Journal Pre-proof

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Conflict of interest: The authors have no conflicts of interest to declare.

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Abstract

Objectives: Sleep difficulties are associated with various behavioral problems and cognitive development, but the association has not been thoroughly evaluated in preschoolers with and without developmental disability (DD). The aim of this study was to compare the behavioral and cognitive characteristics of poor and good sleepers with and without DD in a community-based sample of preschool children.

Methods: We recruited 196 children aged 34 to 77 months from community-based daycare centers, kindergartens, and special education centers. Children were classified as poor sleepers with DD (n=23), poor sleepers without DD (n=23), good sleepers with DD (n=64), and good sleepers without DD (n=94). Poor sleepers were defined based on Children's Sleep Habits Questionnaire Total Sleep Disturbance Score (CSHQ TSDS) cutoff of >52.

Results: When compared to good sleepers with DD, poor sleepers with DD scored significantly higher on the Attention Problems (p=0.005) and Aggressive Behaviors (p=0.001) subscales of the CBCL, indicating greater difficulty. Caregivers of the poor sleepers with DD reported more depressive symptoms (p=0.028) and more stress related to the child (p=0.002) and the parent (p=0.045) than caregivers of the good sleepers with DD. On the other hand, when compared to good sleepers without DD, poor sleepers without DD scored significantly higher only on the Anxious/Depressed subscale (p=0.045) of the CBCL. Cognitive development and adaptive functioning were not significantly different between poor and good sleepers with and without DD. Among the subscales of the CSHQ, the Sleep Onset Delay showed strongest correlation with behavioral measures of the children and distress of the caregivers.

Conclusion: Externalizing problems such as aggressive behaviors, rather than cognitive development, are associated with sleep difficulties in preschool children with DD.

Keywords: Sleep, Children's Sleep Habits Questionnaire, behavioral problems, preschool children, autism spectrum disorder, intellectual disability.

Highlights

- In a sample of preschoolers, behavioral and cognitive characteristics of good sleepers and poor sleepers with and without developmental disability (DD) were compared.

- A new cutoff for Children's Sleep Habits Questionnaire (CSHQ) was defined, suggesting that cutoff adjustment may be needed in younger age group with different cultural background.

- In children with DD, sleep difficulties were associated with externalizing symptoms, but not associated with cognitive development.

- In children without DD, sleep difficulties were associated with internalizing symptoms.

- Among the CSHQ subscales, Sleep Onset Delay subscale showed correlation with behavioral and cognitive measures and caregiver distress.

1. INTRODUCTION

During the first few years of life, sleep patterns change rapidly, and sleep difficulties are commonly found in children, with a prevalence rate ranging from 20% to 30% [1, 2]. Sleep difficulties are one of the major concerns for both parents and clinicians. Studies have reported that these concerns start from infancy and continue into the preschool period [3]. Children at this age often engage in bedtime resistance, leading to delayed sleep onset, and demonstrate frequent night wakings. Both delayed sleep onset and nighttime awakening are referred to as behavioral insomnias of childhood [4].

Sleep difficulty is an important public health issue, since inadequate sleep affects not only the physical health but also the mental health of the children [5]. Sleep difficulties are associated with medical conditions such as obesity, insulin resistance, and immune dysfunction [6]. Furthermore, sleep disturbances during the preschool period may persist over subsequent years [7], affecting mood, cognition, and school performance [8], with associated daytime behavioral problems. Poor sleep in children affects their families as well, increasing family stress and disrupting parental sleep, and consequently impairing daytime function in both parents [9, 10]. As a result, the quality of life is decreased in children with sleep difficulties and their families.

In preschool children, development and sleep difficulty are interrelated. Developmental disability (DD) refers to a condition that shows impairment in physical, learning, or language development, and include autism spectrum disorder (ASD) and intellectual disability (ID). In children with ASD, sleep difficulties are particularly common, with prevalence rate ranging from 50% to 80% [11]. Multiple etiologies underlie sleep difficulty in ASD, including long-standing poor sleep hygiene, disruption in circadian rhythms,

hyperarousal, and sensory reactivity [12-14]. Clinically, sleep difficulties in ASD are known to be associated with increased stereotypic, self-injurious behaviors [15], increased anxiety [16] and decreased quality of life [17]. Although understudied compared to ASD, literature suggests deficits in sleep duration and quality in children with ID, with clearer trends observed in individuals with known genetic syndromes [18].

There is accumulating evidence that sleep affects behavior, mood, and cognition in children [19]. However, to our knowledge, few studies have thoroughly addressed the association between sleep and diverse areas of development using both self-reported questionnaires and psychological tests in preschoolers. Furthermore, few studies directly compared sleep difficulties in children with and without DD. Our objective in the present study was to compare the behavioral problem and cognitive development of good sleepers and poor sleepers with and without DD, classified by the Children's Sleep Habits Questionnaire (CSHQ) in a community-based sample of preschool children. In addition, we aimed to assess the relationship between different dimensions of sleep difficulties, and behavioral and cognitive measures. We hypothesized that (1) poor sleep would have a negative effect on behavioral problem and cognitive development, and (2) CSHQ subscales related to behavioral insomnias of childhood would show stronger correlations with behavioral problem and cognitive development.

2. MATERIALS AND METHODS

2.1. Participants and Procedure

A total of 196 children were recruited from May 2020 to July 2020 at community-based daycare

centers, kindergartens, and special education centers. Information on the research were noticed in each center, and children were enrolled if the children and their caregivers wished to participate in the study. Enrolled children were between 34 and 77 months of age. Children were excluded from the study if they had (i) a history of neurologic disease such as cerebral palsy, (ii) any sensory disturbances (i.e., vision, hearing, taste, or smell), or (iii) severe gross or fine motor problems that prevented them from participating in the psychometric tests. The study was approved by the Institutional Review Board of Asan Medical Center, and informed consent was obtained from the caregivers of each child.

Of the 196 subjects that were recruited, 79 children had DD, and 117 children had neurotypical development. DD included ASD, ID and language disorder (LD) in which a diagnosis was confirmed by board-certified child and adolescent psychiatrists based on the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5) diagnostic criteria and relevant psychometric tests. When the diagnosis was equivocal, the child and the parent were invited for an extra visit to the clinic, and additional interview was performed. Subsequently, a consensus meeting involving two or three child and adolescent psychiatrists took place to confirm the diagnosis. When a diagnosis of ID was confirmed in a child, a diagnosis of an LD was not made.

2.2. Assessment and Measures

2.2.1. Sleep Difficulties

The CSHQ is a widely adapted questionnaire used to evaluate childhood sleep difficulties. The CSHQ was originally designed based on symptoms presented in the *International Classification of Sleep Disorders, Diagnostic and Classification Manual* [20], and its reliability and validity have been tested in children aged 4 to 10 years [21]. The

questionnaire has successfully been used not only to screen for sleep difficulties but also to assess treatment effects [22]. Although children younger than 4 years were not included in the initial study, the CSHQ has been shown to be useful in children as young as 2 years [23] and has been used in children with DD such as ASD to verify the presence of sleep disorders [24].

Caregivers of the participants completed the CSHQ, which consists of 33-items. For each item, three answers are possible based on frequency of sleep difficulties during the last uneventful week. There are 8 subscales in the CSHQ that address various aspects of sleep difficulties: Bedtime Resistance, Sleep Onset Delay, Sleep Duration, Sleep Anxiety, Night Waking, Parasomnias, Sleep Disordered Breathing, and Daytime Sleepiness. The CSHQ Total Sleep Disturbance Score (TSDS) is calculated to assess overall sleep difficulty.

2.2.2. Behavioral Problems

Behavioral and emotional problems were measured by the Child Behavior Checklist for ages 1.5–5 (CBCL) [25]; this is a 99-item scale rated by parents with scores ranging from 0 to 2 for each item. The scores for the following seven subscales were calculated: Emotionally Reactive, Anxious/Depressed, Somatic Complaints, Withdrawn, Sleep Problems, Attention Problems, and Aggressive Behaviors. CBCL demonstrated good reliability and validity in clinical and non-clinical populations, and showed good cross-informant agreement [25].

In addition, the Aberrant Behavior Checklist (ABC) [26], which is a rating scale used to assess behavioral problems in individuals with DD, was administered. The ABC consists of 58 items answered on a 4-point scale from 0 to 3 based on problem severity. The items are further categorized into the following five domains: Irritability, Lethargy/Social Withdrawal, Stereotypic Behavior, Hyperactivity/Noncompliance, and Inappropriate Speech. The psychometric properties of ABC have been assessed, and the subscales have high internal

consistency, adequate reliability, and established validity [26].

Attention deficit hyperactivity disorder (ADHD) symptoms were assessed by the ADHD Rating Scale (ARS) [27]. The ARS is an 18-item questionnaire with each item scored from 0 to 3 based on symptom frequency. The 18 items correspond to the 18 symptoms of ADHD in the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) and measure attention-deficit and hyperactivity-impulsivity symptoms. The reliability and validity of the ARS have been previously established [28].

2.2.3. Cognitive Development

Development was assessed by the Psychoeducational Profile-Revised (PEP-R) [29], which was designed to assess seven domains of development in children with autism: Imitation, Perception, Fine motor, Gross motor, Eye-hand Coordination, Cognitive Performance, and Cognitive-Verbal Performance. Although initially developed for children with autism, PEP-R is also applicable to children with neurotypical development [30]. The PEP-R showed good internal consistency, test-retest reliability, and high concurrent validity with the Stanford-Binet Intelligence Scale and the Vineland Adaptive Behavior Scale [31-33]. The Developmental quotient (DQ) was calculated to assess the overall developmental level ([developmental age/chronological age]×100).

2.2.4. Adaptive Functioning

The Vineland Adaptive Behavior Scale, second edition (VABS), which is a semi-structured interview, was administered to estimate adaptive functioning [34], and the overall standard Adaptive Behavior Composite Score (ABCS) was obtained. The VABS demonstrated good to excellent split-half and test-retest reliability and modest concurrent validity [34].

2.2.5. ASD Symptoms

The Social Responsiveness Scale (SRS), a parent-completed, 65-item questionnaire, was used to measure the frequency of autism-related behaviors [35]. In addition, the Korean version of the Childhood Autism Rating Scale (K-CARS) was administered by child psychologists to measure autism symptomatology [36]. The K-CARS consists of 15 items rated on a 7-point scale with scores range from 1 to 4 (half points), in which higher total scores indicate worse severity.

2.2.6. Parenting Stress and Depression

Parenting stress and depression were measured by the Parenting Stress Index, Fourth Edition (PSI-4) [37] and the Center for Epidemiologic Studies Depression Scale Revised (CESD-R) [38], respectively. The PSI-4 is a 120-item measure with two domains: (i) the Child Characteristics domain and (ii) the Parent Characteristics domain. The internal consistency was excellent for both domains, and the PSI-4 displayed predictive validity in studies with other countries [39]. The CESD-R consists of 20 items related to depression rated on a 5-point scale based on symptom frequency. Good psychometric properties were demonstrated in CESD-R, including high internal consistency, and consistent convergent and divergent validity [40].

2.3. Data Analyses

In this study, we used a modified CSHQ TSDS cutoff score to define sleep status. When the original CSHQ TSDS cutoff of ≥ 41 was used [21], 95.9% of children included in this study were classified as poor sleepers, and we were concerned that the cutoff may overidentify sleep problems, and may be inappropriate for our sample. Thus, based on the literature that

approximately 25% of preschool children have sleep disturbances [41, 42], the first quartile of CSHQ TSDS was acquired in the 117 children with neurotypical development. A new CSHQ TSDS cutoff of >52 was defined, and subjects who scored higher than the cutoff were assigned to the poor sleeper group, whereas subjects below the cutoff were assigned to the good sleeper group. Similar cutoff modifications were adopted in a previous study [24], where a cutoff score of 48 was used in 2- to 5-year-old children.

The primary analysis examined whether behavioral and cognitive measures differed between good sleepers and poor sleepers with and without DD. We divided subjects into four groups based on the sleep status (i.e., poor sleeper and good sleeper) and the presence of DD (i.e., with DD and without DD). Descriptive statistics, and behavioral and cognitive measures were compared between the four groups. One-way analysis of variance (ANOVA) with post-hoc Tukey's test was used for continuous variables, and Pearson's chi-square test with post-hoc Bonferroni correction was used for categorical variables, and two-tailed p values were calculated. Subsequently, multiple logistic regression was conducted to identify variables that were significantly associated with sleep status. Age, gender, diagnosis, and behavioral and cognitive measures that showed significant ($p<0.05$) difference between groups were included in the backward stepwise multiple logistic regression model. The ARS subscales were excluded from the multiple logistic regression model due to an overlap with the Attention Problem subscale of the CBCL, and the Sleep Problems subscale of the CBCL was also excluded from the multiple logistic regression model. To detect collinearity, variance inflation factors (VIFs) and correlations between variables were assessed. All included variables showed a VIF value <10 [43] and a correlation <0.80 [44], suggesting low concern for collinearity.

The secondary analysis examined the correlation between the CSHQ subscales and behavioral and cognitive measures. To this end, Pearson's correlation coefficient (r) was

calculated, and significant correlations were identified ($p<0.05$). All statistical analyses were performed using R Statistical Software, version 4.0.2 (R Foundation for Statistical Computing, Vienna, Austria) [45].

3. RESULTS

3.1. Study Sample

The overall characteristics of the study sample are summarized in Table 1. A total of 196 children were recruited; of these, 16 children were categorized as poor sleepers with DD (age=59.6 ± 8.6 months, 8 boys), 23 children were categorized as poor sleepers without DD (age=53.0 ± 8.1 months, 12 boys), 63 children were categorized as good sleepers with DD (age=57.9 ± 9.0 months, 49 boys), and 94 children were categorized as good sleepers without DD (age=52.3 ± 8.7 months, 56 boys). Significant difference in age ($p<0.001$) and gender ($p=0.033$) existed between the four groups. The proportions of diagnoses of ASD, ID and LD significantly different between the four groups ($p<0.001$, $p<0.001$, and $p<0.001$, respectively).

3.2. Comparison of Behavioral and Cognitive Measures between Poor and Good Sleepers with and without Developmental Disability

To examine the difference between the four groups, the mean scores for behavioral and cognitive measures were compared, and post-hoc analyses were conducted (Table 2). When compared to good sleepers with DD, poor sleepers with DD scored significantly higher on the Attention Problems and Aggressive Behaviors subscales (post-hoc $p=0.005$ and 0.001, respectively) of the CBCL, indicating greater difficulty. Poor sleepers with DD showed significantly higher scores on the Inattention subscale (post-hoc $p=0.005$) of the ARS than good

sleepers with DD. On the SRS scale, poor sleepers with DD showed significantly higher total scores than Good sleepers with DD (post-hoc p=0.004), but on the K-CARS, no significant score differences were observed (post-hoc p=0.270). The caregivers of the poor sleepers with DD reported significantly higher level of stress than caregivers of the good sleepers with DD according to the PSI, on both Child Characteristics and Parent Characteristics domains (post-hoc p=0.002 and 0.045, respectively). In the same context, the caregivers of the poor sleepers with DD were significantly more depressed than the caregivers of the good sleepers with DD (post-hoc p=0.028), as rated by the CESD-R. Cognitive development and adaptive functioning were not significantly different between the poor sleepers with DD and the good sleepers with DD groups when comparing the PEP-R DQ (post-hoc p=0.556) and VABS ABCS (post-hoc p=0.196). On the other hand, when compared to good sleepers without DD, poor sleepers without DD scored significantly higher only on the Anxious/Depressed subscale (post-hoc p=0.045) of the CBCL, indicating greater difficulty.

Multiple logistic regression was conducted to identify variables that were significantly associated with sleep status (Table 3). Backward stepwise regression model was built, and the final model included gender, the Aggressive Behaviors subscale of the CBCL, and the Parent Characteristics domain of the PSI. Of the variables included in the final model, higher scores on the Aggressive Behaviors subscale of the CBCL was significantly associated with poor sleep (odds ratio 1.10, confidence interval 1.03-1.17, p=0.003)

3.3. CSHQ Subscale Scores and Diagnosis

The CSHQ subscale scores were further examined, and children with and without a clinical diagnosis were compared (Table 4). Children diagnosed with ASD scored significantly higher

on the Sleep Onset Delay subscale than children without an ASD diagnosis (p=0.045). The Sleep Anxiety subscale scores were lower in children with ASD than in those without ASD, but the difference was not significant after multiple comparisons were adjusted (p=0.090). The Total Sleep Time was shorter in children with ASD than in children without ASD, although this finding did not remain after adjustment for multiple comparisons (p=0.171). An identical trend was observed in children diagnosed with ID, with minor differences in the adjusted p values.

3.4. Correlation of CSHQ Subscale Scores with Behavioral and Cognitive Measures

The correlation between each of the eight CSHQ subscales and each of the behavioral and cognitive measures was calculated (Figure 1). We focused on the Bedtime Resistance, Sleep Onset Delay, and Night Wakings subscales of CSHQ, which are related to behavioral insomnias of childhood.

The Bedtime Resistance subscale was significantly correlated with the Emotionally Reactive and Anxious/Depressed subscales of the CBCL (r=0.164 and 0.172, respectively). The Sleep Onset Delay subscale was significantly correlated with the Emotionally Reactive, Withdrawn, Attention Problems, Aggressive Behaviors subscales of the CBCL (r=0.146, 0.202, 0.226, and 0.264, respectively), the Inattention and Hyperactivity/Impulsivity subscales of the ARS (r=0.265 and 0.278, respectively), the VABS (r=-0.217), the SRS (r=0.231), the K-CARS (r=0.274), the Child Characteristics and Parent Characteristics domains of the PSI (r=0.265 and 0.175, respectively), and the caregivers' CESD-R (r= 0.163). The Night Waking subscale showed significant correlations with Attention Problems and Aggressive Behaviors subscale of the CBCL (r=0.166 and 0.194, respectively), the Inattention and Hyperactivity/Impulsivity subscales of the ARS (r=0.160 and 0.179, respectively), the SRS (r=0.148), the Child Characteristics domain of the PSI (r=0.154), and the caregivers' CESD-R (r=0.235).

4. DISCUSSION

In a community-based sample including preschool children with and without DD, we aimed to compare the behavioral problem and cognitive development of good sleepers and poor sleepers with and without DD, and to assess the relationship between different dimensions of sleep difficulties and behavioral and cognitive measures. We found that in children with DD, externalizing problems such as aggressive behaviors were associated with poor sleep. In children without DD, internalizing problems such as anxiety and depression were associated with poor sleep. In children with and without DD, cognitive development and adaptive behavior showed no significant association with poor sleep. Among the subscales of the CSHQ, the Sleep Onset Delay subscale was significantly higher in children with DD, and showed strongest correlation with behavioral measures of the children and distress of the caregivers.

In this study, subscale measuring Sleep Onset Delay was significantly higher in children with ASD and children with ID, while no significant difference was observed among the other subscales. Children with DD are known to exhibit a different pattern of sleep difficulty compared to children without developmental disorders, and our findings are in line with previous findings. In children with ASD, problematic behaviors at bedtime can occur, related to unusual bedtime routine and anxiety [13], leading to a delay of sleep onset. As for the children with ID, higher rates of night settling problems were observed compared to neurotypical children [46]. When compared to a similar previous study, no significant difference was observed in other subscales such as Sleep Duration, Sleep Anxiety, Night Wakings, and Parasomnias [47]. One of the possible explanations may be the overall higher

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CSHQ scores in younger children, which minimizes the score differences between children with and without DD. In this context, we are aware of a study conducted in toddlers and preschool children that found no significant difference in the CSHQ subscales between children with and without DD [23].

Based on our study, poor sleepers had more externalizing symptoms, such as attentional problems and aggressive behaviors. Sleep difficulties have been shown to be associated with increased rate of aggression and hyperactivity in children with ASD and in children with neurotypical development [48]. Regarding the age of the children, some studies have argued that sleep difficulties are associated with externalizing problems in children between 24 and 36 months but not in those between 48 and 60 months [49]. However, the results from our study demonstrate that sleep difficulties in older preschool children are also associated with externalizing behavioral problems, in accordance with the findings of another study conducted in preschool children aged 48 months [50].

In addition, we found that subscales of the CSHQ related to behavioral insomnias of childhood, such as Sleep Onset Delay and Night Wakings, were frequently correlated with externalizing behaviors. Difficulties in initiating and maintaining sleep have been documented to be related to dysfunction in the arousal/attention systems, which can in turn affect attention, aggressive behavior, and irritability [51]. Furthermore, the Sleep Onset Delay subscale showed stronger correlation with behavioral and cognitive measures than the CSHQ TSDS, suggesting that assessing specific areas of sleep may be important.

Internalizing symptoms such as anxiety and depression were more common in poor sleepers without DD, compared to good sleepers without DD. Association between poor sleep difficulties and internalizing problem have been previously addressed. Children who slept less at age 2 years had increased risk of anxiety and depression at age 3, and children who woke up

longer at 29 months of age had higher anxiety and depression [52, 53]. Moreover, a prospective cohort study also verified sleep as a significant driver of internalizing problems [54]. This association between poor sleep and internalizing problem were studied in children with ASD, and internalizing problems such as anxiety were identified as a predictor of poor sleep. In our sample, poor sleepers with DD did not show significantly more internalizing symptoms compared to good sleepers with DD; considering the small sample size, careful interpretation is required.

We noted that cognitive development measured by the PEP-R was not significantly different between poor and good sleepers in children with and without DD. In preschool children, the link between sleep and cognition has not been extensively studied, and the results are unclear [55]. Previous studies focusing on vocabulary capacities found a positive association between night sleep disturbances and receptive vocabulary. However, other studies reported no association between cognition and total sleep duration, night wakening, or sleep onset latency [55, 56], which are in agreement with the results of this study.

In this study, we defined a modified CSHQ TSDS cutoff of >52 based on previous reports of the prevalence of sleep difficulties in children with typical development [42]. Similar cutoff modifications adopted in a previous study [24] suggest that a more conservative cutoff for CSHQ TSDS might be required in toddlers and preschool children. In addition, considering that the CSHQ is completed by parents, higher scores may be the result of more sleep-related attention and anxiety in parents of young children [23]. Parents in Asian countries perceive and more sleep difficulties than those in predominantly Caucasian countries, and thus, parental expectations of sleep may be affected by cultural norms [57]. These factors can concurrently affect the higher CSHQ cutoff score defined in this study.

This study has several limitations. First, no objective measure of sleep, such as

actigraphy, was used in this study, and no clinical assessment of sleep difficulties were made, which limits the strengths of our findings. In subsequent studies, obtaining objective measures of sleep would be necessary. Second, the community sample included 76 children with DD, which is far higher than the known prevalence rate. Therefore, the sample did not adequately represent a random community sample, although we made an attempted to adjust for clinical diagnosis. Third, some of the measures, such as attention problems, rely only on caregiver reports, which may have decreased the accuracy of our results. Fourth, a higher cutoff for CSHQ score defined in our study may indicate that CSHQ is not valid in the study population. Further study is needed to assess the validity of CSHQ in preschool children in Korea. Fifth, due to limited sample size of each of the four groups, careful interpretation is required. Finally, our study had a cross-sectional design, preventing the identification of a causal relationship.

Despite these caveats, the strength of this study comes from the diverse measures used, including both psychological tests and questionnaires. Thereby, when compared to using questionnaires only, cognitive development and adaptive functioning of a child were more accurately assessed. In addition, the association of sleep status with various measures, including clinical diagnosis, which had a significant effect on majority of measures, was assessed and adjusted. The CSHQ scales were completed without missing data, enabling analysis of diverse domains of sleep problems. Finally, although our sample size was modest, this community sample from Korea represents a unique sample from Eastern Asia where sleep-related culture is different.

Clinically, the association of behavioral problems with sleep difficulties identified in this study imply that adequate intervention is necessary. Behavioral sleep interventions based on the principles of Applied Behavior Analysis (ABA) are effective in reducing diverse sleep difficulties including sleep onset delay, and while the mechanism is unknown, these

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interventions may improve daytime functioning of the children with sleep difficulties [58]. When delivering behavioral interventions, the caregiver characteristics should also be considered. Caregivers of poor sleepers in this study, as in other studies, report increased stress and depression [59]. Considering that behavioral interventions require many hours of parental input, more support may be needed for caregivers with mental health difficulties [60].

In conclusion, our results suggest that externalizing problems such as aggressive behaviors, rather than cognitive development, are associated with sleep difficulties in children with DD. Among the subscales of the CSHQ, the Sleep Onset Delay subscale showed strongest correlation with behavioral measures of the children and distress of the caregivers. These results underscore the importance of assessing sleep difficulties in detail in preschool children.

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Table 1. Summary Characteristics of the Study Sample [a]

Variable	Poor Sleeper		Good Sleeper		p	Post-hoc analysis [b]
	With DD (n=16)	Without DD (n=23)	With DD (n=63)	Without DD (n=94)		
Age, mean (SD), months	59.6 (8.6)	53.0 (8.1)	57.9 (9.0)	52.3 (8.7)	<0.001	1>4
Gender						
Male, n (%)	8 (50.0%)	12 (52.2%)	49 (77.8%)	56 (59.6%)	0.033	-
Diagnosis, n (%)						
ASD	14 (93.3%)	0 (0.0%)	45 (78.9%)	0 (0.0%)	<0.001	1>2, 1>4, 2<3, 3>4
ID	13 (86.7%)	0 (0.0%)	48 (84.2%)	0 (0.0%)	<0.001	1>2, 1>4, 2<3, 3>4
LD	2 (12.5%)	0 (0.0%)	10 (15.9%)	0 (0.0%)	<0.001	3>4
PEP-R DQ < 70, n(%), [N=195]	13 (81.3%)	0 (0.0%)	46 (73.0%)	0 (0.0%)	<0.001	1>2, 1>4, 2<3, 3>4
VABS ABCS < 70, n(%)	15 (93.8%)	0 (0.0%)	44 (69.8%)	3 (3.2%)	<0.001	1>2, 1>4, 2<3, 3>4

[a] The total sample number (N) is 196 unless otherwise indicated.

[b] Tukey's test for continuous variables, and Bonferroni correction for categorical variables were conducted, and significant results are presented

($p<0.05$). 1=Poor Sleeper with DD, 2=Poor Sleeper without DD, 3=Good Sleeper with DD, 4=Good Sleeper without DD.

ASD, Autism spectrum disorder; DD, Developmental Disability; ID, Intellectual Disability; K-CARS, Korean version of the Childhood Autism Rating Scale; LD, Language Disorder; PEP-R DQ, Psychoeducational Profile Revised Developmental Quotient; SD, Standard Deviation; VABS ABCS, Vineland Adaptive Behavior Scale Adaptive Behavior Composite Score

Table 2. Comparison of Behavioral and Cognitive Measures Between the Four Groups [a]

Variable	Poor Sleeper		Good Sleeper		p	Post-hoc analysis [b]
	With DD (n=16)	Without DD (n=23)	With DD(n=63)	Without DD (n=94)		
CBCL						
Emotionally Reactive	57.3 (5.2)	53.1 (4.4)	53.9 (5.7)	51.8 (3.5)	<0.001	1>2, 1>3, 1>4, 3>4
Anxious/Depressed	55.6 (5.1)	54 (7.1)	52.8 (4.7)	51.3 (3.1)	0.001	1>4, 2>4
Somatic Complaints	55.0 (7.2)	52.6 (5.0)	53.3 (4.5)	51.9 (3.5)	0.043	-
Withdrawn	69.0 (6.8)	54.0 (7.0)	65.2 (9.0)	51.5 (3.6)	<0.001	1>2, 1>4, 2<3, 3>4
Sleep Problems	61.2 (5.5)	56.6 (8.7)	53.6 (5.3)	52.5 (4.5)	<0.001	1>2, 1>3, 1>4, 2>4
Attention Problems	66.6 (5.9)	53.9 (5.2)	61.0 (8.0)	52.3 (4.0)	<0.001	1>2, 1>3, 1>4, 2<3, 3>4
Aggressive Behaviors	60.4 (8.2)	54.0 (5.3)	55.2 (5.9)	51.2 (2.9)	<0.001	1>2, 1>3, 1>4, 3>4
ABC						
Irritability	9.1 (9.5)	3.6 (2.9)	6.2 (5.1)	1.6 (2.4)	<0.001	1>2, 1>4, 3>4
Lethargy/Social Withdrawal	10.4 (7.0)	1.7 (4.3)	8.7 (6.3)	0.5 (1.1)	<0.001	1>2, 1>4, 3>4
Stereotypic Behavior	3.2 (4.5)	0.0 (0.2)	3.0 (3.6)	0.1 (0.4)	<0.001	1>2, 1>4, 2<3, 3>4

Hyperactivity/Noncompliance	8.8 (6.8)	2.5 (2.3)	6.9 (4.5)	1.4 (2.2)	<0.001	1>2, 1>4, 2<3, 3>4
Inappropriate Speech	2.2 (2.2)	0.5 (0.8)	2.2 (2.1)	0.4 (0.7)	<0.001	1>2, 1>4, 2<3, 3>4
ARS						
Inattention	16.9 (5.1)	5.0 (4.1)	11.7 (6.0)	3.6 (3.3)	<0.001	1>2, 1>3, 1>4, 2<3, 3>4
Hyperactivity/Impulsivity	10.6 (5.7)	4.7 (4.1)	7.9 (4.8)	2.8 (3.1)	<0.001	1>2, 1>4, 2<3, 3>4
PEP-R DQ, [N=195]	42.9 (25.3)	108.6 (10.7)	50.4 (29.9)	107.5 (12.2)	<0.001	1<2, 1<4, 2>3, 3<4
VABS ABCS	52.2 (11.6)	93.7 (8.5)	59.7 (15.0)	92.3 (13.9)	<0.001	1<2, 1<4, 2>3, 3<4
SRS	76.7 (17.4)	49.7 (15.2)	65.6 (14.7)	44.9 (5.5)	<0.001	1>2, 1>3, 1>4, 2<3, 3>4
K-CARS	32.5 (4.3)	15.9 (1.2)	29.9 (8.4)	16.1 (1.5)	<0.001	1>2, 1>4, 2<3, 3>4
PSI						
Child Characteristics	68.2 (9.7)	50.3 (10.1)	58.8 (9.0)	45.5 (9.2)	<0.001	1>2, 1>3, 1>4, 2<3, 3>4
Parent Characteristics	61.6 (9.2)	51.2 (9.6)	54.7 (9.8)	48.0 (9.1)	<0.001	1>2, 1>3, 1>4, 3>4
Parent CESD-R	19.1 (12.3)	9.6 (11.0)	11.3 (12.3)	6.6 (6.8)	<0.001	1>2, 1>3, 1>4, 3>4

[a] The total sample number (N) is 196 unless otherwise indicated.

[b] Tukey's test was conducted, and significant results are presented ($p<0.05$). 1=Poor Sleeper with DD, 2=Poor Sleeper without DD, 3=Good Sleeper with DD, 4=Good Sleeper without DD.

ABC, Aberrant Behavior Checklist; ARS, ADHD Rating Scale; CBCL, Child Behavior Checklist; CESD-R, Center for Epidemiologic Studies Depression Scale Revised; CSHQ TSDS, Children's Sleep Habits Questionnaire Total Sleep Disturbance Score; DD, Developmental Disability; K-CARS, Korean version of the Childhood Autism Rating Scale; PEP-R, Psychoeducational Profile Revised; PSI, Parenting Stress Index; SRS, Social Responsiveness Scale; VABS ABCS, Vineland Adaptive Behavior Scales Adaptive Behavior Composite Score

Table 3. Multiple Logistic Regression of Variables Associated with Sleep Status

Variable	OR	95% CI	*p*
Female gender [a]	2.10	0.99 - 4.47	0.053
Aggressive Behaviors subscale of the CBCL	1.10	1.03 - 1.17	**0.003**
Parent Characteristics domain of the PSI	1.03	0.99 - 1.07	0.095

[a] Male gender as reference

CBCL, Child Behavior Checklist; CI, Confidence interval; ID, Intellectual disability; OR, Odds ratio; PSI, Parenting Stress Index

Table 4. CSHQ Subscales and Total Sleep Time by Diagnosis

Variable	ASD (n=61)	without-ASD (n=139)	p	adjusted p [a]	ID (n=63)	without-ID (n=137)	p	adjusted p [a]
CSHQ subscale, mean (SD)								
Bedtime Resistance	12.9 (2.2)	13.0 (2.2)	0.733	1.000	12.7 (2.1)	13.0 (2.2)	0.402	1.000
Sleep Onset Delay	1.8 (0.8)	1.4 (0.7)	**0.005**	**0.045**	1.8 (0.8)	1.4 (0.7)	**0.004**	**0.036**
Sleep Duration	4.2 (1.5)	3.9 (1.3)	0.174	1.000	4.2 (1.5)	3.9 (1.2)	0.179	1.000
Sleep Anxiety	7.2 (1.1)	7.7 (1.1)	**0.010**	0.090	7.3 (1.0)	7.6 (1.2)	**0.046**	0.414
Night Waking	3.6 (1.0)	3.6 (0.9)	0.958	1.000	3.6 (0.8)	3.6 (1.0)	0.941	1.000
Parasomnias	9.1 (1.7)	9.2 (1.7)	0.814	1.000	9.0 (1.6)	9.2 (1.7)	0.361	1.000
Sleep Disordered Breathing	3.3 (0.5)	3.3 (0.6)	0.724	1.000	3.3 (0.6)	3.3 (0.6)	0.957	1.000
Daytime Sleepiness	11.7 (3.0)	11.8 (3.0)	0.764	1.000	11.6 (2.8)	11.8 (3.1)	0.622	1.000
Total Sleep Time, hr, mean (SD)	9.7 (1.0)	10.1 (0.9)	**0.019**	0.171	9.7 (1.0)	10.1 (0.9)	**0.009**	0.081

[a] Corrected for multiple comparison (Bonferroni correction).

ASD, Autism spectrum disorder; CSHQ, Children's Sleep Habits Questionnaire; ID, Intellectual disability; SD, Standard deviation;

Figure 1. Correlation Between CSHQ Subscales and Behavioral/Cognitive Measures.
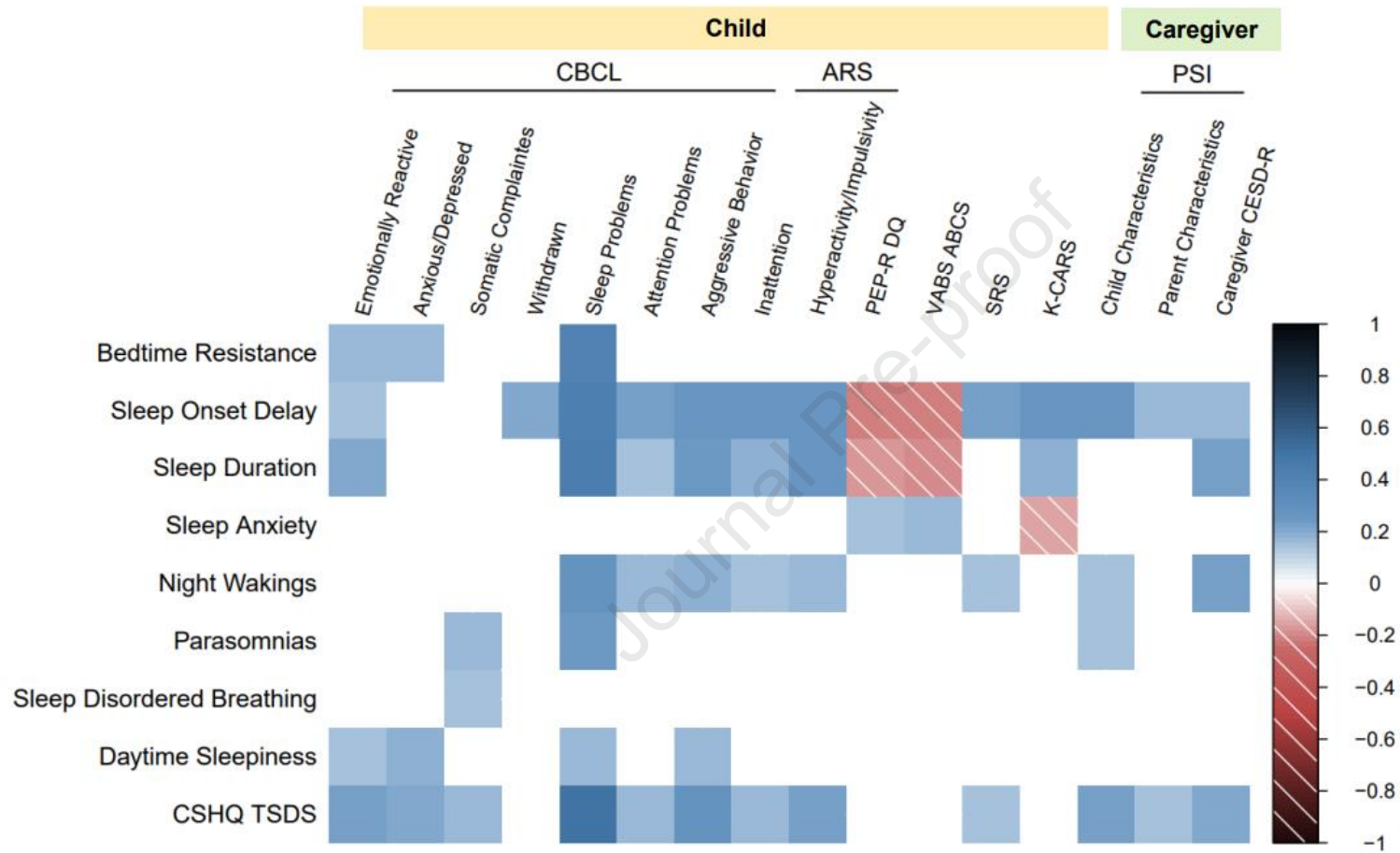
A positive correlation is presented as a solid blue square, whereas a negative correlation is presented as a shaded red square. Only significant (p<0.05) correlations are shown.

ABC, Aberrant Behavior Checklist; ARS, ADHD Rating Scale; CBCL, Child Behavior Checklist; CESD-R, Center for Epidemiologic Studies Depression Scale Revised; CSHQ TSDS, Children's Sleep Habits Questionnaire Total Sleep Disturbance Score; K-CARS, Korean version of the Childhood Autism Rating Scale; PEP-R DQ, Psychoeducational Profile Revised Developmental Quotient; PSI, Parenting Stress Index; SRS, Social Responsiveness Scale; VABS ABCS, Vineland Adaptive Behavior Scales Adaptive Behavior Composite Score

Highlights

- In a sample of preschoolers, behavioral and cognitive characteristics of good sleepers and poor sleepers with and without developmental disability (DD) were compared.

- A new cutoff for Children's Sleep Habits Questionnaire (CSHQ) was defined, suggesting that cutoff adjustment may be needed in younger age group with different cultural background.

- In children with DD, sleep difficulties were associated with externalizing symptoms, but not associated with cognitive development.

- In children without DD, sleep difficulties were associated with internalizing symptoms.

- Among the CSHQ subscales, Sleep Onset Delay subscale showed correlation with behavioral and cognitive measures and caregiver distress.

Credit author statement

Taeyeop Lee: Conceptualization, Methodology, Formal analysis, Writing - Original Draft, Visualization; Jichul Kim: Resources, Data Curation; Kee Jeong Park: Resources, Data Curation; Hyo-Won Kim: Conceptualization, Methodology, Resources, Writing - Review & Editing, Supervision.