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Better sleep, better life? How sleep quality influences children's life satisfaction

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Abstract

Purpose To assess the association between children's sleep quality and life satisfaction; and to evaluate the underlying mechanisms of this relationship.

Methods Three pediatric cohorts in the National Institutes of Health (NIH) Environmental influences on Child Health (ECHO) Research Program administered Patient-Reported Outcome Measurement Information System (PROMIS®) parent-proxy measures to caregivers ($n = 1111$) who reported on their 5- to 9-year-old children's ($n = 1251$) sleep quality, psychological stress, general health, and life satisfaction; extant sociodemographic data were harmonized across cohorts. Bootstrapped path modeling of individual patient data meta-analysis was used to determine whether and to what extent stress and general health mediate the relationship between children's sleep quality and life satisfaction.

Results Nonparametric bootstrapped path analyses with 1000 replications suggested children's sleep quality was associated with lower levels of stress and better general health, which, in turn, predicted higher levels of life satisfaction. Family environmental factors (i.e., income and maternal mental health) moderated these relationships.

Conclusion Children who sleep well have happier lives than those with more disturbed sleep. Given the modifiable nature of children's sleep quality, this study offers evidence to inform future interventional studies on specific mechanisms to improve children's well-being.

Keywords ECHO · Life satisfaction · Positive health · Sleep quality · Well-being

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Abbreviations

ANOVA	Analysis of variance
CFI	Comparative fit index
CI	Confidence interval
ECHO	Environmental influences on Child Health Outcomes
HRQoL	Health-Related Quality of Life
LRT	Likelihood ratio test
NIH	National Institutes of Health
PROMIS	Patient-Reported Outcomes Measurement Information System
RMSEA	Root Mean Square Error of Approximation
SD	Standard deviation
SRMR	Standardized root mean squared residual
TLI	Tucker–Lewis Index

Sleep quality, or the adequacy of and satisfaction with sleep [1], is a core component of sleep health. The National Sleep

Foundation recently operationalized sleep quality via sleep continuity indicators, including sleep latency and efficiency, awakening after sleep onset, and frequency of nighttime awakenings > 5 min [2]. Recently deemed a national priority in the USA [3, 4], sleep quality is a critical contributor to general health and well-being across the lifespan, with broad public health significance. More than one-third of US 6- to 9-year-old children have inadequate sleep according to their parents—up from 23% in 2003—and inadequate sleep increases in adolescence to nearly half of US teenagers [5]. For children and youth, consequences of poor sleep quality span physical, mental, and social health outcomes [6–11]. Although the direction of associations has not been definitively established, epidemiological findings from prospective longitudinal studies indicate that poor sleep quality early in life predicts health issues later in life as well, including emotional and behavioral problems and substance use in adolescence and adulthood, as well as worse health-related quality of life (HRQoL) [12–14].

Prior research emphasizes poor sleep quality and associations with health problems, illness, and impairment. Whether *better* sleep quality promotes *positive* health (well-being), particularly in childhood, remains a gap in the literature. Studies with adults suggest sleep is a crucial health asset that enables optimal functioning, including better general health and HRQoL as well as well-being, including positive affect, life satisfaction, and purpose in life [15, 16]. The limited research in pediatric populations focuses on older children and adolescents and suggests sleep characteristics that underpin sleep quality (i.e., longer sleep duration, earlier bedtimes, non-disrupted sleep) are associated with higher life satisfaction and HRQoL [17–19]. Less is known about whether such associations are present earlier in childhood.

This dearth of research may be due to limitations in reliable and valid measures for this age group. Several existing instruments [20–23] have contributed to the burgeoning knowledge on the importance of well-being—and life satisfaction in particular—as both an outcome and predictor of positive physical, mental, and social functioning (see [24–26] for reviews); however, such measures have limited content validity because they were developed without input from children and families and did not undergo cognitive testing to ensure comprehensibility and developmental appropriateness [27]. The recently developed National Institutes of Health's (NIH) Patient-Reported Outcomes Measurement Information System (PROMIS®) parent-proxy measures now make it possible to evaluate this relationship [28, 29]. Using these US population-based norm reference measures, the current study examines whether and how sleep quality influences children's well-being. In particular, we focus on children's life satisfaction—defined an individual's assessment of his/her life as good and satisfying [24]—as an indicator of well-being because of its strong positive relationship with a myriad of favorable youth developmental outcomes and its ability to mitigate the negative effects of stressful life events and poor parenting styles [24, 25, 30].

Using combined cross-sectional parent-report data from three pediatric cohorts, we examined whether 5- to 9-year-old children's sleep quality is associated with their life satisfaction, and the underlying mechanisms of this relationship. Based on previous research with adolescents and adults, we propose a model (Fig. 1) where (1) poor sleep quality is positively associated with psychological stress (path a; [9, 31]) and negatively associated with general health (path b; [1, 10, 32]); (2) stress is negatively associated with general health (path c; [31, 33]) and life satisfaction (path d; [27,

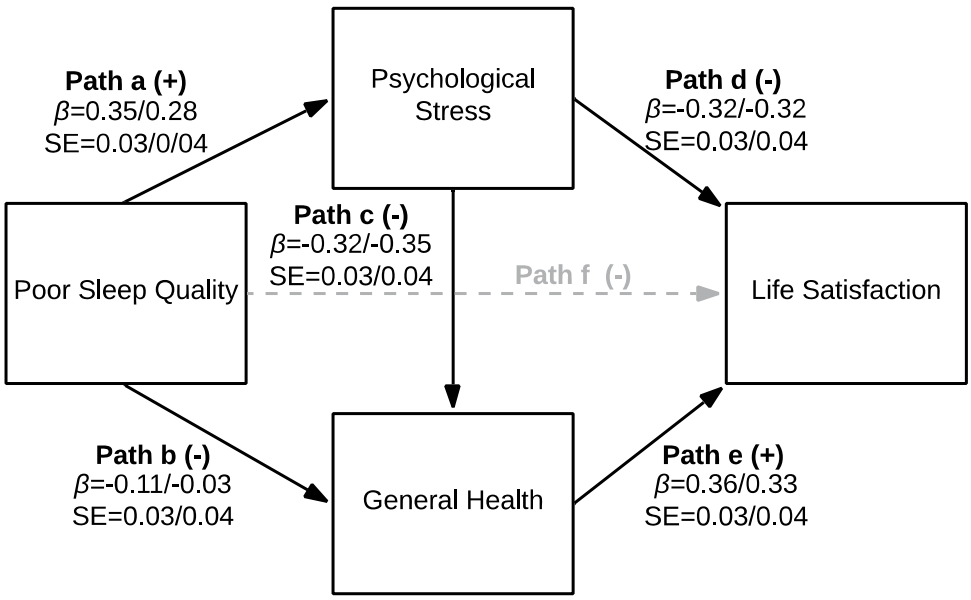

Fig. 1 Hypothesized path model and path intercepts (β) and standards errors (SE) (Model 1—full sample/Model 2—subsample). Paths a, b, and c control for child age, sex, race, Hispanic origin, annual family income, and maternal mental health problems. Paths d and e control for annual family income and maternal mental health problems. Path f was not significant in either model and did not change model fit; thus, path f was dropped from the final models

33]); and (3) general health is positively associated with life satisfaction (path e; [33]). We also examined whether poor sleep quality has a direct negative relationship (i.e., unmediated) with life satisfaction (path f; [15, 16]).

Methods

This study draws on data collected for the National Institutes of Health (NIH) Environmental influences on Child Health (ECHO) Research Program (see [34] for overview) as part of the Positive Health Volunteer Pilot Study. Between March and December 2017, investigators from 3 ECHO cohorts administered PROMIS Parent-Proxy Sleep Disturbance [32], Life Satisfaction [27], Global Health [28], and Psychological Stress Experiences [29] measures to caregivers who completed these surveys about their children. We did not impose specific inclusion and exclusion criteria on the basis of sleep quality or disorders. Cohorts also shared previously collected data pertaining to child and family sociodemographics. The institutional review board at each cohort's home institution approved data collection and sharing, and the lead Institutional Review Board approved de-identified sharing of data for secondary data analyses under protocol #STU00203654.

A total of 1111 caregivers completed all 4 PROMIS measures for 1251 children ages 5 to 9 years (mean: 6.5, Standard Deviation [SD]: 1.3). Participants primarily resided in the Midwest (77%), with 13% in the South, 8% in the Northeast, 2% in the West (based on region designation by the U.S. Census Bureau). Approximately half of children were male (53%), 79% were white, and 10% were Hispanic. Children came from diverse income levels, including 21% from households making ≤ $20,000/year (see Table 1 for complete demographic information).

Measurements

Sleep quality

Sleep quality was evaluated using the 4-item PROMIS Parent-Proxy Sleep Disturbance Short Form 4a ($\alpha = 0.79$) [32], which evaluates sleep onset, continuity, and satisfaction in the past 7 days on a 5-point Likert scale anchored by *never* and *always*. A lower score reflects better sleep quality.

Stress

Stress was evaluated with the 4-item PROMIS Parent-Proxy Psychological Stress Experiences Short Form 4a ($\alpha = 0.79$) [29], which assesses perceptions of feeling overwhelmed and unable to manage general life stress in the past 7 days on a 5-point Likert scale from *never* to *always*. A lower score reflects lower stress.

General health

General health was measured with the 7-item PROMIS Parent-Proxy Global Health 7 ($\alpha = 0.78$) [28], which provides a global measure of physical, mental, and social health and well-being. The instrument includes 4 omnibus items (e.g., "In general, would you say your child's health is…") measured without a specific timeframe on a 5-point Likert scale from *excellent* to *poor* and 3 social-emotional items (e.g., "How often does your child have fun with friends?") measured on a 5-point Likert scale from *always* to *never*. A higher score reflects better general health.

Life satisfaction

Life satisfaction was assessed with the 4-item PROMIS Parent-Proxy Life Satisfaction Short Form 4a ($\alpha = 0.87$) [27], which assesses overall satisfaction with life in the past 4 weeks on a 5-point Likert scale anchored by *not at all* and *very much*. A higher score reflects higher life satisfaction.

We scored PROMIS measures using the standard PROMIS scoring procedures to produce PROMIS *T*-scores with mean = 0 and SD = 1. A score of 50 represents the average sleep, general health, life satisfaction, and psychological stress for children based on national samples used for calibration and norming. See [35] for overview of PROMIS scoring and measurement development methods and [27–29, 32] for reliability and validity of measures used in this study.

Sociodemographics

Sociodemographics included *child age* in years (continuous from 5 to 9), *sex* (male = 1), *race*, (White, reference; African American; "other race," representing all other categories with sample sizes too small for individual evaluation), and *Hispanic origin* (Hispanic = 1); *annual family income* (≤ $20,000, reference; $20–40,000; $40–60,000; ≥ $60,000); and *maternal mental health problems* (yes = 1), representing whether the mother ever had a mental health problem (e.g., depression, anxiety).

Statistical analysis

We used individual patient data meta-analysis by combining child-level data from all three cohorts (validity of and rationale for selecting this approach for this dataset is discussed elsewhere [33]). We conducted bivariate descriptive analyses (i.e., Pearson's correlations and Analysis of Variance [ANOVA]) to examine associations between PROMIS scores and sociodemographic variables (see

Table 1 Descriptive comparisons between the good/average and poor sleep quality subsamples

	Good/average sleep quality	Poor sleep quality	*p*	Full sample
Number of children	537	714	–	1252
Number of caregivers	460	651	–	1111
Age (years), mean (SD)	6.5 (1.2)	6.5 (1.3)	0.92	6.5 (1.3)
Range	5.0–9.0	5.0–9.0		5.0–9.0
Sex (male = 1), %	55%	51%	0.11	53%
Race, %			0.07	
White	79%	78%	–	79%
African American	7%	5%	–	6%
Other race	14%	17%	–	16%
Hispanic origin, %	13%	8%	< 0.01	10%
Annual family income, %			–	
≤ $20,000	19%	23%	0.06	21%
$20–40,000	18%	19%	–	18%
$40–60,000	34%	35%	–	34%
≥$60,000	30%	23%	–	26%
Single parent, %	13%	9%	0.05	11%
Maternal mental health, %	27%	33%	0.02	30%
Sleep Disturbance, mean (SD)[a]	42.3 (2.1)	56.8 (6.3)	< 0.001	50.6 (8.7)
Range	41.4–49.3	49.6–79.4	–	41.4–79.4
Psychological Stress, mean (SD)[a]	45.8 (7.1)	50.7 (8.3)	< 0.001	48.6 (8.2)
Range	39.6–67.3	39.6–73.5	–	39.6–73.5
General health, mean (SD)[a]	54.3 (8.2)	51.6 (8.1)	< 0.001	52.7 (8.3)
Range	29.4–66.1	27.6–66.1	–	27.6–66.1
Life satisfaction, mean (SD)[a]	54.5 (6.7)	51.8 (7.5)	< 0.001	53.0 (7.3)
Range	34.3–59.2	30.9–59.2	–	30.9–59.2

The cutpoint for "good/average" and "poor" sleep quality was based on the PROMIS Pediatric Parent-Proxy Sleep Disturbance nationally normed scores, where "good/average" represented children at or below the 50th percentile and "poor" represented children above the 50th percentile

–, not applicable

[a]Sleep disturbance, general health, stress, and life satisfaction were assessed with the PROMIS Pediatric Parent-Proxy instruments, which are scored on the PROMIS T-metric (mean = 50, SD = 10). Norm-referenced percentile ranks were derived from nationally representative samples through calibration and centering such that the 50th percentile represents an average PROMIS T-score of 49.3 (range 41.4–80.3) for sleep (lower scores reflect better sleep quality); 49.9 (range 14.7–66.1) for general health (higher scores reflect better health); 55.3 (range 20.2–59.2) for life satisfaction (higher scores reflect higher life satisfaction); and 46.2 (range 39.6–82.8) for stress (lower scores reflect lower stress)

Table 2; Supplementary Table 1). We used standard intervals established in the literature to evaluate the strength of correlations ($r = 0$, *no correlation;* $r =$ below ± 0.10, *low*; $r = \pm 0.30$, *moderate*; $r \pm \geq 0.50$, *large*; $r = 1$, *perfect correlation*) [36]. Due to floor effects of the sleep quality measure, we conducted Pearson's chi-square and ANOVAs to evaluate observed differences between children above ("poor" sleep quality) and below ("good" sleep quality) the 50th percentile of nationally normed scores on the PROMIS Parent-Proxy Sleep Disturbance measure (Table 1).

To examine the relationship between children's sleep quality and life satisfaction, we used path modeling with nonparametric bootstrapped standard errors using 1000 replications and normal-based 95% confidence intervals (CI) to account for non-normal distributions of endogenous variables and ensure stability and replicability of model results [37–39]. We controlled for child demographic variables in paths from sleep to stress (path a, Fig. 1) and general health (paths b and c, Fig. 1) but not for life satisfaction based on extant research showing they exert little influence on this outcome [24–26], particularly for younger children. We also controlled for maternal mental health and annual family income in all paths as these are known environmental factors that contribute to the primary variables of interest [40, 41]. Observations with missing values were omitted from the analysis using case-wise deletion ($n = 54$). Bivariate analyses revealed omitted cases had lower stress $F(1249) = 8.65$; $p < 0.01$ and higher life satisfaction $F(1249) = 6.80$; $p = 0.01$,

Table 2 Correlation matrix

	Sleep	General health	Life satisfaction	Stress	Age
Sleep	–				
General health	− 0.19**	–			
Life Satisfaction	− 0.24**	0.4**	–		
Stress	0.38**	− 0.47**	− 0.32**	–	
Age	0.01	− 0.13**	0.01	0.13**	–

**$p < 0.01$

such that models may slightly underestimate relationships (see Supplementary Table 2 for comparisons). However, given the missing cases represent a small proportion of the overall sample, excluding them likely does not strongly influence the final results.

We assessed model fit with x^2 significance ($p > 0.05$ suggests good fit) and the ratio of x^2 to degrees of freedom (df; values < 5 indicate good fit) [42]. Given the susceptibility of x^2 metrics to large sample sizes, we examined additional goodness-of-fit indices: Root Mean Square Error of Approximation (RMSEA) < 0.06; Comparative Fit Index (CFI) and Tucker–Lewis Index (TLI) > 0.95; and Standardized Root Mean Squared Residual (SRMR) < 0.08 [42]. We also examined modification indices to determine if model adjustments should be made. Additionally, we tested a model with a direct path from sleep quality to life satisfaction, and replicated the hypothesized models for the subsample of children with poor sleep quality to confirm it accurately characterized this subset of children. See Table 3 for model results, Fig. 1 for summarized path coefficients, and Supplementary Table 3 for standardized direct, indirect, and total effects of sleep quality, stress, general health, and life satisfaction.

Results

Bivariate analyses

We summarize results from Pearson correlations (Table 2) and ANOVAs (Supplementary Table 1) below by the main exogenous and endogenous variables in the path models. All statistically significant values were at the $p < 0.01$ level, unless otherwise noted.

Sleep quality

Sleep quality was significantly moderately correlated with life satisfaction ($r = -0.24$), general health ($r = -0.19$), and stress ($r = 0.38$), income category $F(3) = 4.57$, and maternal mental health $F(1) = 9.27$, all in the hypothesized directions. Sleep quality was not significantly associated with child age, race, gender, or Hispanic origin. See Table 2 and Supplementary Table 1 for complete results.

General health

General health was significantly moderately correlated with stress ($r = -0.32$), income $F(3) = 16.14$, and maternal mental health $F(1) = 10.63$, all in the hypothesized directions. Additionally, girls, White and "other race" children, and non-Hispanic children had better general health compared to boys $F(1) = 4.01$; $p = 0.05$, African Americans $F(3) = 5.17$, and non-Hispanic children $F(1) = 13.87$, respectively. General health was not associated with child age. See Table 2 and Supplementary Table 1 for complete results.

Life satisfaction

Life satisfaction was significantly moderately correlated with general health ($r = 0.4$), stress ($r = -0.47$), income $F(3) = 10.65$, maternal mental health $F(1) = 10.97$, and child age ($r = -0.13$), all in the hypothesized directions. Additionally, life satisfaction was associated with child race, $F(2) = 3.30$; $p = 0.04$, with African American children having higher life satisfaction compared to White and "other" race children. Alternatively, children's life satisfaction was not significantly associated with child sex or Hispanic origin. See Table 2 and Supplementary Table 1 for complete results.

Stress was significantly moderately associated with income $F(3) = 5.75$ and highly correlated with maternal mental health $F(1) = 43.05$, both in the hypothesized directions. Additionally, younger children, African American children, and Hispanic children had lower stress compared to older children ($r = -0.13$), White and "other" race children $F(3) = 9.72$, and non-Hispanic children $F(1) = 13.01$. Stress was not associated with child sex. See Table 2 and Supplementary Table 1 for complete results.

Full sample analyses

Results showed children's sleep quality predicted psychological stress and general health in the hypothesized directions, with excellent model fit ($x^2(6) = 14.03$, $x^2/\text{df} = 2.34$, $p = 0.03$, CFI = 0.99, TLI = 0.96, RMSEA = 0.03, SRMR = 0.01; Table 3). Children with poor sleep quality had higher levels of psychological stress (path a) and worse health (path b), as

Table 3 Path analysis results evaluating whether children's general health and stress mediate the relationship between sleep quality and life satisfaction for the full sample and subsample of children with above average sleep distance

	Model 1—full sample					Model 2—subsample				
		SE	95% CI		*p* value		SE	95% CI		*p* value
			LL	UL				LL	UL	
Sleep disturbance → stress	0.35	0.03	0.29	0.4	< 0.01	0.28	0.04	0.2	0.35	< 0.01
Covariates → stress										
Age (in years)	0.08	0.03	0.02	0.13	< 0.01	0.08	0.03	0.01	0.15	0.02
Sex										
Female	Ref					Ref				
Male	− 0.02	0.03	− 0.07	0.03	0.53	− 0.02	0.04	− 0.09	0.05	0.64
Race										
White	Ref					Ref				
Black/African American	− 0.09	0.03	− 0.14	− 0.04	< 0.01	− 0.1	0.04	− 0.17	− 0.03	< 0.01
Other race	− 0.01	0.03	− 0.07	0.05	0.67	− 0.01	0.04	− 0.09	0.08	0.87
Hispanic origin										
Non-Hispanic	Ref					Ref				
Hispanic	− 0.08	0.03	− 0.13	− 0.02	< 0.01	− 0.09	0.04	− 0.17	− 0.01	0.03
Annual household income										
$20,000	Ref					Ref				
$20–40,000	− 0.02	0.03	− 0.08	0.05	0.58	− 0.01	0.04	− 0.1	0.07	0.76
$40–60,000	− 0.03	0.04	− 0.1	0.05	0.45	− 0.09	0.05	− 0.18	0.01	0.08
$60,000	− 0.1	0.04	− 0.17	− 0.03	< 0.01	− 0.11	0.05	− 0.2	− 0.02	0.02
Maternal mental health										
No problems	Ref					Ref				
Problems	0.14	0.03	0.09	0.19	< 0.01	0.12	0.04	0.05	0.19	< 0.01
Sleep disturbance → general health	− 0.11	0.03	− 0.16	− 0.05	< 0.01	− 0.03	0.04	− 0.1	0.04	< 0.01
Stress → general health	− 0.32	0.03	− 0.38	− 0.27	< 0.01	− 0.35	0.04	− 0.42	− 0.28	0.36
Covariates → general health										
Age (in years)	0.01	0.03	− 0.04	0.06	0.69	0	0.03	− 0.07	0.06	0.96
Sex										
Female	Ref					Ref				
Male	− 0.07	0.03	− 0.12	− 0.02	0.01	− 0.07	0.03	− 0.14	0	0.04
Race										
White	Ref					Ref				
Black/African American	− 0.11	0.03	− 0.17	− 0.05	< 0.01	− 0.13	0.04	− 0.2	− 0.05	< 0.01
Other race	0.07	0.03	0.01	0.13	0.02	0.07	0.04	− 0.01	0.14	0.09
Hispanic origin										
Non-Hispanic	Ref					Ref				
Hispanic	− 0.12	0.03	− 0.18	− 0.07	< 0.01	− 0.06	0.04	− 0.14	0.01	0.09
Annual household income										
$20,000	Ref					Ref				
$20–40,000	0.05	0.03	− 0.02	0.12	0.14	0.12	0.04	0.03	0.2	< 0.01
$40–60,000	0.14	0.04	0.07	0.21	< 0.01	0.2	0.05	0.11	0.29	< 0.01
$60,000	0.17	0.04	0.1	0.25	< 0.01	0.24	0.05	0.14	0.33	< 0.01
Maternal mental health										
No problems	Ref					Ref				
Problems	− 0.01	0.03	− 0.07	0.04	0.68	0	0.04	− 0.07	0.08	0.89
Stress → life satisfaction	− 0.32	0.03	− 0.38	− 0.26	< 0.01	− 0.32	0.04	− 0.39	− 0.24	< 0.01
General health → life satisfaction	0.36	0.03	0.3	0.41	< 0.01	0.33	0.04	0.26	0.41	< 0.01

Table 3 (continued)

	Model 1—full sample					Model 2—subsample				
		SE	95% CI		*p* value		SE	95% CI		*p* value
			LL	UL				LL	UL	
Covariates → life satisfaction										
Annual household income										
$20,000	Ref					Ref				
$20–40,000	0.03	0.03	− 0.03	0.1	0.23	0.04	0.04	− 0.04	0.12	0.32
$40–60,000	0.02	0.03	− 0.04	0.08	0.55	0.02	0.04	− 0.06	0.11	0.57
$60,000	0.08	0.03	0.02	0.15	< 0.01	0.12	0.04	0.04	0.2	< 0.01
Maternal mental health										
No problems	Ref					Ref				
Problems	0	0.02	− 0.05	0.05	0.97	− 0.02	0.03	− 0.09	0.04	0.51
Stress error variance	0.81	0.02	0.77	0.85	–	0.87	0.02	0.82	0.92	–
General health error variance	0.81	0.02	0.77	0.85	–	0.8	0.03	0.75	0.86	–
Life satisfaction error variance	0.67	0.02	0.62	0.72	–	0.68	0.03	0.62	0.74	–

Results reflect bootstrapped standard errors and normal-based confidence intervals

– not applicable, *SE* standard error, *95% CI* 95% confidence interval, *LL* lower limit, *UL* upper limit, *Ref* reference category

reported by their caregivers. Stress had a negative association with general health (path c) and life satisfaction (path d); in turn, general health positively predicted children's life satisfaction (path e; see Fig. 1). Additionally, the total indirect effect of poor sleep quality on life satisfaction via stress and general health was significant, as was the indirect effect of stress on life satisfaction via general health (Supplementary Table 3). We also tested whether adding a direct path from sleep quality to life satisfaction improved model fit using the likelihood ratio test (LRT), but this additional path did not significantly change model fit ($\Delta df = 1$, $\Delta x^2 = 0.10$, $p = 0.75$) and was thus dropped from the model.

Subsample analyses

Results from secondary analyses with the subsample of children with poor sleep quality ($n = 695$) confirmed that the original hypothesized model appropriately fit the observed data ($x^2(6) = 10.53$, $x^2/df = 1.76$, $p = 0.10$, CFI = 0.99, TLI = 0.95, RMSEA = 0.03, SRMR = 0.01; Table 3; Fig. 1). The path from sleep quality to general health was not significant (path b). Additionally, the total indirect effect of poor sleep quality on life satisfaction via stress and general health was significant, as was the indirect of stress on life satisfaction via general health (Supplementary Table 3). Using the LRT, we examined whether adding a direct path from sleep quality to life satisfaction improved model fit, but the path was not statistically significant (95% CI [0.0, 0.12]), nor did it change model fit ($\Delta df = 1$, $\Delta x^2 = 3.39$, $p = 0.07$); therefore, we dropped it from the model and retained the same model as the full sample.

Discussion

While extant literature primarily focuses on the negative impacts of poor sleep, results from this study add to an emerging body of work examining associations of sleep quality on children's positive well-being. As numerous studies have established positive relationships between life satisfaction and children's positive affect, self-esteem, self-confidence, and resiliency [20, 24–26], as well as long-term implications of positive well-being on adult health outcomes [14], the importance of understanding how modifiable factors such as sleep quality directly or indirectly influence children's well-being cannot be understated.

Findings from the current study suggest better quality sleep is associated with higher life satisfaction via lower psychological stress and better general health; such results remained stable for the subsample of children with poor sleep quality, suggesting the underlying mechanisms by which sleep quality influences well-being are robust across the normal-abnormal sleep quality spectrum. These findings reflect and extend prior theoretical and empirical evidence from adolescent and adult literature [19, 31, 43] to younger children.

Whereas much of the extant literature focuses on stress as a predictor of sleep and sleep as a predictor of general health, we examined stress as a potential mediator of children's sleep quality and life satisfaction based on studies with adult populations [43, 44]. Conceptualizing poor sleep as a neurobiologic and physiologic stressor that, in turn, increases stress and decreases overall health and well-being, we found a stronger relationship between sleep and

psychological stress compared to sleep and general health. This finding is consistent with previous research that identified associations between poor sleep quality and stress dysregulation [6] and elevated blood pressure [7]—an indicator of physiological stress. Further, stress mediated associations between sleep quality and life satisfaction and general health, suggesting that improving sleep quality could lead to improvements in children's life satisfaction as well as general health via decreasing stress. This is an important message for caregivers, who may understand that adequate sleep and low stress are important for school performance and mood, but may be unaware of the role of sleep quality in possibly decreasing stress and, in turn, enhancing children's life satisfaction.

Given that children's stress is among the top health concerns for US parents [45], educating families and communities on sleep's impact on stress, among other developmental outcomes, could be one path to boosting children's health and well-being. As [31] noted, however, sleep quality is critical to address above and beyond stress. Such education programs would require concrete strategies for overcoming barriers to high-quality sleep at the child, caregiver, and community levels. For example, not having a TV in the bedroom or engaging with digital media in the hour before bedtime are associated with better sleep quality in children [46, 47]. Having a consistent bedtime routine, including reading before bedtime and going to bed before 9 pm, and not consuming caffeine are also associated with better sleep quality [47]. Clinicians may be particularly suitable to promote such strategies, as parents are more likely to seek out parenting advice from pediatricians than any other non-familial source [48]. Alternatively, adjusting school start times to accommodate bus schedules has led to decreases in sleep duration and detrimental ramifications on student academic performance and behavior [17] such that broader public policy changes may be required to adequately address children's sleep quality.

Published data from intervention and education programs have primarily targeted infancy [49], the preschool years [50], and adolescents [51], with less work focused on middle childhood. Additionally, the research literature overwhelmingly focuses on sleep duration as the primary indicator of sleep health, with less attention given to other sleep characteristics that contribute to sleep quality. Further, to date, little to no policy-related research (e.g., school start times, homework policies, napping schedules) that may impact the sleep health of 5- to 9-year-old children is available. One study did assess the effects of advancing school start times in school-age children and found increases in behavioral problems, as well as in-school removals, suspensions, and expulsions [52]. Thus, there remain critical gaps in data needed to support making policy recommendations affecting sleep and life satisfaction in young school-age children.

The current study has several limitations that should be considered when interpreting results. First, the data were not nationally representative such that findings may not generalize to the broader US population. While results for child race were significant, the sample was not representative for a detailed subgroup analysis by race. Additionally, we did not have data on sleep duration (i.e., how many hours of sleep, on average, children got each night), but focused specifically on sleep quality given the lack of prior work on this component of sleep health and suggestions that sleep quality is a unique and equally important contributor to health outcomes than duration [53]. Data came from parental reports of children's sleep quality, stress, general health, and life satisfaction, versus child self-report. While associations between parent and child reports are low to moderate [54], using parent-proxy reports is a common and necessary strategy, particularly for younger children who unable to provide reliable self-reports [35]. Most person-reported outcome measurement tools begin at age 8 for child self-report, and those that obtain self-reports from younger children often require interviewer-administered surveys or qualitative interviews; such methods are not feasible for population health research endeavors. Alternatively, PROMIS parent-proxy instruments are particularly useful for large-scale epidemiological studies such as ECHO, where balancing brief and efficient assessments with scientific rigor are of utmost importance.

Second, the data were cross-sectional, limiting the ability to establish the directionality of the relationship between sleep quality, stress, general health, and life satisfaction. For example, it is plausible that higher stress may lead to poorer sleep and worse health, which in turn could decrease life satisfaction. Most likely, associations between sleep quality and stress are bidirectional in nature during childhood. The current study, however, is a first step in establishing whether sleep quality and life satisfaction are related and identifying potential mediators. Future longitudinal studies are required to determine how and when the associations identified emerge during childhood.

Third, the PROMIS measure aligns with the core sleep quality indicators put forth by the National Sleep Foundation [2], but only includes 1 positively framed item along with 3 negatively framed items. The negative framing is not unique to the PROMIS instrument, as other instruments for children's sleep health also focus on poor sleep quality [55, 56]. Such an emphasis is consistent with the broader healthcare focus on alleviating suffering.

Finally, this study examined one component of well-being (i.e., life satisfaction), and associations may differ with other components of this multidimensional construct (e.g., positive affect and purpose in life). Given the interrelatedness of such constructs, we expect similar relationships with sleep quality during childhood, but future work can build upon the foundation provided here to examine such associations.

Conclusion

Overall, this study provides novel insight into associations between sleep quality and children's life satisfaction, as well as the underlying mechanisms of this relationship. Given the reality that many children who experience disease or illness continue to grow emotionally, cognitively, and behaviorally, and lead fulfilling and satisfying lives [33], the current focus on negative outcomes resulting from poor sleep quality may devalue individuals' lived experience. Alternatively, adopting a positive health perspective and defining health as more than the absence of disease shifts the focus to processes that promote positive growth and development; this perspective moves beyond traditional healthcare models that seek to treat problems by, instead, placing positive well-being at the center of care.

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Compliance with ethical standards

Conflict of interest The authors have no conflicts of interest relevant to this article to disclose.

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