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## **Sleep problems in attention-deficit/hyperactivity disorder and autism spectrum disorder: sex differences and parental stress**

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Sleep problems are common in children with neurodevelopmental disorders, such as Attention Deficit/Hyperactivity Disorder (ADHD) and Autism Spectrum Disorder (ASD). For example, it has been reported that up to 55% of children with ADHD may have sleep problems (Cortese et al., 2013). Furthermore, Lai et al. in a recent meta-analysis estimated an overall pooled prevalence of 13% for sleep-wake disorders in autism (Lai et al., 2019). Sleep disorders in children with ASD or ADHD are associated with poorer parent mental health and higher parenting stress. However, only a few studies have investigated sex differences in sleep problems in children with ADHD or ASD, and these yielded conflicting findings (Sivertsen et al., 2012; Mazzone et al., 2018). It should be noted that the heterogeneity found in these results could be given by the fact that all of these studies used a different measure to assess sleep problems (Sivertsen et al., 2012). Therefore, additional research on sleep problems in these clinical populations have important implications for diagnosis and treatment and may help to address existing literature gaps (Mazzone et al., 2018).

The present study aimed at describing the presence of sleep problems in a sample of drug-naïve ADHD and ASD patients without intellectual disability. Furthermore, we assessed sex differences in sleep problems in these clinical populations. Finally, we studied the relationship between sleep problems and parental stress in these clinical groups.

A total of 111 drug-naïve participants [ASD N= 38, 16 females (F), 22 males (M); ADHD N=36, 12 F, 24 M; Typically Developing (TD) N=37, 12 F, 24 M] aged 7-13 years with an Intelligent Quotient (IQ)  $\geq 85$  were enrolled in the study. ADHD and ASD diagnosis were based on clinical assessment, observation, and parent interviews, and were confirmed by a senior child psychiatrist according to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) criteria. Participants enrolled in the TD group were recruited in schools and none of them had a history of neurological disorders, psychiatric disorders, developmental delay, or learning disabilities.

All the participants' parents provided a written informed consent and completed the Children's Sleep Habits Questionnaire (CSHQ) and the Parenting Stress Index-Short Form (PSI-SF).

Comparisons between groups were via one-way analysis of variance (ANOVAs) followed by Tukey's contrast for multiple comparisons of means. Spearman's correlation coefficients were used to evaluate correlations between sleep problems and parental stress within the ADHD and the ASD group. Comparison between groups and sex differences within the ADHD and the ASD group on the CSHQ and the PSI-SF are reported in Table 1.

The ADHD group showed significantly higher scores on all the CSHQ and the PSI-SF subscales compared to the TD group. The ASD group showed significantly higher scores on the sleep anxiety, the night walking, and the daytime sleepiness CSHQ subscales, on the CSHQ total score, and on all the PSI-SF subscales compared to the TD group. Furthermore, the ADHD group showed more sleep problems on several CSHQ subscales and on all PSI-SF subscales compared to the ASD group.

Sex differences in the ASD group showed that females had significantly higher scores on the daytime sleepiness CSHQ subscale. Males in the ADHD group had significantly higher scores on the parasomnias CSHQ subscale. No significant sex differences were detected in the ASD group on any of the PSI-SF scales, whereas males in the ADHD group exhibited higher scores in the Difficult Child (DC) PSI-SF subscale compared to females.

In the ADHD group the highest significant correlations were found between the PSI-SF total stress index and the bedtime resistance and the daytime sleepiness CSHQ subscales. Within the ADHD group, the sleep onset delay, the sleep duration, the parasomnias, and the daytime sleepiness CSHQ subscales showed a positive correlation with the DC PSI-SF subscale, whereas the parent-child dysfunctional interaction PSI-SF subscale showed a significant positive correlation with the sleep

duration and the daytime sleepiness CSHQ subscales. No statistically significant correlations have been observed between the CSHQ and the PSI-SF in the ASD group. These results confirm previous literature findings, even if the presence of parasomnias we have observed in the ADHD participants has been rarely described in previous studies. Furthermore, in our research, parents of ADHD participants showed a substantial level of stress and problematic parent-child interactions. ASD participants exhibited more anxiety problems related to falling asleep, and more night walking and daytime sleepiness compared to the TD group. Our results do not highlight the presence of bedtime resistance or sleep onset delay described in previous studies (Singh and Zimmerman, 2015).

Furthermore, the current study supports the hypothesis that there are sex differences in sleep disorders in patients with ASD or ADHD. Specifically, these findings show that males with ADHD show more parasomnias than females, whereas ASD females have more daytime sleepiness than ASD males. Sex differences in the type sleep problems in these clinical populations may be associated to underlying neurobiological processes. Further studies may help clarify the connection between these behavioral sex differences and sex specific biomarkers related to sleep disorders in these clinical populations.

Some limitations of this study should be mentioned. First, sleep problems were assessed through a parent-reported rating scale rather than objective measures. Second, participants' report of sleep problems was not collected. On the other hand, strengths of this study are the large number of subjects, the exclusion of participants with intellectual disability, and the inclusion of well screened drug-naïve participants, which eliminates drug treatments that might influence the presence of sleep disturbances. In addition, the inclusion of a representative group of females in both the ADHD and the ASD groups allowed us to consider a sex comparison. Further studies on sex differences in sleep problems in ADHD and ASD populations can help develop individualized intervention models and have significant implications for early identification efforts.

### **Declaration of Competing Interest**

The authors declare that they have no conflict of interest.

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	ADHD	ASD	TD	ADHD vs ASD*	ADHD vs TD*	ASD vs TD*	ASD M	ASD F	ASD M vs ASD F	ADHD M	ADHD F	ADHD M vs ADHD F
<b>CSHQ</b>												
Bedtime resistance	9.78±2.71	7.68±1.81	7.81±2.06	<b>p &lt; .001</b>	<b>p &lt; .001</b>	p = .967	8.05±2.01	7.19±1.42	p = .153	9.71±3.01	9.92±2.10	p = .811
Sleep onset delay	1.86±0.79	1.37±0.71	1.3±0.52	<b>p = .007</b>	<b>p = .002</b>	p = .895	1.59±0.85	1.06±0.25	p = .011	1.79±0.83	2.00±0.73	p = .468
Sleep duration	4.81±1.80	3.79±1.39	3.38±0.95	<b>p = .008</b>	<b>p &lt; .001</b>	p = .426	3.95±1.49	3.56±1.26	p = .401	5.08±1.86	4.25±1.60	p = .195
Sleep anxiety	7.42±2.18	6.11±1.94	4.89±1.43	<b>p = .009</b>	<b>p &lt; .001</b>	<b>p = .016</b>	6.32±2.05	5.81±1.79	p = .436	7.38±2.26	7.50±2.11	p = .874
Night walking	4.31±1.52	4.34±1.34	3.43±0.72	p = .991	<b>p=0.009</b>	<b>p = .006</b>	4.59±1.43	4.00±1.15	p = .184	4.50±1.56	3.92±1.44	p = .286
Parasomnias	9.94±1.63	8.26±1.34	8.32±1.29	<b>p &lt; .001</b>	<b>p &lt; .001</b>	p = .981	8.23±1.41	8.31±1.30	p = .851	10.50±1.56	8.83±1.19	<b>p = .003</b>
Sleep-disordered breathing	3.89±1.28	3.37±0.81	3.32±0.62	p = .051	<b>p = .032</b>	p = .978	3.14±0.35	3.69±1.13	p = .078	4.04±1.48	3.58±0.66	p = .212
Daytime sleepiness	13.64±4.10	16.53±3.02	9.32±2.09	<b>p &lt; .001</b>	<b>p &lt; .001</b>	<b>p &lt; .001</b>	15.41±2.87	18.06±2.59	<b>p = .006</b>	14.33±4.60	12.25±2.49	p = .087
CSHQ tot	51.53±11.47	48.21 ± 4.84	39.24 ±5.13	p = .159	<b>p &lt; .001</b>	<b>p &lt; .001</b>	47.68±5.19	48.94±4.37	p = .425	53.46±12.90	47.67±6.80	p = .087
<b>PSI-SF</b>												
Parental Distress	36.06±7.99	28.26±9.73	18.76±5.50	<b>p &lt; .001</b>	<b>p &lt; .001</b>	<b>p &lt; .001</b>	26.14±9.60	31.19 ±9.43	p = .116	36.50±7.64	35.17±8.93	p = .644
Parent-Child Dysfunction Interaction	31.81±7.75	24.53±8.09	15.92±3.41	<b>p &lt; .001</b>	<b>p &lt; .001</b>	<b>p &lt; .001</b>	22.77±8.02	26.94±9.60	p = .119	33.08±8.55	29.25±5.27	p = .165
Difficult Child characteristics	41.36±9.14	32.58±10.44	18.62±5.61	<b>p &lt; .001</b>	<b>p &lt; .001</b>	<b>p &lt; .001</b>	29.95±10.97	36.19±8.74	p = .069	43.63±8.97	36.83±8.02	<b>p = .034</b>
Total Stress index	97.25±14.65	79.92±21.36	51.00±12.47	<b>p &lt; .001</b>	<b>p &lt; .001</b>	<b>p &lt; .001</b>	75.00±22.14	86.69±18.85	p = .096	100.25±13.97	91.25±14.82	p = .082

**Table 1.** Comparison between the ADHD, ASD, and the TD groups, and sex differences within the ASD and the ADHD group on the CSHQ and the PSI-SF.  
\*Post-hoc analysis; p-values adjusted by means of Tukey contrasts for multiple comparisons of means. Bold font indicates statistical significance.