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An Exploratory Study of Sleep Habits in School-Aged Survivors of Retinoblastoma

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Abstract

Objective/Background: Retinoblastoma is an ocular cancer diagnosed in early childhood. Previous research has indicated the impact of cancer treatment on sleep, but little is known about how sleep is impacted among survivors of retinoblastoma. The current study aimed to describe sleep habits of school-age survivors of retinoblastoma, to examine associations between sleep and quality of life, and to examine concordance between parent and child reports of sleep habits.

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Competing Interest Statement
The authors have no competing interests to declare.

Patients/Methods: Sixty-nine survivors of retinoblastoma (*Mage*=10.89, *SD*=1.07, 50.7% female; 56.5% unilateral disease) and their caregivers participated, providing information on both self- and parent-reported sleep habits, quality of life, and demographic data.

Results: Greater sleep concerns than national norms were reported by parents (bedtime resistance ($t(58)=2.69$, $p=.009$), greater sleep onset delay ($t(66)=2.46$, $p=.017$), shorter sleep duration ($t(57)=2.12$, $p=.038$), increased daytime sleepiness ($t(53)=6.45$, $p=<.001$)) and children (sleep location ($t(61)=2.39$, $p=.02$), restless legs syndrome ($t(62)=-2.21$, $p=.03$), parasomnias ($t(64)=19.19$, $p=<.001$)) . Both children and parents of children who received enucleation endorsed greater sleep concerns across several domains (e.g., electronic use before bed, sleep-disordered breathing). Child- and parent-reported sleep concerns were generally associated with decreased quality of life. Finally, child- and parent-report of sleep habits appeared generally consistent.

Conclusions: Survivors of retinoblastoma experience sleep difficulties. As such, assessment and targeted intervention is important to mitigate any effects on quality of life. Future research should examine sleep habits of survivors of retinoblastoma across cultures and developmental periods.

Keywords

retinoblastoma; sleep habits; quality of life; children; cancer survivorship

1. Introduction

Retinoblastoma is a rare form of childhood cancer, diagnosed in about 250 to 300 children in the United States each year.[1] Originating in the retina of the eye, the disease may occur in one (unilateral) or both eyes (bilateral). It is most commonly diagnosed in young children before the age of 4 years, with mean ages of diagnosis of 25 months for unilateral retinoblastoma and 13 months for bilateral. Although the survival rate for children with retinoblastoma in developed countries is extremely high (>95%),[2] common treatment for the disease, including chemotherapy, focal therapies, radiation, and/or enucleation (e.g., surgical procedure that involves removal of the globe and sclera while preserving other orbital and periorbital structures),[3] has the potential to significantly impair a child's quality of life through reduced vision. However, relatively little is known about the physical and emotional functioning of this population, particularly how their sleep may be impacted and whether sight-related difficulties may exacerbate sleep concerns after treatment and into survivorship.

While research is limited on sleep-related concerns specifically among retinoblastoma patients, sleep problems are widely recorded as one of the most chronic side effects experienced by pediatric cancer patients and survivors. Approximately 50-90% of childhood cancer survivors report significant sleep disturbances, particularly insomnia and fatigue, after treatment completion.[4–7] Long-term survivors of childhood cancer commonly experience sleep disturbances such as low-quality sleep, excessive daytime sleepiness (EDS), snoring or sleep apnea, and the inability to initiate or maintain sleep.[6,8–11] For example, the prevalence rate of EDS in survivors of childhood cancer is 14-35%,[12,13] and sleep disordered breathing impacts up to 40% of children with cancer.[14] Additionally, the sleep habits of children with cancer are significantly impacted due to a variety of factors such as the nature of their treatment and the hospital environment.[15,16] Previous research

indicates that poor sleep habits are closely related to poor sleep outcomes.[13] Given the many difficulties associated with sleep that may be experienced by pediatric cancer patients and survivors broadly,[17] it is important to examine sleep difficulties experienced by patients with retinoblastoma.

Quality of life is an important factor when considering the impact of sleep difficulties on children with oncology diagnoses. Poor sleep in survivors of pediatric cancer is associated with reduced quality of life, especially when coupled with emotional and attentional difficulties.[4,18–20] Further, sleep disturbance causes dysfunction in several daily functioning and life domains including cognitive difficulties such as executive functioning,[21–24] behavioral functioning,[24] and social and peer relationships.[25–28] Interestingly, however, previous research has found that pediatric cancer survivors and caregivers perceive differential levels of impairment as a result of sleep difficulties, with parents rating survivors' sleep difficulties as resulting in greater impairment.[13,29,30] The prevalence of sleep concerns among survivors of childhood cancer coupled with the significant impairments that may occur as a result of sleep difficulties underscore the importance of better understanding whether such concerns are also present in survivors of retinoblastoma. Additionally, it is important to further understand how both survivors of retinoblastoma and their caregivers view any impacts of sleep difficulties. Understanding the concordance or discordance between caregivers' and survivors' perceptions may help illuminate specific concerns related to sleep difficulties, which could allow for improved interventions.

Children with retinoblastoma frequently experience impaired vision as a result of their disease and treatment, up to and including loss of an eye and/or blindness. Importantly, many children with visual impairments experience some form of sleep disturbance.[31–33] Further, in patients with altered light perception, the circadian rhythm can be significantly impacted.[34] Additionally, the resultant alterations in circadian rhythm and disruptions within the hypothalamic-pituitary axis can lead to the lack of melatonin suppression, thus resulting in further change in sleep-wake patterns among individuals with visual impairment.[35] For example, it is estimated that up to 50% of individuals who are completely blind experience a non-24-hour sleep-wake disorder.[36] As a whole, previous research indicates that sleep disturbances among children with visual impairment are often the result of sleep-wake rhythm disorders due to a lack of input to the circadian clock.[37] Such sleep disturbances may have significant impact on overall quality of life.

Given the prevalence of sleep concerns in survivors of childhood cancer, as well as that experienced by those with vision impairment, it was deemed critical to examine the sleep habits of youth with retinoblastoma specifically as this may be a population of survivors of childhood cancer that is particularly vulnerable to sleep-related concerns. Thus, the aims of this study were to 1) describe the sleep habits of school-aged survivors of retinoblastoma, including potential diagnostic or treatment-related risk factors, 2) examine associations between sleep and quality of life, and 3) examine the concordance between parent and child reports of sleep habits.

2. Material and Methods

2.1. Participants

Sixty-nine survivors of retinoblastoma and their caregivers were enrolled on the current study. Children were an average of 10.89 years old (*SD*=1.07) at the time of assessment. Participants were 50.7% female, and approximately 62% of the sample identified as white. Patients were diagnosed with retinoblastoma between 0.3 and 6 years of age (*M*=1.51, *SD*=1.37). The majority of patients were diagnosed with unilateral disease (56.5%, *n*=39), and 69.5% (*n*=48) received enucleation. Two participants had blindness with no light perception as a result of bilateral enucleation; all other survivors with bilateral disease maintained at least some vision in one or both eyes. See Table 1 for demographic and disease background information.

2.2. Procedures and Measures

Patients and caregivers completed serial assessments of psychosocial functioning alongside medical appointments as part of an institutional retinoblastoma protocol. Data for this project were taken from the 10-year-old timepoint. The medical and cognitive outcomes for this study have been previously reported.[38–42] The study was approved by the hospital's Institutional Review Board and consent/assent was obtained via IRB-approved guidelines at the time of initial trial enrollment and again at the 10-year-old timepoint. During the assessment, among other measures, children completed targeted measures assessing sleep difficulties (Children's Report of Sleep Patterns)[43] and caregivers completed concurrent assessment of their child's sleep habits (Children's Sleep Habits Questionnaire).[44] Additionally, both children and caregivers provided report on key domains of quality of life via the Pediatric Quality of Life Inventory (PedsQL).[45–48] Finally, caregivers provided demographic information, and medical information was abstracted via chart review.

2.2.1. Children's Report of Sleep Patterns (CRSP)—The CRSP[43] is a validated 76-item self-report measure that assesses a school-aged child's sleep difficulties on three broad modules, including sleep patterns (i.e., bed time, wake time, sleep onset latency, night wakings, sleep duration, naps, sleep schedule variability, and subjective sleep quality), sleep hygiene (i.e., caffeine use, activities in the hour before bed, sleep location, and electronics used at the time of sleep onset), and sleep disturbances (i.e., bedtime fears/worries, restless legs syndrome, parasomnias, and insomnias). As each of the three modules may be administered independently, for the current study, only the sleep hygiene indices and sleep disturbances modules were administered. All questions on this measure are answered for four separate time frames, including, "in the last night," "typical weekdays when the child is in school," "typical weekends/holidays when the child is not in school," and overall sleep on "most days." Higher scores indicate poorer sleep hygiene or greater levels of sleep disturbance; however no clinical cutoffs have been established. Meltzer et al.[43] provide normed data for items/subscales within both the sleep hygiene indices and the sleep disturbances scales.

2.2.2. Children's Sleep Habits Questionnaire (CSHQ)—The CSHQ[44] is a psychometrically strong 45-item measure that is completed by caregivers to assess

behavioral and medical-based sleep concerns for their children. Based on data gathered from control and clinical samples, the CSHQ broadly assesses eight domains related to common childhood sleep difficulties including bedtime resistance, sleep onset delay, sleep duration, bedtime anxiety, night wakings, parasomnias, sleep disordered breathing, and daytime sleepiness.[44] Questions (e.g., Child resists going to bed at bedtime, Child wakes up more than once during the night) are rated on a five-point response scale based on sleep-related behaviors during an average week (e.g., never, rarely, sometimes, usually, always). Rating scores are summed to create a Total Sleep Disturbance Index, where higher scores (≥41) are indicative of a pediatric sleep disorder. Owens and colleagues[44] also provided normative data from a community sample.

2.2.3. Pediatric Quality of Life Inventory (PedsQL)—The PedsQL is a 23-item self- and parent-report measure that assesses health-related quality of life, with the same items included for both self- and parent-report.[45–48] The measure is broken down into four separate subscales: physical, emotional, social, and school functioning. Previous research indicates that both child and caregiver versions of the PedsQL yield excellent internal consistency reliability across the four subscales.[46] The measure also provides three summary scores that can be derived from the subscales, including the physical health summary score, psychosocial health summary score, and the total scale score. For the present study, the four subscale scores were utilized in analyses.

2.3. Analysis Plan

Statistical analyses were completed via SPSS Statistics software (IBM corporation, Armonk, NY, USA). One sample t-tests were used to compare sleep habits of school-aged survivors of retinoblastoma to those of the general pediatric population. Additionally, independent sample t-tests were used to examine sex, disease laterality, and enucleation status differences on the CRSP (e.g., caffeine, activities before bed, sleep location, electronic use before bed, bedtime worries/fears, restless legs, parasomnias, insomnia) and CSHQ subscales (e.g., bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night wakings, parasomnias, sleep disordered breathing, daytime sleepiness) to better understand how sleep habits of survivors of retinoblastoma may differ by diagnostic or treatment-related factors.

In order to examine the associations between sleep and quality of life, Pearson correlations were analyzed to determine the strength of the relation between sleep habits as measured by CRSP (child report; i.e., caffeine, activities before bed, sleep location, electronic use before bed, bedtime worries/fears, restless legs, parasomnias, insomnia) and CSHQ subscales (parent report; i.e., bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night wakings, parasomnias, sleep disordered breathing, daytime sleepiness) and quality of life across PedsQL subscales (both child and parent report; i.e., physical, emotional, social, school functioning).

Pearson correlations were utilized to examine the association between parent and child reports of sleep habits as measured by the CRSP and CSHQ subscales.

1. Results

1.1. Sleep Habits

1.1.1. Comparing Study Sample to Normative Sample—Compared to norms established by Owens and colleagues[44] from a control sample, parents of children with retinoblastoma indicated more bedtime resistance ($t(58) = 2.69$, $p = .009$), a greater sleep onset delay ($t(66) = 2.46$, $p = .017$), a shorter sleep duration ($t(57) = 2.12$, $p = .038$), and increased daytime sleepiness ($t(53) = 6.45$, $p = <.001$). Similarly, compared to norms established by Meltzer and colleagues[43], children with retinoblastoma indicated more problems with sleep location ($t(61) = 2.39$, $p = .02$), restless legs syndrome ($t(62) = -2.21$, $p = .03$) and parasomnias ($t(64) = 19.19$, $p = <0.01$). Mean scores are summarized in Table 2.

1.1.2. Sex, Disease Laterality, and Enucleation—Examination of differences by sex indicated significant differences in survivor-reported symptoms of parasomnias ($t(63) = -2.12$, $p = 0.04$) such that male survivors indicated increased levels of parasomnias ($M = 5.41$, $SD = 0.76$) on the CRSP compared to female survivors ($M = 4.91$, $SD = 1.10$). In contrast, female survivors of retinoblastoma reported higher levels of insomnia ($M = l2.64$, SD=3.57) compared to male survivors ($M = 10.97$, $SD = 3.39$), $t(63) = 1.93$, $p = 0.03$. Parent report did not indicate any significant differences in children's sleep habits by sex.

Regarding differences by disease laterality, CRSP report indicated that survivors with unilateral disease engaged in greater caffeine consumption ($M = 6.89$, $SD = 1.94$) than survivors with bilateral disease ($M = 5.81$, $SD = 2.04$), $t(63) = 2,16$, $p = 0.03$, Parent report of children's sleep behaviors as measured by the CSHQ did not indicate any differences by disease laterality.

Survivors with a history of enucleation reported more electronic use before bed ($M = 7.02$, $SD = 2.57$) compared to survivors who did not receive enucleation ($M = 5.52$, $SD = 2.16$), $t(64) = -2.31$, $p = 0.02$. Parent report indicated a significant difference in sleep disordered breathing, with parents of children who received enucleation reporting increased sleep disordered breathing ($M = 3.35$, $SD = 0.53$) compared to parents of children who did not receive enucleation ($M = 3.00$, $SD = 0.00$), $t(54) = -2.36$, $p = .02$.

1.2. Sleep and Quality of Life

1.2.1. Child-Reported Sleep—Child-reported sleep habits as measured by the CRSP indicated significant associations with quality of life. Specifically, bedtime fears/worries were correlated with parent-reported emotional ($r(64) = -.534$, $p < 0.001$) and social functioning ($r(64) = -.308$, $p = 0.01$), and self-reported physical ($r(64) = -.256$, $p = 0.04$), emotional ($r(63) = -.650$, $p < .001$), social ($r(64) = -.315$, $p = 0.01$), and school functioning ($r(63) = -.271$, $p = 0.03$). Thus, as children's ratings of bedtime fears/worries increased, parents' ratings of quality of life with respect to social and physical functioning decreased. Similarly, as survivors' ratings of their own bedtime fears/worries increased, their perception of their quality of life within all assessed domains (physical, emotional, social, and school functioning) decreased.

Self-reported symptoms of parasomnias were also associated with quality of life. Interestingly, parasomnias were positively correlated with parent-reported emotional functioning, $r(63)=.295$, $p=0.017$. Thus, as parasomnia symptoms increased, parents' perception of survivors' emotional functioning also increased. In contrast, symptoms of insomnia were negatively correlated with child-reported emotional functioning ($r(62)=-.509$, $p<0.001$). As such, insomnia symptoms increased as survivors' perceptions of their own emotional functioning decreased. Child-reported symptoms of insomnia were also negatively correlated with child-reported school functioning, such that quality of school functioning decreased as symptoms of insomnia increased ($r(62)=-.371$, $p=0.003$). Child-reported symptoms of parasomnia, on the other hand, were positively correlated with child-reported school functioning ($r(62)=.266$, $p=0.034$. Correlations are summarized in Table 3.

1.2.2. Parent Report of Children's Sleep—Parents' perception of survivors' sleep habits as measured by the CSHQ indicated significant associations with both child- and parent-reported quality of life. Specifically, parent report of bedtime resistance was negatively correlated with parent-reported emotional ($r(56)=-.342$, $p=0.01$) and school functioning ($r(56)=-.505$, $p<0.001$). Similarly, parent report of sleep duration difficulties was negatively correlated with emotional functioning ($r(55)=-.457$,$p<0.001$). Greater parent report of parasomnia symptoms was associated with worse parent-reported physical ($r(53)=-.284$, $p=0.04$) and emotional functioning ($r(53)=-.451$, $p<0.001$). As parents' report of their children experiencing night wakings increased, children's report of school functioning decreased, $r(30)=-.428$, $p=0.01$.

Significant correlations between parents' report of children's daytime sleepiness and quality of life were also observed. As daytime sleepiness increased, parent-reported social ($r(51)=-.285$, $p=0.04$) and school functioning of quality of life decreased ($r(51)=-.307$, $p=0.03$). Results also indicated significant negative correlations between parents' report of children's sleep anxiety and quality of life. Specifically, parental report of sleep anxiety increased as parental report of emotional ($r(55)=-.431$, $p<.001$) and school functioning decreased ($r(55)=-.367$, $p=0.01$). Similarly, parental report of sleep anxiety was negatively correlated with child-reported quality of life on the emotional domain ($r(53)=-.288$, $p=0.03$).

Parent-reported sleep onset delay was negatively correlated with parent-reported emotional quality of life ($r(64)=-.282$, $p0.02$), but positively correlated with child-reported physical quality of life ($r(63)=.257$, $p=0.04$). All correlations are summarized in Table 3.

1.3. Concordance of Parent and Child Report

Parent- and child-reported sleep habits were compared to examine concordance, and results indicated significant associations in several areas. Specifically, child-reported sleep location was positively associated with caregiver reported bedtime resistance ($r(51)= .281$, $p=.04$). Child-reported bedtime fears/worries were positively associated with both caregiver-reported parasomnias ($r(51)= .310$, $p= .02$) and sleep anxiety ($r(53)= .330$, $p= .04$). Child-reported restless legs syndrome was positively associated with caregiver-reported parasomnia symptoms ($r(49)= .316$, $p= .02$). Greater child report of insomnia symptoms

was associated with increased caregiver report of sleep duration difficulties ($r(52)= .301$, $p= .03$), parasomnias ($r(50)= .346$, $p= .01$), daytime sleepiness ($r(48)= .357$, $p= .01$), and sleep onset delay ($r(61)= .307$, $p= .01$). Additionally, child-reported caffeine use before bed was negatively associated with caregiver reports of parasomnias ($r(50)= -.313$, $p= .02$). Child-reported parasomnia symptoms were negatively associated with caregiver-reported parasomnias ($r(50)= -.375$, $p= .006$). Correlations are summarized in Table 4.

4. Discussion

Given the numerous sleep difficulties and associated impairment in quality of life experienced by pediatric cancer patients, as well as those with visual impairments, the current study sought to better understand sleep habits among school-age survivors of retinoblastoma. Specifically, we aimed to 1) describe sleep habits, 2) examine associations between sleep and quality of life, and 3) examine concordance between parent and child reports of sleep difficulties among school-age survivors of retinoblastoma. Results indicate that both children with retinoblastoma and their caregivers endorse multiple sleep difficulties, and that reported difficulties varied by sex, disease laterality, and enucleation status. Further, differential associations between parent and child report of sleep difficulties were observed, as well as some differential associations between sleep and quality of life.

Both children with retinoblastoma and their parents generally reported more sleep concerns than a normative population, indicating that our sample of retinoblastoma survivors endorse greater than normative difficulties with key sleep behaviors such as perceived parental satisfaction with sleep duration and child-reported parasomnia symptoms. Given the relation between sleep dysfunction and key daily functioning activities such as executive functioning[21] and social and peer relationships,[25] it is important to provide supports to address these areas of increased sleep difficulty among survivors of retinoblastoma. Specifically, survivors and their caregivers may benefit from targeted psychoeducation on healthy sleep habits, for example. Further, routine screening of sleep habits during survivorship medical visits will be critical for survivors of retinoblastoma.

Examination of sleep habits of survivors of retinoblastoma also indicated differences by sex, laterality, and enucleation status. In our sample, male survivors reported more parasomnia symptoms than female survivors, whereas female survivors reported higher levels of insomnia. These sex differences are consistent with the existing literature base which has documented that boys experience more symptoms of parasomnias than girls.[49] Further, previous research has found that girls ages 11-12 years have increased rates of insomnia symptoms compared to boys and posits this difference to be due to biological factors such as prepubertal status.[50] There are many changes that occur during the school-aged years that could influence sleep and understanding how this may differ by sex is important for both assessment and intervention development.

Findings indicated that survivors with unilateral retinoblastoma reported greater caffeine consumption than survivors with bilateral disease. This was the only difference observed when assessing child- and parent-reported sleep habits by disease laterality. Parent report of children's caffeine consumption before bed was not assessed in the current study, and

it would be interesting to assess this in order to determine congruence or incongruence across reporters. Regarding enucleation, survivors who underwent enucleation reported more electronic use before bed compared to those survivors who did not undergo enucleation. Parent report indicated that survivors who underwent enucleation experience increased sleep-disordered breathing. Taken together, enucleation may be a key factor associated with sleep difficulties, however further research is needed to understand this relation.

With respect to quality of life, several child-reported sleep habits were associated with decreased quality of life. Similarly, parent report indicated that multiple sleep habits as well as parasomnia symptoms were associated with worse quality of life across domains. Although the findings in the current study are based on correlations and, therefore, we cannot establish the direction of the relationship between sleep habits and quality of life, these findings add to previous research establishing that sleep difficulties among survivors of pediatric cancer are associated with reduced quality of life.[10,11] As such, it may be beneficial for providers to regularly assess any sleep difficulties that survivors of retinoblastoma may endorse in order to triage treatment options and, thus, enhance quality of life among these survivors.

Children and their parents were generally in agreement regarding sleep habits, with correlations between related subscales in the expected direction. For example, as children reported increased bedtime worries/fears, parents reported perception of greater sleep anxiety. Similarly, child report of insomnia symptoms was associated with increased parent report of daytime sleepiness. Interestingly, however, results did indicate that child-reported parasomnia symptoms decreased as parent-reported parasomnia symptoms increased. A closer examination of items on both the CRSP child report and CSHQ parent report of parasomnia symptoms may help shed light on this finding. Specifically, items that map onto child-reported parasomnia symptoms assess sleepwalking and walking around or crying out.[43] Items that load onto the parent-reported parasomnia symptoms scale as assessed by the CSHQ inquire about enuresis, sleeptalking, restless sleep, teeth grinding, and being alarmed by a scary dream in addition to sleepwalking and awakening by screaming.[44] Thus, parent report of parasomnia symptoms provides a much broader picture of these symptoms than child report in this study. Additionally, our work with retinoblastoma survivors has found that, compared to their own ratings, caregivers sometimes provided more negative ratings of perceived functioning.[51] Previous research has found that pediatric cancer survivors and caregivers perceive differential levels of impairment as a result of sleep difficulties, such that parents rate survivors' sleep difficulties as more impairing.[29] However, research by Brimeyer et al.[52] found that poor concordance between reports from adolescent brain tumor survivors and their parents, with survivors reporting greater impairment. As such, different samples may differ in terms of which reporter (e.g., self versus parent) indicates greater impairment. Given the array of impacts that sleep concerns can have on day-to-day functioning, it is important to continue to assess both parent and child perspective of sleep habits.

In terms of study strengths, to our knowledge, this is the first study examining sleep habits for children with retinoblastoma. As such, the current study adds to the existing literature base by characterizing survivors' sleep habits as well as the impact of sleep

on quality of life in this vulnerable population. However, to understand the full impact of retinoblastoma on survivors' sleep functioning, continuous study of this population throughout the lifespan is pertinent. Specifically, it may be useful to examine sleep during or immediately following treatment. Understanding how retinoblastoma patients' sleep habits are impacted by treatment could help inform intervention. Given that retinoblastoma is typically diagnosed within the first few years of life, identifying opportunities for early intervention around any sleep difficulties could be critical.

Despite some of the strengths of the study, there were some limitations. For example, we used a cross-sectional study design and, therefore, could not analyze these behaviors over longer periods of time. Because this study design does not allow for determination of cause and effect, the data does not allow for causal inference and is likely not representative of survivors' sleep habits over time. Additionally, this study took place in one hospital, which limits our sample size, and may limit our overall understanding of factors that play into sleep habits and difficulties with this specific patient population, including cultural factors that may impact sleep. Furthermore, participants primarily identified as white. Continued research with diverse samples is critical to better understanding sleep in this population. Finally, and perhaps most critically, our use of questionnaires without established clinical cut-offs limited some of the conclusions we were able to draw regarding sleep in survivors of retinoblastoma. Indeed, it will be important for future research to establish clinical benchmarks for questionnaires, as well as to tie questionnaire data to clinical sleep data such as actigraphy or clinical sleep studies.

Future research should seek to expand the understanding of survivors' experience of sleep across developmental periods and cultures. Specifically, future research could focus on the treatment period given the young age of children diagnosed with retinoblastoma. Early intervention studies may provide insight into the possibility of prevention or early remediation of some of these sleep difficulties. Additionally, research during the adolescent period would likely be fruitful, particularly because several sleep disruptions, including sleep deprivation, insomnia, and delayed sleep-wake phase disorder, are reported in adolescence.[53] Regarding cultural differences, it is well-established in the literature that norms around typical sleep behaviors and environments vary widely.[54] As such, a full understanding of sleep habits and quality of life among retinoblastoma survivors is not possible without gathering cross-cultural data. Longitudinal research and further cross-sectional studies are also necessary to examine the impact of retinoblastoma and various treatment on the long-term outcomes of sleep habits and difficulties. Finally, objective measures of sleep duration and quality such as actigraphy or polysomnography may be useful in further increasing our understanding of the sleep patterns of youth with retinoblastoma and may be particularly beneficial for illuminating the impact of enucleation on sleep.

4.1 Conclusions

Ultimately, given previous research documenting sleep difficulties among pediatric cancer survivors,[5,9] the current study adds to the existing literature by broadly examining sleep habits of survivors of retinoblastoma, as well as the association between sleep and quality of

life in this population. Findings indicated that school-age survivors of retinoblastoma report aspects of sleep that represent impairment compared to normative data. Differences by sex and disease type emerged, as well as differential associations between sleep and quality of life. These findings indicate that survivors of retinoblastoma do experience impairments in sleep. Further research on sleep habits and difficulties among this population can potentially help inform better practices and improvements in interventions to help patients during treatment, during transition off treatment, and during survivorship.

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Highlight

- Survivors of retinoblastoma are at risk for sleep difficulties in middle childhood.
- Patients who received enucleation report more sleep difficulties.
- Self- and parent-reported sleep difficulties are associated with worse quality of life.

Table 1.

Participant and Medical Demographics

	M+SD (Ranee) /N(%)
Sex	
Male	35 (49.3%)
Female	36 (50.7%)
Race/Ethnicity	
White/Caucasian	43 (62.3%)
Bi-racial	4 (5.7%)
American Indian/Alaskan	3 (4.3%)
Diagnosis	
Bilateral	26 (37.7%)
Bilateral (Asynchronous)	4 (5.8%)
Retinoblastoma, Eye, Left	23 (33.3%)
Retinoblastoma, Eye, Right	16 (23.2%)
Age at diagnosis (years)	1.51±1.37 (0.3 – 5.94)
Time since diagnosis (years)	9.37±1.16 (6.50 – 12.08)
Enucleation	
Unilateral Enucleation	46 (66.6%)
Bilateral Enucleation	2 (2.90%)

Table 2.

Children's Sleep Habits Questionnaire and Children's Report of Sleep Patterns Questionnaire Comparison to Normative Data

	M (SD)	Normative Comparison M (SD)	One-sample t	p
Child Sleep Habits Questionnaire (CSHO)				
Bedtime Resistance	7.80 (2.11)	7.06 (1.89)	2.69	**.009**
Sleep Onset Delay	1.45 (.66)	1.25 (.53)	2.46	**.017**
Sleep Duration	3.78 (1.31)	3.41 (.93)	2.12	**.038**
Sleep Anxiety	5.07 (1.67)	4.89 (1.45)	.814	.419
Night Wakings	3.52 (.94)	3.51 (.89)	.032	.975
Parasomnias	8.16 (1.47)	8.11 (1.25)	.257	.798
Sleep Disordered Breathing	3.27 (.49)	3.24 (.63)	.429	.670
Daytime Sleepiness	12.30 (3.03)	9.64 (2.80)	6.45	<**.001**
Children's Report of Sleep Patterns (CRSP)				
Caffeine	6.45 (2.04)	6.21 (2.40)	.934	.354
Activities an Hour Before Bed	16.64 (3.02)	16.66 (3.20)	−.051	.959
Sleep Location	11.97 (4.94)	10.47 (4.40)	2.39	**.020**
Electronics Before Bed	6.55 (2.53)	6.07 (2.90)	1.53	.132
Bedtime Fears/Worries	3.35 (1.85)	3.64 (1.90)	−1.28	.206
Restless Legs Syndrome	9.10 (2.18)	9.70 (3.40)	−2.21	**.031**
Parasomnias	5.15 (0.97)	2.84 (1.10)	19.19	<**.001**
Insomnia	11.81 (3.56)	11.60 (4.14)	.488	.627

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Table 3.

Correlations between Parent and Child Reported Sleep Disturbance and Quality of Life

	Quality of Life Domain (PedsQL)							
	Parent-Reported Quality of Life				Child-Reported Quality of Life			
	Physical	Emotional	Social	School	Physical	Emotional	Social	School
Child-Reported Sleep Habits (CRSP)								
Caffeine Index	.154	.112	.212	−.033	−.042	.062	.076	−.022
Activities Before Bed Index	−.181	.161	.056	−.042	.048	.163	.176	.161
Sleep Location	.115	−.010	.029	.101	−.237	−.058	−.152	−.243
Electronics Before Bed	−.143	.099	−.003	.114	.024	.136	−.002	−.025
Bedtime Fears/Worries Scale	−.091	**−.534** **	**−.308** *	−.049	**−.256** *	**−.650** **	**−.315** *	**−.271** *
Restless Legs Scale	−.157	−.218	−.126	−.049	.103	−.160	−.180	−.042
Parasomnias Scale	.101	**.295** *	.012	.086	.028	.004	.150	**.266** *
Insomnia Scale	.179	−.233	.011	.101	−.120	**−.509** **	−.221	**−.371** **
Parent-Reported Sleep Patterns (CSHQ)								
Bedtime Resistance	−.143	**−.342** **	−.174	**−.505** **	.022	−.065	−.026	−.086
Sleep Duration	−.125	**−.457** **	−.155	−.181	.202	.054	−.020	−.035
Parasomnia	**−.284***	**−.451** **	−.144	−.195	−.025	−.261	−.041	−.157
Sleep Disordered Breathing	−.124	−.058	−.095	−.167	.007	−.033	−.026	−.109
Night Wakings	.092	−.184	.148	−.120	−.064	−.051	−.111	**−.428** *
Daytime Sleepiness	.097	−.217	**−.285** *	**−.307** *	.202	−.083	−.065	.072
Sleep Anxiety	−.089	**−.431** **	.009	**−.367** **	−.062	**−.288** *	−.063	−.159
Sleep Onset Delay	−.073	**−.282** *	−.147	−.139	**.257** *	.147	−.014	.026

* $p < .05$

** $p < .01$

Table 4.

Correlations between Parent and Child Reported Sleep Disturbance

	Parent-Reported Sleep Patterns (CSHQ)							
Child-Reported Sleep Habits (CRSP)	**Bedtime Resistance**	**Sleep Duration**	**Parasomnia**	**Sleep Disordered Breathing**	**Night Wakings**	**Daytime Sleepiness**	**Sleep Anxiety**	**Sleep Onset Delay**
	r	**r**	**r**	**r**	**r**	**r**	**r**	**r**
Caffeine Index	−.036	−.164	**−.313** *	−.161	.134	−.046	.181	.073
Activities Before Bed Index	.147	−.243	−.228	.131	−.230	−.052	.116	−.155
Sleep Location	**.281** *	.057	.020	.002	.104	−.003	.054	−.184
Electronics Before Bed	−.062	.152	−.072	.023	−.003	.029	−.142	.096
Bedtime Fears/Worries Scale	.241	.193	**.310** *	.110	.156	.171	**.330** *	.004
Restless Legs Scale	−.090	.064	**.316** *	−.153	.149	−.241	.002	.216
Parasomnias Scale	.148	−.243	**−.375** **	.005	−.267	−.073	.101	−.018
Insomnia Scale	.058	**.301** *	**.346** *	.089	.122	**.357** *	.027	**.307** *
Sleepy Mean	−.124	−.209	−.067	.139	−.045	−.080	−.029	−.102

* $p < .05$

** $p < .01$

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