistency similar to sleep composites utilized in previous studies ( $\alpha = 0.62$ ) [37].

### Irritability

Consistent with a growing body of literature examining youth irritability [40], including factor analytic work on the structure of irritability in anxious youth [8, 41, 42], for the present analysis we assessed youth irritability using a composite tally of the following three CBCL items: CBCL Irritability Item 86 (“stubborn, sullen, or irritable”); CBCL Irritability Item 87 (“sudden changes in mood or feelings”); and CBCL Irritability Item 95 (“temper tantrums or hot temper”). Internal consistency of this irritability scale was adequate in the present sample ( $\alpha = 0.72$ ). Moreover, the validity of this scale is supported by the observation in the present sample that participating youth with disruptive behavior disorders had significantly higher scores on this irritability measure than participating youth without disruptive behavior disorders,  $t(435) = 4.94, p < 0.001$ .

### Procedure

Families seeking youth anxiety services at one of the two study clinics first completed a phone screening to assess initial eligibility. Interested and eligible families were scheduled for a baseline assessment. Following informed consent/

assent procedures, mothers completed the CBCL, and diagnosticians administered the ADIS-IV-C/P separately to the child and to the parent(s). A diagnostic profile was established for each child using the “or” rule to incorporate both parent and child reports [33]. Each participant’s assessment was presented and discussed at a weekly diagnostic meeting in which diagnosticians reviewed the symptoms endorsed, and final diagnostic decisions were made. Diagnosticians were a team of 22 clinical psychologists, postdoctoral associates, doctoral candidates, and doctoral students specializing in the assessment and treatment of pediatric anxiety disorders. Each diagnostician met internal training and reliability criteria: participating in didactic training by one of the developers of the ADIS-IV-C/P, observing 3 assessments, co-leading 3 assessments with a trained diagnostician, and conducting supervised assessments until achieving full diagnostic agreement on 3 of 5 consecutively administered assessments. These training and reliability criteria were developed in collaboration with one of the authors of the ADIS-IV-C/P.

## Data Analysis

Analyses were conducted in SPSS using the Hayes PROCESS Macro. A mediation model was run to examine the indirect effect of youth anxiety severity [X] (i.e., measured via ADIS-C/P principal anxiety diagnosis CSR) on irritability [Y] (measured via CBCL irritability scale), through SRPs [M] (measured via CBCL and RCADS sleep composite) [i.e.,  $X \rightarrow M \rightarrow Y$ ]. Covariates in the model were: depression CSR (i.e., highest CSR for each participant across the following diagnostic categories: MDD, dysthymic disorder, depressive disorder not otherwise specified), ADHD/DBD CSR (i.e., highest CSR for each participant across the following diagnostic categories: ADHD, oppositional defiant disorder, disruptive behavior disorder not otherwise specified), sex, and age. The indirect effect was computed via the product of the effect of youth anxiety severity on SRPs (*a*) and the effect of SRPs on irritability (*b*) (i.e.,  $M = ab$ ). Additional moderated mediation analyses were conducted

in the PROCESS macro to explore whether the presence of any specific anxiety diagnoses moderated observed indirect effects. Parallel moderated mediation models were run separately evaluating whether mediation effects significantly varied across youth with and without GAD, youth with and without SocAD, and youth with and without SepAD. Bias-corrected bootstrapping methods were applied to determine 95% confidence intervals for all effects [43]. When the confidence interval does not overlap with 0, the null hypothesis of no mediation is rejected [44].

## Results

Table 2 includes the means, standard deviations, and bivariate correlations across all study variables. Anxiety severity, SRPs and irritability showed small pairwise associations with one another.

When investigating SRPs as a potential mediator of the link between youth anxiety severity and irritability, the indirect effect of youth anxiety severity on irritability, via SRPs (after controlling for youth age, sex, depression severity, and ADHD/DBD severity) was positive and significant (indirect effect = 0.06; 95% bias-corrected bootstrap CI 0.02, 0.12) (see Fig. 1). Specifically, anxiety severity significantly predicted SRPs,  $B = 0.33$ ,  $p < 0.01$ , and SRPs significantly predicted irritability,  $B = 0.19$ ,  $p < 0.001$ . The total effect of the model was not significant,  $t(429) = 1.82$ ,  $p = 0.06$  (total effect = 0.17; 95% bias-corrected bootstrap CI -0.01, 0.36). In addition, the direct effect of youth anxiety severity and irritability was not significant,  $t(429) = 1.17$ ,  $p = 0.24$  (direct effect = 0.11; 95% bias-corrected bootstrap CI -0.074, 0.295; see Table 2 for coefficients), providing evidence that SRPs partially mediate the association between anxiety severity and youth irritability.

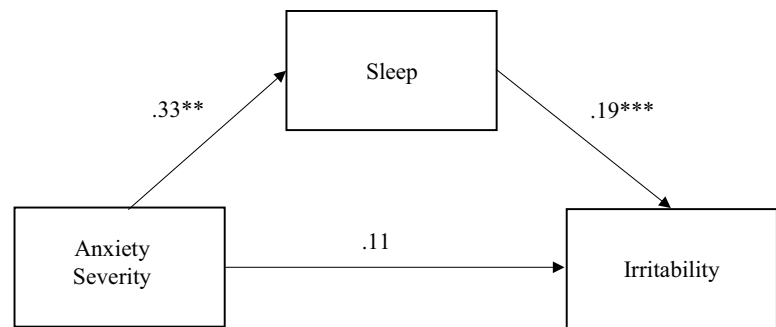
Additional analyses were conducted to examine whether any specific anxiety diagnoses might moderate the observed partial mediation effect. Specifically, we examined the potential moderating effect of GAD, SepAD, and SocAD, using binary moderator variables (e.g., presence or absence

**Table 2** Pairwise correlations among study variables

Variable	Mean	SD	1	2	3	4	5	6
1. Anxiety severity	5.51	0.90	–					
2. Irritability	2.22	1.80	0.15**	–				
3. Sleep problems	4.58	2.14	0.20**	0.24**	–			
4. Depressive disorder severity	0.75	1.67	0.27**	0.19**	0.26**	–		
5. ADHD/DBD severity	0.67	1.5	0.12*	0.23**	-0.01	-0.01	–	
6. Age	12.66	2.97	0.20**	-0.06	0.15**	0.34**	0.04	–
7. Sex	0.55	0.50	0.01	0.01	0.03	-0.04	-0.15**	0.04

\* $p < 0.05$ , \*\* $p < 0.01$

**Fig. 1** Indirect association between anxiety severity and irritability, via sleep-related problems. Note: Model also includes the following covariate predictors of irritability: depressive disorders ( $b=0.20^{***}$ ), disruptive behavior disorders ( $b=0.29^{***}$ ), age ( $b=-.11^{***}$ ), and gender ( $b=0.17$ ).  $*p<0.05$ ,  $**p<0.01$ ,  $***p<0.001$



of GAD) in our models. Analyses revealed that the mediation effect was not moderated by the presence or absence of any specific anxiety disorder (all  $p$ 's  $> 0.05$ , data not shown).

## Discussion

The present study offers the first examination of the extent to which SRPs mediate links between anxiety severity and youth irritability. Despite prior observations of significant pairwise relationships between anxiety and irritability [8, 13, 14], between anxiety and SRPs [15–17, 19], and between irritability and SRPs [20–23], prior to this investigation research had not yet considered whether the association between youth anxiety and irritability may be, in part, accounted for by SRPs. In a large clinical sample, we found preliminary support that SRPs do indeed partially explain the relationship between anxiety severity and irritability among anxious youth. The present findings add to a growing body of research underscoring the centrality of SRPs in the clinical portrait of anxious youth [15–17, 19], and suggest that targeting SRPs in the treatment of youth anxiety may, among other things, improve irritability associated with youth anxiety.

The present findings are consistent with work highlighting how, across clinical populations, youth SRPs prospectively predict worsening problems with behavior and emotional functioning [45]. Moreover, experimental studies of sleep restriction have suggested a causal impact of short sleep on problems with emotion regulation and irritability [20]. Accordingly, studies have recommended that assessment of youth psychopathology should systematically include evaluation of sleep patterns, as SRPs can underlie, contribute to, or exacerbate symptom presentations [36, 45]. The present findings suggest clinical evaluations of anxious youth would do well to more systematically evaluate sleep patterns, as anxious children may be particularly vulnerable to the role that SRPs may play in the excessive reactivity to emotional stimuli and low threshold for frustration [8]. The developmental period of adolescence may be especially critical for these considerations given changes in systems

underpinning sleep as well as emotional regulation [46]. Proper assessment and treatment of SRPs may therefore aid in the comprehensive treatment planning for anxious youth during this sensitive period of adolescent development.

Importantly, the presently observed associations between youth anxiety, SRPs, and irritability were uniform across anxiety diagnoses. Specifically, the mediating effect of SRPs on the relationship between youth anxiety and irritability was not moderated by the presence or absence of any specific anxiety diagnoses. Although GAD and SepAD are the only two anxiety diagnoses with SRPs explicitly included in their definition, and GAD is the only anxiety diagnosis with irritability explicitly included among the associated symptoms in its definition, there was no indication of differential relationships between anxiety, sleep, and irritability in youth with versus without these anxiety disorders. Given elevated SRPs and irritability found across the anxiety disorders [8, 15, 26], and given that the present associations were robust across anxiety diagnoses, diagnostic nomenclature and psychiatric taxonomies may do well to reconsider the extent to which these symptoms should be exclusively part of the GAD and SepAD definitions. Moreover, the present findings may support a more dimensional assessment of anxiety and sleep related problems, consistent with recent advances and funding initiatives [47, 48].

The present study is an important first examination of the relationship between SRPs, anxiety, and irritability within a large clinical sample of anxious youth, but several limitations merit comment. First, the study was a cross-sectional analysis, and as such causal relationships cannot be inferred and matters of temporal precedence among study variables remain untested [49]. Additional longitudinal designs are needed in order to examine how relationships among anxiety, SRPs, and irritability unfold across development. Second, our sample was drawn from families seeking services for youth anxiety problems at university-affiliated clinics, and the majority of the sample were non-Hispanic Caucasian youth. As such, despite diagnostic and economic diversity, the present findings may not generalize to youth in other settings (e.g., community settings, non-university-affiliated clinics), or to youth from racial or ethnic minority



backgrounds. Third, although the assessment methods we used to measure SRPs and irritability have been used in a number of prior studies [8, 35–37, 41, 42, 50], they may not capture key aspects of SRPs (e.g., bedtime resistance, sleep anxiety, night wakings) and irritability (e.g., chronic versus episodic irritability). Therefore, the present models do not clarify which aspects of sleep problems may be particularly relevant in the association between anxiety and irritability. Future work breaking down SRPs into subdomains is needed to clarify whether various forms of SRPs are differentially associated with anxiety and irritability. Similarly, although the present analyses are focused on SRPs as the potential link between anxiety and irritability, several other variables may mediate the link between anxiety and irritability. Future work would do well to consider whether other key factors also underlie this relationship. Additionally, support for our findings would have been bolstered by incorporating other measurements of anxiety severity in addition to the ADIS CSR. Measurement limitations in the present study may have played a role in the somewhat modest effect sizes of some of the observed relationships, although the magnitude of associations are consistent with previous work in this area [8]. Moreover, as our assessments of both SRPs and irritability used items from the parent-report CBCL, shared method variance may have inflated the presently observed associations between youth SRPs and irritability. Parent report may also be limited due to a potential lack of awareness of their children's sleeping behaviors, particularly for older children. These concerns, however, are somewhat tempered by previous work drawing on different method sources to identify significant associations between youth SRPs and irritability [20]. Additionally, despite elevated rates of SRPs, anxiety, and irritability among youth with autism spectrum disorder (ASD) [51], the ADIS is not an appropriate diagnostic tool for identifying ASD, and thus we were unable to account for ASD in our analyses.

Despite these limitations, the present study adds to the growing body of literature underscoring the importance of sleep in anxious youth [15, 16, 19], and offers the first empirical examination of the mediating effect of SRPs on the relationship between anxiety severity and irritability among anxious youth. These findings can help inform treatment planning for anxious youth. Although supported cognitive-behavioral therapies (CBT) for youth anxiety that do not explicitly focus on sleep can nonetheless reduce some SRPs associated with child anxiety [52, 53], some anxious youth—particularly those showing severe irritability—may benefit from treatments that more directly target SRPs as part of treatment planning. Additionally, future work with multi-method sleep assessments (e.g., diary, actigraphy, parent and child report, clinical interview) may allow the examination of specific types of SRPs that may predict irritability, which in turn can inform targeted interventions. Moreover, given

that sleepiness, sleep difficulties, activation, and irritability have each been associated with selective serotonin reuptake inhibitors [54–57], anxious youth presenting with SRPs and irritability may do well to consider psychosocial treatment options as their first step in treatment prior to considering pharmacologic treatment options, although controlled evaluations of this issue are needed.

## Summary

Although recent studies have linked child anxiety to irritability, prior to the present study research had not yet examined the mechanisms through which child anxiety might be associated with irritability. The present study considered whether SRPs mediated the relationship between anxiety severity and irritability in a large sample of treatment-seeking anxious youth, and indeed found there was a significant indirect effect of child anxiety severity on irritability, via SRPs. This analysis was the first to examine youth anxiety, irritability, and SPRs in a single model in a sample of anxious youth, and provides preliminary evidence that SRPs partially mediate links between child anxiety and irritability. These findings add to a growing body of research underscoring the centrality of SRPs in the clinical portrait of anxious youth, and suggest that targeting SRPs in the treatment of youth anxiety may, among other things, improve irritability associated with child anxiety.

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