

# Sleep in Autism Spectrum Disorder and Attention Deficit Hyperactivity Disorder

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Sleep problems are common in autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD). Sleep problems in these disorders may not only worsen daytime behaviors and core symptoms of ASD and ADHD but also contribute to parental stress levels. Therefore, the presence of sleep problems in ASD and ADHD requires prompt attention and management. This article is presented in 2 sections, one each for ASD and ADHD. First, a detailed literature review about the burden and prevalence of different types of sleep disorders is presented, followed by the pathophysiology and etiology of the sleep problems and evaluation and management of sleep disorders in ASD and ADHD. *Semin Pediatr Neurol* 22:113-125 © 2015 Elsevier Inc. All rights reserved.

## Sleep Disorders in Autism Spectrum Disorder

Autism spectrum disorder (ASD) is a group of neurodevelopmental disabilities characterized by persistent deficits manifesting in early development of social communication and social interaction, restricted and repetitive patterns of behavior interests or activities, and which are not better explained by intellectual disability or global developmental delay.<sup>1</sup> Along with the presence of behavioral issues, ASD is frequently accompanied by a variety of sleep problems that can significantly add on to the disease burden and morbidity in not only the patients themselves but also their families. Sleep problems in children with ASD not only worsen daytime behaviors and core symptoms such as stereotypical and repetitive behavior<sup>2</sup> but also increase parental and family stress levels.<sup>3</sup> Recent Centers for Disease Control and Prevention reports<sup>4</sup> indicate that the prevalence of ASD has increased dramatically in the past few decades; therefore it is not unreasonable to believe that the burden of sleep disorders has increased proportionally as well. This subsection of the literature review details the burden and types of sleep disorders in patients with ASD as well as the evaluation and treatment of sleep problems in this population.

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## Prevalence and Types of Sleep Disorders in ASD

Although the types of sleep problems that occur in children with ASD generally span the same spectrum of disorders that occur in typically developing children, children with ASD suffer from these problems at a higher rate. The prevalence of sleep disorders in typically developing children has been estimated to be approximately 25%-40%.<sup>5,6</sup> Studies using parent surveys report a prevalence of sleep problems in ASD as high as 50%-80%.<sup>7-10</sup> Children with ASD also have a higher prevalence of sleep disorders than children with other neurodevelopmental disabilities. Wiggs and Stores<sup>11</sup> reported that, as compared with parents of children with developmental disabilities such as Down syndrome and cerebral palsy, parents of children with ASD described the presence of sleep disorders at a higher rate (68% vs 55% and 43%). Schreck and Mulick,<sup>12</sup> in a study comparing age-matched groups of children with cognitive impairment and developmental disabilities, ASD, and pervasive developmental disorder—not otherwise specified, also found that parents with children with ASD reported sleep disorders at the highest rate. It is not clear whether there is a relationship between the prevalence of sleep problems in ASD and age. Much of the research evaluating sleep disorders in ASD has been cross-sectional rather than longitudinal, which makes it difficult to accurately assess the temporal progression of sleep disorders in ASD. Although on one hand a large retrospective-longitudinal study found no relationship of sleep disorders with developmental stages in ASD,<sup>13</sup> another longitudinal

study<sup>14</sup> with a short follow-up of 1 year and a few other cross-sectional studies did find that sleep difficulties tended to decrease with age.<sup>15-17</sup> The evidence linking the increased prevalence of sleep problems with severity of cognitive and intellectual disability is also not consistent, with different studies reporting conflicting data. Richdale and Prior<sup>18</sup> found that lower functioning children with ASD (those with intelligence quotient < 55) had higher chances of increased sleep latency, shortened total sleep time, and early termination of sleep as compared with higher functioning (intelligence quotient > 55) children with ASD. Gail Williams et al<sup>19</sup> reported increased nighttime awakenings in children with ASD along with mental retardation as compared with children with ASD but without mental retardation. In contrast, several more studies have found the presence of sleep problems in patients with ASD regardless of their level of cognitive impairment.<sup>13,20-22</sup> In addition, it has been shown that lack of adequate sleep is associated with increased severity of ASD symptoms such as stereotypical behaviors, impaired social connectivity, increased aggressiveness, and self-injurious behavior.<sup>2,7,23,24</sup>

The types of sleep disorders in ASD can be broadly classified into insomnias, parasomnias, sleep-related breathing disorders (SRBDs), and sleep-related movement disorders. Sleep-onset insomnia (SOI) or difficulty initiating sleep (increased sleep latency or time to fall asleep) and sleep-maintenance insomnia (decreased sleep duration, decreased sleep continuity, and increased and early awakenings) are among the most common sleep problems reported in ASD. Many parents' or caregivers' studies confirm this. Richdale and Prior<sup>18</sup> reported that children with ASD had long sleep latencies, frequent nighttime awakenings, and shortened total sleep time. Couturier et al<sup>21</sup> compared 23 pairs of age- and gender-matched ASD and control cases and found that patients with ASD had higher prevalence of sleep onset, sleep duration, and sleep anxiety problems. In ASD, SOI appears to be more common as compared with sleep maintenance insomnia. Gail Williams et al<sup>19</sup> in a survey on 500 children with ASD found that although difficulty falling asleep, restlessness during sleep, inability to fall asleep in own bed, and frequent nighttime awakenings were common, problems with sleep onset were by far the most frequently reported complaint (53%). Sleepwalking, morning headaches, crying during sleep, and nightmares or night terrors were least common.<sup>19</sup> Krakowiak et al<sup>22</sup> in a study of 303 ASD and 163 typically developing children also reported that sleep onset problems were more prevalent (as high as 51%) as compared with sleep maintenance problems such as nighttime awakenings (10%) in the ASD group as compared with typically developing children.

Several studies using noninvasive modalities such as actigraphy have confirmed the sleep questionnaire findings that insomnia, specifically sleep-onset insomnia, is the most prevalent in ASD.<sup>25,26</sup> There are not many studies using polysomnography (PSG) that have been conducted for evaluating sleep disorders in ASD. The few that have been conducted confirm and validate the questionnaire and actigraphy findings of prolonged sleep latency and

decreased sleep efficiency,<sup>27</sup> as well as reduced time in bed, total sleep time, sleep period time, and rapid eye movement (REM) latency.<sup>28</sup>

Although they are not as common as sleep onset or sleep maintenance insomnias, *parasomnias* consisting of non-REM (NREM) and REM sleep-related disorders have been described in ASD. A few studies have reported the occurrence of NREM arousal conditions such as sleepwalking and night terrors in deeper or slow-wave NREM sleep stages more often than in controls. Patzold et al<sup>20</sup> compared 31 ASD and 36 typically developing children and found that although nighttime arousals did not differ significantly between the 2 groups, the children with ASD, when awakened, stayed awake for a longer period of time and were more likely to experience nightmares (13% vs 11%), nocturnal enuresis (10% vs 3%), and were more likely to indulge in unusual and disruptive behaviors such as muttering to self, grunting, laughing, and head banging. Schreck and Mulick<sup>12</sup> also compared a group of 55 patients with ASD with 49 typically developing children and found that the ASD group experienced more nightmare behaviors such as screaming, sleepwalking, and acting out their dreams. Limoges et al<sup>29</sup> performed PSGs on 16 pairs of adolescent or adult ASD and reference controls and found that patients with ASD had more frequent nocturnal awakenings combined with decreased NREM (stages 2-4) sleep and decreased slow-wave sleep. Ming et al<sup>30</sup> performed sleep questionnaires and 2-night PSGs in a group of 23 age-matched ASD and control children pairs, and found that children with ASD had a much higher likelihood of experiencing NREM parasomnias (14 of 23) as compared with the control group children (3 of 23). These findings correlated remarkably well with questionnaire findings, which reported that 16 patients with ASD had NREM parasomnias such as sleep terrors, confusional arousals, sleepwalking, bruxism, and enuresis.<sup>30</sup> In an earlier study, Richdale and Prior<sup>18</sup> did not find an overall increased occurrence of nighttime arousals and nightmares in ASD; rather they reported that typically developing children were more likely to experience these episodes.

A few studies evaluating sleep architecture in ASD have found an increased occurrence of REM-associated sleep disturbances in ASD. Buckley et al<sup>31</sup> performed PSG in 60 children with autism, 15 typically developing and 13 with developmental delay, which revealed that children with ASD had a shorter total sleep time, greater slow-wave sleep percentage, and a smaller REM sleep percentage. The study by Limoges et al<sup>29</sup> mentioned before also had fewer REMs during the REM sleep stages. The study by Ming et al<sup>30</sup> cited earlier also reported impaired REM architecture whereby the children with ASD experienced increased spontaneous arousals, had prolonged REM latency, and a reduced REM percentage as compared with the control group. Very rarely, REM sleep behavior disorder (RBD) can also occur where the subjects may act on their dreams. Thirumalai et al<sup>32</sup> performed nocturnal PSGs on 11 children with ASD who had symptoms of disturbed sleep and nocturnal awakenings, and reported RBD in 45% of them. This finding

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