Sleep and Behavior Problems in Children With Epilepsy

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ABSTRACT

We designed a cross-sectional study to examine the association between sleep and behavior problems in toddlers and preschool-age children with epilepsy. We found that 71 (78.9%) children slept less than 10 hours in a 24-hour period according to the actigraphy, with 75 (83.3%) children waking for more than an hour during nocturnal sleep. Twenty-five (27.8%) children usually or sometimes had an inconsistent bedtime, and 24 (26.7%) did not sleep the same amount each day. Twenty-nine (32.2%) and 18 (20.0%) children had an internalizing and externalizing problem in clinical range, respectively. Sleep anxiety was significantly ($p < .01$) associated with increased internalizing and externalizing problems, even after the relevant epilepsy variables were controlled for. Findings from our study suggest that screening of sleep and behavior problems should be part of routine epilepsy care to identify children with problematic sleep and unrecognized sleep disorders and those at risk of behavioral dysfunction. J Pediatr Health Care. (2019) *33*, 138–145

KEY WORDS

Actigraphy, behavior problems, children, epilepsy, sleep

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Conflicts of interest: None to report.

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J Pediatr Health Care. (2019) *33*, 138-145

0891-5245/$36.00

Published online August 24, 2018.

https://doi.org/10.1016/j.pedhc.2018.07.004

INTRODUCTION

Epilepsy is a chronic and serious neurologic disorder characterized by recurrent and unprovoked seizures, affecting 0.3% to 1.0 % of the pediatric population, with the majority presenting during early childhood (Chiang & Cheng, 2014; Shinnar & Pellock, 2002). Cross-cultural and regional research on healthy children suggests that the prevalence rates of sleep problems in early childhood are already high, with up to 44% of parents considering that their child has a sleep problem (Byars, Yolton, Rausch, Lanphear, & Beebe, 2012; Mindell, Sadeh, Kwon, & Goh, 2013). Sleep problems are more common and severe in children with epilepsy compared with their healthy counterparts (Batista & Nunes, 2007; Tang, Clarke, Owens, & Pal, 2011; van Golde, Gutter, & de Weerd, 2011). For children with epilepsy, sleep problems have also specifically been linked to increased maternal emotional symptoms and poor parental sleep quality (Ekinci, Isik, Gunes, & Ekinci, 2016; Larson et al., 2012; Shaki, Goldbart, Daniel, Fraser, & Shorer, 2011). Although sleep disturbances in early childhood have been associated with behavioral and psychiatric problems in children without medical conditions (Sivertsen et al., 2015; Whalen, Gilbert, Barch, Luby, & Belden, 2017; Zaidman-Zait & Hall, 2015), to our knowledge no study has explored such a relation including prospective and objective sleep parameters in toddlers and preschool-aged children with epilepsy.

Epilepsy per se or seizures themselves are associated with alterations in sleep architectures, nocturnal arousals, and daytime sleepiness (Kothare & Kaleyias, 2010; Maganti et al., 2005). Even seizures that occur during the day or epileptic discharges that occur in the absence of seizures can disrupt normal sleep stage progression and create daytime tiredness in epileptic individuals (Bazil, 2003; Kothare & Kaleyias, 2010). A high comorbidity also exists between sleep disorders and epilepsy, with up to 20% of epileptic children having obstructive sleep apnea, a condition characterized by repeated upper airway obstruction causing sleep disruption (Kaleyias et al., 2008; Manni & Terzaghi, 2010). Sleep and daytime alertness in children with epilepsy are additionally influenced by antiepileptic drugs, which are the primary treatment for epilepsy to reduce seizure activities

(Batista & Nunes, 2007; Larson et al., 2012; Schmitt, Martin, Critelli, Molinari, & Jenni, 2009).

Some evidence exists from school-aged children suggesting that sleep disturbances, particularly poor sleep quality, are linked to behavioral difficulties in pediatric epilepsy (Beattie, Koch, Bolden, & Thompson, 2016; Cortesi, Giannotti, & Ottaviano, 1999; Samaitiene, Norkuniene, Tumiene, & Grikiniene, 2013). In a study by Stores, Wiggs, and Campling (1998), poor sleep quality was significantly correlated with inattention in 28 epileptic children aged 5 to 8 years and with inattention, hyperactive–impulsive behavior, and psychosomatic complaints in 28 epileptic children aged 9 to 11 years. Becker, Fennell, and Carney (2004) studied 30 children aged 7 to 14 years who had comorbid epilepsy and sleep disturbances and found that 73% of the sample fulfilled the criteria for clinically significant problems with inattention/hyperactivity and 33% for anxiety. In the same study, sleep disturbances, rather than seizure frequency, were positively associated with daytime behavioral dysfunction. A more recent study also reported significantly higher behavior disturbance scores in school-aged epileptic children with sleep problems than in those without sleep problems (Samaitiene et al., 2013). Although results from these prior studies in older children are informative, suggesting that behavioral difficulties could be influenced by problematic sleep and the underlying pathology of epilepsy, they may not be generalizable to toddlers and preschool-aged children, because sleep and behavior characteristics are both maturational processes that are distinct in each developmental stage. For example, daily sleep duration is longer and daytime napping is more common in early childhood than in late childhood and adolescence (Iglowstein, Jenni, Molinari, & Largo, 2003; Price et al., 2014).

To date, most pediatric epilepsy studies rely on parental recall of their children's sleep (Byars et al., 2008; Samaitiene et al., 2013; Tang et al., 2011), with younger children still an understudied population (Chan et al., 2011; Ong, Yang, Wong, alSiddiq, & Khu, 2010; Wirrell, Blackman, Barlow, Mah, & Hamiwka, 2005). The purpose of this study was to examine the association between sleep and behavior problems in toddlers and preschool-aged children with epilepsy. The specific aims were to (a) document actigraphy-derived and parent-reported sleep in children with epilepsy, (b) characterize the types and frequency of problematic sleep in children with epilepsy, and (c) examine the association between sleep and behavior problems in children with epilepsy. This study hypothesized that problematic sleep would be associated with more behavioral problems in toddlers and preschool-aged children with epilepsy.

METHODS

Design and Participants

Children and their parents were recruited from a pediatric neurology clinic at a large academic medical center located in northern Taiwan between September 2015 and November 2016 to participate in an ongoing intervention study for youth with epilepsy. Inclusion criteria were (a) children aged 1.5 to 6 years old diagnosed with epilepsy according to electroencephalography and clinical examinations and (b) parents able to speak, read, and understand Chinese. Children were excluded for participation if they were born at less than 37 weeks' gestation, had structural brain damage, were bedridden, or had a diagnosis of cerebral palsy. Of the 100 eligible children identified, 93 families agreed to participate in the study. The final analyses for the current report were based on the results of the 90 participating children who had at least 4 days of valid actigraphy data. The National Taiwan University Hospital Institutional Review Board reviewed and approved the study (201412211RINA). Parents of all participating children provided informed written consent. The study design for the present report was cross sectional and included pre-intervention baseline sleep and behavior rating data from the parent study.

Procedures

Parents provided information on sociodemographic and child health, sleep, behavior characteristics via structured questionnaires. Children were instructed to wear an actigraph device on the wrist for 7 days except when taking showers, bathing, or swimming. Parents and caregivers were instructed to maintain a concurrent sleep diary during the study week for their children. Research personnel contacted the participating families at least twice during the study week to answer questions and to schedule time for returning the study materials when recordings were completed.

Measures

Actigraphy

Sleep in epileptic children was measured objectively using an actigraph (Actiwatch2; Phillips-Respironics, Murrysville, PA) worn on the child's wrist continuously for 7 consecutive days. Actigraphy is an activity-based sleep monitoring system that has been increasingly used in pediatric populations and has been proven to be a valid and reliable approach for quantifying sleep duration and quality in children with epilepsy (Galland, Meredith-Jones, Terrill, & Taylor, 2014; Meltzer, Montgomery-Downs, Insana, & Walsh, 2012; Sadaka et al., 2014). Physical motion data recorded by the actigraphic device were stored every 30 seconds and converted to sleep parameters using the medium wake threshold setting, defined as 40 activity counts per epoch, in the Actiware 5.52 software (Phillips-Respironics). Parents and caregivers also documented child daytime and nighttime sleep episodes and periods when the monitor was removed in a sleep diary to facilitate more accurate actigraphy data scoring and interpretation. Sleep parameters derived from the actigraphic recordings for the current study included: (a) total nighttime sleep, defined as the amount of time between sleep onset and sleep offset scored as sleep; (b) wake after sleep onset, defined as the amount of time between sleep onset and sleep offset scored as wake; (c) total daytime sleep, defined as the amount of time scored as sleep within each nap interval; and (d) total 24-hour sleep, defined as the sum of total nighttime and daytime sleep.

Children's Sleep Habits Questionnaire

Children's sleep habits were assessed by the Children's Sleep Habits Questionnaire (CSHQ; Owens, Spirito, & McGuinn, 2000), a retrospective parental report that examines children's sleep patterns and problems over a recent typical week. The CSHQ was originally developed for screening problematic sleep behaviors in children aged 4 to 10 years old and was later validated for toddlers and preschool-aged children with and without medical conditions (Goodlin-Jones, Sitnick, Tang, Liu, & Anders, 2008; Liu et al., 2016; Owens et al., 2000). The CSHQ obtains a total sleep disturbance score based on 33 items and eight subscale scores, including bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night awakenings, daytime sleepiness, parasomnias, and sleep disordered breathing. Items are rated on a 3-point scale from *usually* (5−7 times per week), to *sometimes* (2−4 times per week), to *rarely* (0-1 times per week), with higher scores indicating greater sleep disturbances. A total score greater than 41 has been established as a cutoff indicative of clinically significant sleep disturbances. The CSHQ has shown basically acceptable internal consistency reliability (Cronbach $\alpha = .44-.72$) and 2-week test−retest reliability (intraclass correlation coefficient = 0.38−0.78) in preschool-aged Chinese children (Liu, Wang, Tang, Wen, & Li, 2014). The CSHQ Chinese translation and its original English version have been used in research on childhood epilepsy with statistically and clinically significant results obtained (Chan et al., 2011; Larson et al., 2012).

Child Behavior Checklist for Ages 1.5 to 5 Years

Children's behavioral, emotional, and social functioning were assessed using the parent-report Child Behavior Checklist for Ages 1.5 to 5 Years (CBCL/1.5−5; Achenbach & Rescorla, 2000). This questionnaire is well-validated and used worldwide, with 99 items each scored as 0 (*not true*), 1 (*somewhat or sometimes true*), or 2 (*very true or often true*) according to the child's behaviors over the previous 2 months. The scores of the items constituting the Emotionally Reactive, Anxious/Depressed, Somatic Complaints, and Withdrawn Syndrome subscales are summed to provide the internalizing problem scores. The scores of the items constituting Attention Problems and Aggressive Behavior Syndrome subscales are summed to provide the externalizing problem scores. Raw internalizing and externalizing problem scores were converted to *T* scores (mean = 50, standard deviation = 10), with higher scores representing more behavioral problems. A *T* score of 65 or greater is considered clinically significant for both subscales. Because most children were younger than 6 years at the time of the assessment, the CBCL/1.5−5 was chosen for the current study to enhance comparability across children in our sample.

Data Analysis

Children's demographic, clinical, and sleep characteristics were summarized using mean ± standard deviation for continuous variables and frequencies and percentages for categoric variables. Actigraphy sleep data were averaged within each individual child across the study period to obtain daily mean values. Bivariate Pearson correlations were applied to investigate whether various aspects of sleep were associated with internalizing and externalizing problems. Finally, associations among behavior outcomes and sleep variables were examined with two multiple linear regression models. In both models, the control variables, including child's age and sex, being seizure free for the past 3 months (*yes/no*), being the only child at home (*yes/no*), having developmental delays (*yes/no*), and using two or more types of antiepileptic medications (*yes/no*), were entered in the first block. Sleep variables that have a significant correlation with behavior outcomes, as evidenced by bivariate Pearson correlation analyses, were entered in the second block. The intercorrelation among the predictor variables was examined to ensure that multicollinearity and other assumptions of regression analysis were fulfilled. All analyses were conducted in SPSS, version 16.0, with two-sided tests, and a p value of less than .05 was considered statistically significant.

RESULTS

Sample Characteristics

The mean age of the sample was 3.83 years old (range = 1.51−6.00), and 22 (24.4%) children were between 5 and 6 years of age (Table 1). Thirty-two (35.6%) children were the only child at home, and 46 (51.1%) children had their first seizure occur at younger than 1 year of age. Fifty (55.6%) children had been free of seizures for at least 3 months at the time of study, with 28 (31.1%) children taking two or more antiepileptic drugs. Mean total nighttime sleep by actigraphy was 7.74 hours, and mean wake time after sleep onset was 87.54 minutes, with 75 (83.3%) children waking for at least an hour during nocturnal sleep. Average daily sleep duration by actigraphy was 9.38 hours, with 71 (78.9%) children sleeping less than 10 hours in a 24-hour period. Daily sleep duration in 11 (12.2%) children fulfilled the current recommended amount of sleep for toddlers and preschool-aged children (Paruthi et al., 2016). Eighty-five (94.4%) children had a CSHQ total sleep disturbance score greater than 41. Twenty-nine (32.2%) and 18 (20.0%) children had an internalizing and externalizing problem in the clinical range, respectively.

Children's Sleep Habits

Almost all of the problematic sleep behaviors were reported as occurring *sometimes* and *usually* in at least 20% of the sample, such as *does not go to bed at the same time* (27.8%), *cannot fall asleep in 20 minutes* (56.6%), *falls asleep in another's bed* (64.4%), *struggles at bedtime* (31.1%), *moves to other's bed during the night* (24.5%), *awakes more than once at night* (27.8%), *does not sleep the same amount each day* (26.7%), *restless sleep* (65.5%), *snores loudly* (30.0%), *wakes up in negative mood* (50.0%), *hard time getting out of bed* (46.7%), *takes a long time to be alert* (45.5%), or *seems tired during the day* (33.3%).

Pearson's Correlations Between Sleep and Behavior Outcomes

The CSHQ sleep anxiety, night wakings, and parasomnia subscale scores and the total sleep disturbance scores showed a significant positive correlation with internalizing problems (Table 2). The CSHQ bedtime resistance, sleep

TABLE 1. Characteristics of the participating children ($N = 90$)

Variables	Value[a]
Age, years	3.83 ± 1.33
Female	40 (44.4)
Maternal education	
High school or less	27 (30.0)
College	52 (57.8)
Graduate school	11 (12.2)
Paternal education	
High school or less	26 (28.9)
College	51 (56.7)
Graduate school	13 (14.4)
Only child at home	32 (35.6)
Age at seizure onset ≤ 1 year	46 (51.1)
Duration of epilepsy, months	19.82 ± 15.37
Comorbidities	
Developmental delay	41 (45.6)
Autism	2 (2.2)
Attention deficit/hyperactivity disorder	2 (2.2)
Seizure free for the past 3 months	50 (55.6)
Number of antiepileptic drugs	
0	7 (7.8)
1	55 (61.1)
≥2	28 (31.1)
Actigraphy	
Total nighttime sleep, hours	7.74 ± 0.81
Wake after sleep onset, minutes	87.54 ± 33.65
Total daytime sleep, hours	1.63 ± 0.62
Total 24-hour sleep, hours	9.38 ± 0.97
Children's Sleep Habits Questionnaire	
Bedtime resistance	11.14 ± 2.98
Sleep onset delay	1.71 ± 0.70
Sleep duration	4.61 ± 1.57
Sleep anxiety	7.6 ± 2.19
Night wakings	4.52 ± 1.52
Parasomnias	9.91 ± 2.11
Sleep disordered breathing	3.68 ± 0.91
Daytime sleepiness	13.2 ± 3.29
Total sleep disturbance score	51.86 ± 7.41
Total sleep disturbance score > 41	85 (94.4)
Child behavior checklist	
Internalizing problem *T* score	59.18 ± 10.81
Internalizing problem *T* score in clinical range	29 (32.2)
Externalizing problem *T* score	55.68 ± 11.46
Externalizing problem *T* score in clinical range	18 (20.0)

Note. *Data are presented as mean ± standard deviation or n (%).*

anxiety, and parasomnia subscale scores as well as the total sleep disturbance scores showed a significant positive correlation with externalizing problems. Strong intercorrelations between bedtime resistance and sleep anxiety ($r = 0.72$, $p < .01$) and between night wakings and parasomnia subscale scores ($r = 0.52$, $p < .01$) were found. Therefore, bedtime resistance and night wakings were not entered in the regression model, considering that sleep anxiety and parasomnia have stronger correlations with behavior outcomes. Total sleep disturbance scores were also not entered in the regression model to avoid variable redundancy. None of the actigraphy-derived sleep parameters was significantly correlated with internalizing or externalizing problems.

Multiple Regression Models for Prediction of Behavior Outcomes

In the first (Table 3) and second regression models (Table 4), sleep anxiety was the only significant predictor ($p < .01$) of internalizing and externalizing problems, even after adjusting for whether the child's sleep fulfilled the recommended sleep duration. The addition of the sleep variables in the second step contributed to a statistically significant increment in R^2 in both models. Together, the variables in the first and second steps explained 19% and 24% of the variance in internalizing and externalizing problems, respectively.

DISCUSSION

This study extends the pediatric literature by using both objective and parental-report measurement of sleep in toddlers and preschool-age children with epilepsy. Our findings indicate that problematic sleep, and sleep anxiety in particular, was associated with more behavioral problems in young epileptic children even after controlling for age, sex, seizure frequency, and number of antiepileptic medications used. Sleep anxiety is defined and measured by four items in the CSHQ, including *child needs parent in the room to fall asleep, child is afraid of sleeping in the dark, child is afraid of sleeping alone,* and *child has trouble sleeping away from home* (Owens et al., 2000). The significant positive correlation between multiple CSHQ subscale scores and the CBCL scores indicates that sleep problems are broadly linked to behavioral difficulties in young children with epilepsy. Sleep anxiety and parasomnia appeared to have the most extensive relationship to behavioral problems in that they were significantly correlated with both the CBCL internalizing and externalizing problem scores. In contrast, night waking was correlated with internalizing problems but not with externalizing problems, which suggested some specificity in the relationship between different types of sleep problems and behavioral difficulties in young epileptic children. Although prior studies have documented the link between sleep and behavior problems in older children with epilepsy (Beattie et al., 2016; Cortesi et al., 1999; Samaitiene et al., 2013), our findings suggest that such an association appears very early in children with epilepsy, even during toddlerhood.

This study found that sleep disturbances and behavioral problems are common in early childhood epilepsy, with up to one-third and one-fifth of the children in our sample having internalizing and externalizing problem scores in the clinical range, respectively. We found that 94.4% of epileptic children in our study fulfilled the criteria for global sleep disturbance,

> Problematic sleep, and sleep anxiety in particular, was associated with more behavioral problems in young epileptic children.

TABLE 2. Pearson correlation between sleep variables and internalizing and externalizing problems (*N* = 90)

Sleep variable	Internalizing problem		Externalizing problem	
	r	*p*	*r*	*p*
Actigraphy				
Total nighttime sleep, hours	0.17	.10	0.18	.08
Wake after sleep onset, minutes	0.01	.91	0.05	.60
Total daytime sleep, hours	−0.05	.64	−0.03	.74
Total 24-hour sleep, hours	0.12	.26	0.13	.21
Children's Sleep Habits Questionnaire				
Bedtime resistance	0.20	.05	0.24	.02
Sleep onset delay	<0.01	.98	<0.01	.99
Sleep duration	0.14	.17	0.04	.65
Sleep anxiety	0.29	<.01	0.29	<.01
Night wakings	0.28	.03	0.17	.09
Parasomnia	0.25	.01	0.29	<.01
Sleep disordered breathing	0.15	.13	0.14	.18
Daytime sleepiness	0.19	.07	0.11	.30
Total sleep disturbance score	0.38	<.01	0.33	<.01

TABLE 3. Predictors of internalizing problems in children with epilepsy (*N* = 90)

Variables	β	SE β	Standardized β	p
Step 1				
Age	0.66	0.89	0.08	.46
Male	1.30	2.41	0.06	.59
Only child at home	0.89	2.41	0.04	.71
Developmental delay	3.63	2.47	0.16	.14
Seizure within the past 3 months	0.96	2.42	0.04	.69
Treated with ≥ 2 antiepileptic drugs	−4.09	2.77	−0.17	.14
$R^2 = 0.05$, $F(6, 83) = 0.77$, $p = .59$				
Step 2				
Sleep anxiety	1.53	0.55	0.31	<.01
Parasomnia	0.70	0.57	0.14	.22
Sleep duration fulfilled recommendation	4.40	3.47	0.13	.20
$R^2 = 0.19$ ($\triangle R^2 = 0.14$), $F(9, 80) = 2.18$, $p = .03$				

Note. *SE, standard error.*

TABLE 4. Predictors of externalizing problems in children with epilepsy (*N* = 90)

Variables	β	SE β	Standardized β	p
Step 1				
Age	−0.37	0.94	−0.04	.69
Male	4.50	2.54	0.19	.08
Only child at home	0.26	2.54	0.01	.91
Developmental delay	3.36	2.60	0.14	.19
Seizure within the past 3 months	−0.87	2.54	−0.03	.73
Treated with ≥ 2 antiepileptic drugs	−1.32	2.91	−0.05	.65
$R^2 = 0.07$, $F(6, 83) = 1.01$, $p = .42$				
Step 2				
Sleep anxiety	1.79	0.57	0.34	<.01
Parasomnia	0.80	0.59	0.14	.18
Sleep duration fulfilled recommendation	5.32	3.57	0.15	.14
$R^2 = 0.24$ ($\triangle R^2 = 0.17$), $F(9, 80) = 2.84$, $p < .01$				

Note. *SE, standard error.*

defined as the CSHQ total score greater than 41. Such a prevalence rate was substantially higher than the 78.8% derived from the normative data in preschool-aged Chinese children (Liu et al., 2016). Mean CSHQ total score from this study was 51.86, which was also higher than the 48.89 reported from a sample of Chinese epileptic children aged 4 to 12 years old and the 48.25 from an American sample of epileptic children aged 2 to 10 years old (Chan et al., 2011; Larson et al., 2012). The relatively higher CSHQ scores in our study versus those previously reported may be due to age-related decreases in problematic sleep behaviors across childhood (Goodlin-Jones et al., 2008). A large-scale survey involving 13 countries also showed increased parental perception of sleep problems in children from predominately Asian countries than children from predominately Caucasian countries (Mindell et al., 2013). Nevertheless, objective evidence from our actigraphy recordings showed up to 83.3% of the children waking for more than an hour during the nocturnal sleep period. Findings from our study suggest a need to actively evaluate and screen for sleep and behavioral problems concurrently when seeing children with epilepsy in neurologic clinics.

We found evidence of poor sleep habits in the epileptic children in our sample, with 27.8% of the children usually or sometimes not going to bed at the same time and 26.7% not obtaining the same amount of sleep each day. Batista and Nunes (2007) found that children with epilepsy had worse sleep habits than those without. In their study, children with poorly controlled seizures had even worse sleep habits compared with children with better control of seizures. These inadequate sleep habits included, but were not limited to, not following a bedtime routine, having irregular bedtimes and risetimes, and frequent daytime napping. A case–control study conducted in Hong Kong also reported 50 minutes less sleep during weekdays compared with weekends in 63 epileptic preschool- and school-aged children (Chan et al., 2011). The interaction between sleep and epilepsy is complex (Bazil, 2003; Kothare & Kaleyias, 2010), with epileptic children having poorer sleep and more clinically defined sleep disorders such as parasomnia and obstructive sleep apnea than their healthy counterparts (Larson et al., 2012; Ong et al., 2010; Tang et al., 2011). However, these sleep disturbances may not be fully explained by epilepsy severity, seizure frequency, comorbid sleep disorders, or cumulative antiepileptic medication effects because they are already present in children with first-recognized seizures (Byars et al., 2008). Findings from our study suggest that adequate sleep habits should be addressed in pediatric epilepsy care and that sleep hygiene should be a target for intervention in young children with epilepsy.

Adequate sleep habits should be addressed in pediatric epilepsy care, and sleep hygiene should be a target for intervention in young children with epilepsy.

Thirty percent of the parents in this study reported on the CSHQ that their children usually or sometimes snored loudly during sleep, with daytime sleepiness also a frequent problem observed in our sample. Becker, Fennell, and Carney (2003) compared sleep in 14 epileptic children with sleep complaints aged between 7 and 14 years with 14 age- and sex-matched children with obstructive sleep apnea. They found no differences in snoring, apnea-hypopnea index, and excessive daytime sleepiness between the two groups. Subsequently, Kaleyias et al. (2008) reported polysomnographic (PSG) findings in 40 epileptic children aged 6 to 14 years old with sleep complaints and found that 42.5% of the children in their study exhibited snoring and 20% had obstructive sleep apnea, with only 7.5% showing normal PSG results. This study's results are in agreement with results of these prior studies, documenting that sleep-disordered breathing and its related symptoms are commonly observed in children with epilepsy (Becker et al., 2004; Kaleyias et al., 2008; Manni & Terzaghi, 2010). A slightly lower rate of snoring found in our study compared with that reported by Kaleyias et al. (2008) could be explained by the fact that our recruitment was not targeted at epileptic children with sleep complaints when seen in our clinic. Findings from this study suggest that routine screening for sleep disordered breathing and referring epileptic children for PSG studies when needed is imperative, particularly for those epileptic children with sleep complaints and those with reported high symptoms of sleep disordered breathing.

This study did not find sleep duration, either as objectively measured by actigraphy or as perceived by parents, to be a correlate of behavioral problems in epileptic children. Children in our study likely had coped with or habituated to the sleep amount that they obtained, or internalizing and externalizing problems may be less sensitive to sleep duration than are disruptive sleep behaviors such as bedtime resistance and sleep anxiety. One questionnaire-based study also found that preschool- and school-aged children with epilepsy have similar daily sleep duration but more sleep disturbances compared with healthy control children (Chan et al., 2011). However, our study found sleep duration to be a concern for most parents of toddlers and preschool-aged children with epilepsy. Up to 50% of parents reported that their children usually or sometimes sleep too little on the CSHQ. Although young children presumably have greater sleep needs (Iglowstein et al., 2003; Price et al., 2014), average daily sleep duration by actigraphy in our sample was only 9.38 hours, even shorter than the 9.44 hours reported by a U.S. study of epileptic school-aged children and adolescents (Tang et al., 2011). Short sleep duration, defined as daily sleeping for less than 10 hours, in typically developing toddlers has been found to predict emotional and behavioral problems during the preschool years (Sivertsen et al., 2015). In our study, up to 78.9% of the children fulfilled the criteria for obtaining less than 10 hours of daily sleep. Future

pediatric actigraphy studies with a longitudinal design are needed to examine whether insufficient sleep during early childhood may be a risk factor for subsequent behavioral difficulties in children with epilepsy.

This study has some noteworthy limitations. First, we had only one group of children with epilepsy. A two-group design or matched comparison of children with and without epilepsy would be helpful to show whether the sleep characteristics measured with actigraphy and the parent-reported sleep habits are common across young children of this age. Second, the study population is Chinese children, and there may be cultural differences when comparing this population versus studies conducted in other countries where different parenting norms and sleep practices exist. Third, we were not able to determine the causal relationship between sleep disturbances and behavioral problems because of the cross-sectional design of the current study. Such a relationship found in our study was also likely bi-directional, with negative consequences on both sleep and behavior domains. Fourth, this study controlled the number of antiepileptic medications prescribed in our statistical models, because polytherapy has been linked to sleep problems in previous pediatric epilepsy studies (Batista & Nunes, 2007; Bazil, 2003; Larson et al., 2012). However, the association between sleep duration and behavior consequences in epileptic children may be complicated when the adverse effects of antiepileptic medications are considered. Antiepileptic medications vary by drug category and may influence children's sleep and alter their daytime alertness level differently (Chan et al., 2011; Kothare & Kaleyias, 2010; Schmitt et al., 2009), potentially contributing to the nonsignificant findings of the association between objective actigraphic sleep and behavioral problems in our sample. Finally, our goal in this report was to examine the global association between sleep and behavior problems in young children with epilepsy. We did not assess the temporal association between nocturnal seizures and the next day's activities, which is an area to be assessed in future studies.

> Our study found sleep duration to be a concern for most parents of toddlers and preschool-aged children with epilepsy.

In conclusion, toddlers and preschool-aged children with epilepsy experience both sleep and behavior problems, and their problematic sleep is associated with behavioral difficulties. Findings suggest that screening of sleep and behavior problems should be part of routine epilepsy care to identify children with problematic sleep and unrecognized sleep disorders as well as those at risk of behavioral dysfunction. Future studies are warranted to investigate whether interventions targeted at improving sleep would ameliorate the burden of sleep and behavior problems in pediatric epilepsy populations.

This work was supported by Ministry of Science and Technology, Taiwan, MOST 104 - 2314 - B - 002 - 115 - MY3. The authors would like to thank Hsin-Yu Li and Ying-Ying Lin for their assistance in data collection and processing. Special thanks to the children and families who participated in the study.

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