Sleep Problems, Behavior, and Psychopathology in Autism:

Inter-relationships across the Lifespan

Kimberly A. Schreck[a]

Amanda L. Richdale[b]

[a]Penn State Harrisburg
777 W. Harrisburg Pike
W311 Olmsted Building
Middletown, PA 17057
kas24@psu.ed

[b]Olga Tennison Autism Research Centre,
La Trobe University
Melbourne
Victoria
Australia 3086
a.richdale@latrobe.edu.au

Corresponding Author: Kimberly A. Schreck
Penn State Harrisburg
777 W. Harrisburg Pike
W311 Olmsted Building
Middletown, PA 17057
kas24@psu.edu
717-948-6048

Abstract

Across the lifespan, autistic individuals experience symptomatology concomitant with their diagnosis including increased rates of daytime behavior (e.g., stereotypy, self-injurious behavior, and aggression) and psychopathology (e.g., attention deficit hyperactivity disorder, anxiety, and depression). In addition to this inter-related behavior and psychopathology, autistic children, adolescents, and adults consistently exhibit a wide variety of sleep problems (e.g., insomnia, reduced total sleep time, increased sleep onset latency, night waking, etc.). Early research and current research continue to describe the inter-relatedness among these daytime behaviors, psychopathology, and sleep problems for autistic individuals. Although descriptions of these issues appear in research, only preliminary suggestions exist for the causes and contributors toward the sleep problems or the interactions of sleep problems with psychopathology, although current research suggests a possible biopsychosocial interaction.

Keywords: Sleep, Autism, Psychopathology

Introduction:

The diagnostic criteria for autism have evolved from their original classification as a psychopathology (i.e., childhood schizophrenia) to that of a distinct neurodevelopmental syndrome based on developmental behavioral differences. Nevertheless, the core areas of diagnosis have remained relatively consistent [1]. Autistic individuals exhibit difficulties with social communication and interactions (e.g., eye contact, social initiation and rules, communication, imaginative play), increased rates of restricted, repetitive patterns of behavior (e.g., lining up toys, perseverative motor movements/stereotypies, fixated interests, distress with environmental changes) and sensory sensitivities [2]. A wide range of comorbid developmental, physiological, behavioral, and psychopathological conditions also commonly co-occur in autism, such as intellectual disability (ID), epilepsy, sleep problems, self-injurious behavior (SIB), aggression, attention deficit hyperactivity disorder (ADHD), anxiety, and depression [2,3].

Early research explored the relationships of these comorbid conditions with autism. This research showed that significant sleep problems inter-related with both behavior and psychopathology. These results lead to the proposal of a biopsychosocial model interpreting autism's core symptoms in relationship with commonly co-occurring sleep problems, behavior problems, and psychopathology [3]. Since the publication of this model, research investigating sleep's interconnectedness with behavior and psychopathology has remained relatively consistent in its focus and conclusions. Current research mostly replicates earlier research and continues to describe types of sleep problems and their connections to comorbid behaviors (i.e., stereotypy, restricted and repetitive behavior, self-injurious behavior: SIB, aggression) and psychopathology (i.e., ADHD, anxiety, depression). This paper provides an overview of current research (primarily since 2016) regarding the types of sleep problems in autism, sleep's

relationships to co-morbid behaviors, ADHD, and anxiety, and possible explanations for this inter-relatedness.

1.1 Sleep Problems in Autism

Early research concluded that the majority of autistic individuals experience some type of chronic sleep problem within their lifetime [3]. Consistent with this, current research indicates that autistic children, adolescents, and adults primarily experience symptoms of insomnia and/or circadian sleep-wake rhythm disorders (CSWRDs), including difficulty falling asleep, increased sleep onset latency (SoL), reduced total sleep time (TST), increased wake after sleep onset (WASO), and poor sleep efficiency (SE) [3, 4-7]. Table 1 provides descriptions of these sleep problems in autism.

Specifically for autistic children, sleep problems begin as early as toddlerhood [8]. In addition to insomnia and CSWRDs, autistic children experience parasomnias, obstructive sleep apnea [9], and sleep enuresis [10], the latter possibly due to toilet training difficulties. Current research with autistic children has replicated or extended previous work with some studies using larger samples or longitudinal cohorts [9-13]. Findings continue to support earlier conclusions concerning the types of sleep problems for autistic children [9-13]. While sleep problems often remain chronic [3], some children may improve over time [12, 14], while others develop more severe sleeping problems with age [12].

Both early and current recent research have largely neglected examining sleep in autistic adolescents and adults compared to children. In these age groups, current results indicate a continuation of the sleep problems found in childhood [4], particularly insomnia symptomatology [5-7]. Problematic sleep for adolescents may be exacerbated by biological changes associated with puberty where adolescent sleep patterns naturally shift their circadian phase resulting in later bed and wake times. Shifts in sleep phase and related sleep problems

often associated with early school start times result in insomnia symptoms and related fatigue/daytime sleepiness for about half of adolescents [4, 5]. These changes in circadian phase can continue into early adulthood [6], primarily with delayed sleep wake phase disorder [6,7,15, 10] and insomnia symptoms. Adults with autism and ID may experience higher rates of sleep problems, such as increased SoL, increased WASO, and reduced SE when compared to non-autistic adults [15]. These sleep problems often impair or correlate with daytime functioning [16].

1.2 Sleep Problems & Co-morbid Behaviors

Autistic individuals can exhibit a variety of daytime behaviors, including stereotypy and repetitive and restrictive behaviors, SIB, aggression, and sensory sensitivities [2]. Early research indicated relationships among these behaviors and sleep problems in autism [3]. Current research continues to describe the inter-relatedness of sleep and behaviors, supporting earlier findings which established relationships between sleep problems and comorbid autistic behaviors [17].

Sleep problems and co-morbid behaviors appear to be associated across the lifespan. For example, general and specific sleep problems (e.g., reduced TST, bedtime resistance, CSWRD, WASO with screaming, reduced SE, parasomnias) relate to increased rates of stereotypy and repetitive/restricted behaviors, SIB, and aggression [9, 12, 18-28]. Some research describing behaviors related to or leading to aggression also relate to reduced TST, sleep anxiety, WASO, reduced SE, variable SoL, and parasomnias [20, 22-24, 29].

The etiologies underlying the inter-relatedness of co-morbid behaviors with sleep problems remains primarily unstudied and unclear. For example, for toddlers with autism, sensory over-responsivity predicted late sleep difficulties, but this relationship did not hold for 4- to 10-year-olds [12], indicating the potential complexity and developmental differences of sleep-behavior

relationships in autism. For the association of SIB with sleep for adults the relationship may be influenced by the severity of autism symptoms, rather than the presence of SIB [23]. It remains unclear if the physiological differences underlying autism and its severity or sleep difficulties contributed more to the SIB-sleep problem relationship. The question remains if the relationships exist due more to psychosocial or behavioral impacts of an autism diagnosis or to the sleep difficulties themselves.

1.3 Sleep Problems & ADHD

Autistic individuals also exhibit a variety of symptoms of ADHD (e.g., inattention and hyperactivity) leading to some being co-diagnosed of ADHD and autism [2, 30, 31]. Both past and current research consistently describe the relationship of these autism-ADHD symptom connections with sleep problems [3-17] across the lifespan. For all ages, hyperactivity especially relates to reduced TST, WASO, and parasomnias [22, 23, 27]. However, more specifically for children, the combination of hyperactivity and inattention symptoms correlate with generally poor sleep, including daytime sleepiness, WASO, and reduced TST [12, 20, 21, 27]. Path analysis of longitudinal sleep data indicates that poor sleep predicts later ADHD behaviors in autistic toddlers, but not 4- to 10-year-olds [12]. The known impact of significant sleep difficulties and their individual variability on attention and daytime functioning [32] may result in behavior change consistent with an ADHD diagnosis.

The causal relationships among sleep problems and ADHD in autism have not been studied directly. However, current research of treatments for autistic children's and adolescents' sleep problems indicates that successful behavioral sleep treatment (e.g., sleep hygiene, non-graduated and graduated extinction, bedtime fading, bedtime pass) had a trans-diagnostic effect on ADHD symptoms [33, 34]. Behavioral treatments targeting sleep problems improved ADHD

symptoms without directly treating ADHD. This provides support for a behavioral explanation for the autism-ADHD-sleep problem relationship [33, 34].

Research on the autism-ADHD-sleep problem connection strongly supports their inter-relatedness. However, current research suggests that ADHD symptoms may make a smaller contribution to the autism-psychopathology-sleep problems connection than do anxiety or internalizing symptoms. Internalizing or anxiety symptoms may be more predictive of sleep problems in autism than ADHD symptoms [29, 35].

1.4 Sleep Problems & Anxiety/Depression

Symptoms of internalizing disorders (i.e., anxiety and depression), commonly co-occur with autism leading to a co-diagnosis in a third or more of autistic individuals [36-40]. Up to 40% of autistic children and adolescents meet criteria for an anxiety disorder [39]. As anxiety and depression symptoms for autistic children may present as stereotypies, restricted/repetitive behaviors, and sensory arousal (e.g., hypersensitivity to touch), the underlying anxiety may not be recognized [41], suggesting even higher rates. The rates of anxiety and depression in adults remain similar to children's at 42% and 37% respectively [36].

Research shows a relationship among anxiety symptoms and sleep problems across the lifespan of autistic individuals, which appears as early as 2-years and may predict anxiety over time (i.e., at 8 years) [42]. Specifically for children, the combination of autism-specific anxiety symptoms (i.e., sensory arousal and restricted/repetitive behavior) and traditional anxiety diagnoses (e.g., generalized anxiety), or depressive symptoms predict sleep problems [19, 43]. Current research concludes that anxiety/depression/sensory arousal and sleep problems correlate with high rates of insomnia symptomatology including increased SoL, fatigue/daytime

sleepiness, sleep hygiene problems (e.g., nightlights, co-sleeping), nightmares/WASO, reduced TST, and increased TST [9, 11, 14, 21, 44].

The scarce current research on the relationship of anxiety/depression and sleep problems for autistic adolescents and adults provides conflicting results. Some research suggests relationships among poor sleep, anxiety, and depression, which predict poor daytime functioning [45], while another that separately analyzed adolescents and children indicates anxiety and depression do not relate to sleep problems for autistic adolescents [21]. These contradicting results may be due to methodological differences (e.g., parent report versus adolescent self-report); however, they indicate more research describing the relationship among anxiety/depression and sleep problems must be conducted for adolescents.

Although a specific understanding of the inter-relatedness of autism, anxiety, and sleep problems does not exist in children and adolescents, autistic adults appear to have similar sleep issues and relationships. The most current research suggests that hyperarousal, particularly pre-sleep arousal or anxiety, may strongly influence sleep in adults, potentially explaining the relationships of these variables for autistic adults [46, 47]. For adults, higher levels of anxiety, depression, and/or sensory arousal (which has been suggested to be related to anxiety [41]) may relate specifically to insomnia symptomatology, including increased SoL and poor SE [46, 47].

As with co-morbid behavioral difficulties and ADHD, the etiology of the correlation of anxiety/depression, autism, and sleep problems remains understudied and mostly descriptive. Treatment studies support the conceptualization of an interaction among biological (autism/anxiety traits) and psychosocial (behavioral) variables and poor sleep [3]. Current treatment studies for children and adolescents indicate a similar trans-diagnostic effect as found in ADHD. Behavioral interventions for reducing sleep problems, which also involve modifying

the sleep environment (e.g., remove toys, cool room, remove lights, calming bedtime activities, faded bedtimes, bedtime passes) decreased daytime anxiety [34, 48]. After treatment, children and adolescents no longer met anxiety/depression diagnostic criteria or had reduced anxiety/depression symptoms, and sleep problems (e.g., night time fears, SoL, SE, sleep hygiene problems) decreased [34, 48]. Although these results suggest support for a biopsychosocial explanation for the inter-relatedness of sleep problems, autism, and psychopathology, significantly more research is needed to address the both the description and etiology of these relationship.

1.5 Moving Forward: Inter-Relatedness of Symptoms

As described above, current research mostly replicates earlier research on autism, sleep problems, and their relationships, primarily providing descriptions of sleep problems in autism, especially insomnia, across the lifespan. The status of knowledge of relationships between sleep problems, comorbid behaviors and psychopathology diagnoses in autism also remains highly correlational (with suggested relationships existing for all ages of autistic individuals). Research mostly focuses on the cross-sectional description of sleep and behavior in autism, regardless of age, generally ignoring developmental or longitudinal changes particularly in adolescence and adulthood. To move the field forward, the developmental progression of sleep problems and their correlations with co-morbid behavior and psychopathology across the lifespan must be studied longitudinally with descriptions of the existence and development of symptoms among autistic adolescent and adults.

Further advances to the field also must include investigations into mechanisms contributing to sleep problems and their inter-relatedness to autism symptoms and psychopathology. Current reported relationships among sleep, autism, and psychopathology

continue to support a biopsychosocial model [3]. Since problematic behaviors and psychopathology often co-occur in autism [36-40, 41], sleep disturbances may contribute significantly to prevalence and maintenance of psychopathology and poor behavior regulation. Sleep problems, behavioral issues, and psychopathology also may negatively impact core autism symptomatology and other co-morbid developmental issues (e.g., ID, social communication, learning, ADHD, mood and anxiety disorders [2,3]). These interactions preliminarily appear reciprocal and interactive yet remain mostly unstudied.

To move forward, the field also requires understanding of the interaction of the biological variables within the biopsychosocial model [3]. Future research must investigate interactions between sleep and possible physiological differences for autistic people (e.g., genetic circadian rhythm dysregulation, melatonin, and neurotransmitters [49 -55]. Some of the possible multiple genetic influences on the expression of autism symptoms may contribute to sleep and psychopathology relationships. For example, variation in clock genes (i.e., genes controlling circadian rhythms) in autistic individuals [56] may be etiologically implicated in the expression of sleep difficulties as suggested in the biopsychosocial model [3] and in autism itself [49, 50, 56], but the latter remains speculative. Heritability of melatonin synthesis pathways [52] and alterations in melatonin pathway genes possibly that relate to sleep onset delay [57] also point to the potential role of melatonin. Melatonin's effectiveness for reducing insomnia in autistic children [58] and anxiety in non-autistic populations [59, 60] support this assertion. Investigation of the role of neurotransmitters (e.g., serotonin, GABA) that influence the sleep/wake state [51, 54, 55] differ in autism requiring more research [53, 55].

Despite existing research suggesting possible biological/genetic mechanisms that contribute to a biopsychosocial model, research supporting a purely physiological etiology underlying sleep

difficulties in autism remains mostly conjectural with little empirical data to support proposed biological etiologies. Since it remains probable that many pathways lead to autism, similarly several pathways may lead to co-morbid sleep difficulties and their inter-relationships with psychopathology. Future research into the inter-relationships among autism, sleep problems, behaviors, psychopathology, and underlying physiology will need to investigate these and other potential causal mechanisms. As existing correlational research suggests a possible bio-psychosocial feedback model [3], distinct studies on the relationships among physiological differences must be conducted in coordination with changes in the psychosocial component of the model [3, 49, 50]. The effectiveness of trans-diagnostic treatments [33, 34, 44, 48, 61, 62] suggests that physiology, psychopathology, and behavior cannot be distinctly separated. Thus, it does not appear that physiological mechanisms alone can explain differences in sleep and related daytime problems in autism. To move the field forward, exploring the inter-relatedness of physiological, and behavioral differences appears to be needed.

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Table 1 Common sleep problems for individuals on the autism spectrum

Sleep Problem (abbreviation)	Description/Summary
Insomnia	Individuals on the AS tend to have trouble with settling at bedtime, co-sleeping, bedtime resistance, sleep hygiene problems (e.g., poor bedtime routines or sensitivity to sleeping environments)
Circadian Sleep-Wake Rhythm Disorder (CSWRD)	Individuals on the AS may have advanced (early onset/ early waking) or delayed (late sleep, late waking) sleep-wake phase. Some may have irregular sleep-wake rhythms that are poorly entrained to the 24 hour light-dark cycle or even non-24 hour patterns
Increased Sleep Onset Latency (SoL)	Individuals on the AS tend to take longer than neuro-typical peers to fall asleep from the time of lights out
Reduced Total Sleep Time (TST)	Individuals on the AS may sleep fewer hours per night as compared to similar-age neuro-typical peers
Increased Wake After Sleep Onset (WASO)	Individuals on the AS may spend longer awake during the night than neuro-typical peers. This sometimes co-occurs with screaming, talking, or playing with toys
Poor Sleep Efficiency (SE)	Individuals on the AS tend to proportionately spend less time asleep while in bed compared to awake while in bed compared to neuro-typical peers
Parasomnias	Individuals on the AS can experience night waking similar to nightmares and night terrors, possibly more frequently than neuro-typical peers. They also experience higher rates of sleep enuresis (bed wetting)
Sleep-related breathing disorders	Individuals on the AS may have difficulty with breathing during sleep. This can include obstructive sleep apnea (breathing interruption due to obstructions, such as enlarged adenoids or tonsils) or snoring

Note: Representative references [3, 9, 10]