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Quantitative Paper

Feasibility of a Swimming Intervention to Improve Sleep Behaviors of Children With Autism Spectrum Disorder

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Abstract

Children with ASD experience high rates of sleep disturbance, but there are limited interventions addressing sleep in this population. We investigated the feasibility and acceptability of a specialized swim program, Sensory Enhanced Aquatics, for children with ASD. Additionally, we examined the extent to which the physical activity intervention impacted children's sleep behavior as well as specific child characteristics in those most responsive to intervention. We used a pre-post intervention design to test the effects of an 8-week swim intervention on sleep of ten children aged 5-12 years. Caregivers completed measures of sleep disturbance, autism severity, and sensory processing. Findings showed that children differentially responded to the swim intervention based on autism severity and sensory processing. Children with increased sensory sensitivity and decreased autism severity showed decreased sleep disturbance following the intervention. Results showed that the intervention was feasible and highly acceptable. Sensory Enhanced Aquatics differentially improved the sleep behaviors of children with ASD based on specific child characteristics. This is relevant to recreational therapist who may need to match intervention to child characteristics for best response.

Keywords

Autism spectrum disorder, sensory processing, swimming, physical activity, recreational therapy

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Introduction

Children with autism spectrum disorder (ASD) often present with sleep disturbance as a co-occurring problem of their disorder. Sleep disturbance disrupts family routines and is a significant source of stress for families. Approximately 44% to 86% of children with ASD experience sleep difficulties (Schreck, Mulick, & Smith, 2004; Williams, Sears, & Allard, 2004), and research consistently demonstrates that sleep difficulties contribute to the worsening of other child symptoms (i.e., social communication, repetitive behavior, problem behavior) (Schreck et al., 2004). Moreover, difficulty settling, frequent night waking, and poor quality sleep along with exacerbated autism symptoms cause significant caregiver stress (Hoffman et al., 2008). There are limited interventions that target sleep behavior in children with ASD, although preliminary findings from intervention studies are promising (Turner & Johnson, 2013). Given that physical activity improves sleep behavior in typical development, we investigated the extent to which a physical activity intervention, Sensory Enhanced Aquatics, impacts sleep behavior in children with ASD.

Emerging literature suggests disorders in sensory processing and sleep may be related in ASD (Reynolds, Lane, & Thacker, 2012; Shochat, Tzischinsky, & Engel-Yeger, 2009). Dunn's sensory processing framework (Dunn, 2014) suggests that children have four distinct patterns of sensory processing: seeking (i.e., fascination with/engagement with intense sensory stimuli), registration (i.e., lack of or delayed response to sensory stimuli), avoidance (i.e., aversion to sensory stimuli) and sensitivities (i.e., intense awareness of sensory stimuli, although not active avoidance). Sensory issues commonly co-occur with ASD (American Psychological Association, 2013), and studies suggest that sensory patterns are differentially associated with specific child characteristics such as language ability (Watson et al., 2011), mental age (Baranek et al., 2013) repetitive behavior (Boyd et al., 2010), and adaptive behavior (Jasmin et al., 2009). With regard to sleep, research suggests that sensory sensitivity, particularly tactile sensitivity, and sensation seeking are significant predictors of poor sleep in ASD (Shochat et al., 2009). The Biopsychosocial Model of Sleep provides a conceptual framework for further understanding sleep disturbances of children with ASD (Richdale & Schreck, 2009). The Biopsychosocial Model of Sleep illustrates factors specific to ASD that may underlie many common sleep difficulties, including a) biological abnormalities (autism gene, clock gene) affecting circadian rhythm and melatonin levels, b) the relationship between core features of ASD and sleep problems, and c) the relationship of sleep disorders to psychopathology (i.e., anxiety, depression). The model also highlights how child and family factors (i.e., access to programs/services) influence sleep. In typically developing populations, physical activity interventions are associated with better sleep. However, the Biopsychosocial Model of Sleep cautions against directly transferring knowledge about sleep in typically developing populations to those with ASD. Sleep disturbances in children with ASD may be influenced by the variability of core symptoms that influence development in ASD (repetitive behavior, sensory processing, social communication), suggesting interventions that target sleep be tailored to match specific child characteristics.

Physical activity interventions for children with ASD have been shown to improve maladaptive and repetitive behaviors (Elliott, Dobbin, Rose, & Soper, 1994; Powers, Thibadeau, & Rose, 1992; Prupas & Reid, 2001). Children with ASD have been shown

to experience success with swimming as a physical activity intervention (Dulcy, 1992; Huettig & Darden-Melton, 2004; Mische Lawson, Foster, Harrington, & Oxley, 2014). Swim intervention studies have found improvements in repetitive behavior (Yilmaz, Yanardağ, Birkan, & Bumin, 2004) and social skills (Pan et al., 2015). One study to date has investigated the impact of swimming on sleep. Using a single-subject design, researchers investigated the effects of participation in twice-weekly water exercise and found improvements in both sleep latency (time it takes to fall asleep) and sleep duration of eight children with ASD (Oriel, Kanupka, DeLong, & Noel, 2014a).

A barrier to investigating the effects of physical activity on sleep in children with ASD is lack of physical activity programs that meet the needs of individuals with ASD (Lang et al., 2010; Weaver, 2015). Children with ASD experience a 4.5 times higher rate of physical inactivity compared to children without disabilities due to lack of skills, social, environment, and policy/program barriers (Bandini et al., 2013). Swimming is a safe, effective, and lifelong intervention for reducing obesity and chronic health conditions, which are often associated with ASD (Curtin, Anderson, Mist, & Bandini, 2010; Hill, Zuckerman, & Fombonne, 2015). Children with ASD show heightened interest in the water, which might make swimming a good match for them (Mische Lawson, Cox, & Foster, 2013). Water provides proprioceptive sensory input many children with ASD crave, and the repetitive nature of swimming works well for children needing structure and routine (Mische Lawson et al., 2014).

The current study is the next step toward understanding the effects of physical activity, specifically swimming, on sleep behaviors of children with ASD. The goal of this study was to examine the feasibility and preliminary efficacy of a Sensory Enhanced Aquatics program in improving sleep of children with ASD. We addressed the following research questions: 1) What is the feasibility of an eight-week swim program for children with ASD (i.e., child participation/parent acceptability of program)?, 2) To what extent do child sleep behaviors change over the intervention period?, and 3) Are there specific characteristics of children who show decreased sleep disturbance in response to intervention?

Methods

Participants

Children with ASD (Autistic Disorder, Pervasive Developmental Disorder-Not Otherwise Specified, Asperger's Syndrome per DSM-IV or autism spectrum disorder per DSM-5 (American Psychiatric Association, 2003, 2013) were included in this study. The current sample included 10 boys with ASD (mean age=7.5 years; SD=2.4 years; range=5–12.3 years). The sample was predominantly white (100%), and one family identified as Hispanic. Participants are excluded from the swim intervention if they were older than 14 years old or had significant sensory impairments (e.g., blindness).

Intervention

Sensory Enhanced Aquatics was developed by a recreational therapist and two occupational therapists with over 50 years of combined experience with swimming and working with children with ASD. Though the program is similar to other programs that teach skills in a developmental sequence, Sensory Enhanced Aquatics differs from other swim programs for children with disabilities in that it provides sensory

modifications based on a sensory assessment prior to beginning the intervention (i.e., Sensory Profile) (Dunn, 1999) to support children's skill acquisition. Sensory Enhanced Aquatics incorporates evidence-based approaches for children with ASD, including: 1) visual supports, 2) sensory supports, 3) communication strategies, 4) physical supports, and 5) modeling (Breslin & Rudisill, 2011; Dunn, Cox, Foster, Mische-Lawson, & Tanquary, 2012; Oh, Licari, Lay, & Blanksby, 2011; Yanardağ, Akmanogly, & Yilmaz, 2013; Yilmaz et al., 2004). For the current study, we provided eight weekly 30-minute swimming lessons. Most lessons were one-on-one with social opportunities (e.g., songs and games) at the beginning and end of each lesson. Lessons were individualized for each student based on learning and sensory preferences, and emphasized both skill development and water safety.

Procedures

All procedures were approved by the university's institutional review board. A pre-post design was used to investigate the effects of swimming on sleep. Researchers performed informed consent interviews with parents prior to initiating study activities. Parents were provided a packet of questionnaires (see Measures) to complete prior to the first lesson. Parents completed a packet of questionnaires again at the end of the eight-week session of swim lessons.

Measures

Demographic form (unpublished questionnaire; pre-test only). The demographic form provided information about family characteristics, such as race/ethnicity, socioeconomic status, and number of children in the household. The form also questioned services and medications related to the child's ASD.

Social Responsiveness Scale, 2nd edition (SRS-2; pre-test only) (Constantino et al., 2004). The SRS is a 64-item caregiver report of autism severity. It has been found to have a single-factor structure (Constantino et al., 2004) and convergent validity with the Autism Diagnostic Interview-Revised (Lord, Rutter, Dilavore, & Risi, 1999). A cut-off score of 62 identifies 96.8% of children with ASD yielding sensitivity and specificity values of .92.

Sensory Profile Caregiver Questionnaire (Dunn, 1999). The Sensory Profile is a 125-item parent questionnaire that measures sensory responses in children aged three to 10 years. The caregiver rates the frequency (*never* = 4 to *always* = 0) of children's responses in different sensory categories including: taste/smell, movement, visual, tactile, auditory, and activity levels. The measure has high validity, internal consistency (Cronbach's Alpha 0.47–0.91), and test-retest reliability (SE m 1.00–2.8).

Children's Sleep Habit Questionnaire (CSHQ) (Owens, Spirito, & McGuinn, 2000). The CSHQ is a 39-item parent report measure to quantify children's sleep problems. A total sleep disturbance score is computed from 33 items. Parents are asked to recall sleep behaviors occurring over a "typical" recent week and rate items on a 5-point scale, "always" (5), "usually" (4), "sometimes" (3), "rarely" (2), and "never" (1). To compute total scores, ratings were combined as "always" and "usually" (3), "sometimes" (2), and "rarely" and "never" (1). The lowest possible score for the questionnaire was 33 (minimal to no sleep problems) and the highest possible score was 99 (severe sleep problems). A cut-off score of 41 identifies 80% of the children with sleep disorders yielding a sensitivity of 0.80 and specificity of 0.72. The CSHQ has acceptable test-retest reliability (internal consistency 0.68–0.78) and has been

extensively used in ASD literature (Oriel, Kanupka, DeLong, & Noel, 2014b; Owens et al., 2000; Schreck et al., 2004; Williams et al., 2004).

Parent Satisfaction Questionnaire (unpublished questionnaire). The parent questionnaire was created for Sensory Enhanced Aquatics as a program evaluation measure. Parents rate satisfaction with the program, as well as changes in their child's swim skills, physical activity, safety, and interest in swimming. Parents rated items on a scale from (1) "very unsatisfied" to (5) "very satisfied." The form also allowed space for qualitative comments regarding observed changes as a result of program participation and future plans (e.g., swim team, family swimming, etc.).

Data Analysis

Statistical analyses were performed using SPSS 22.0. In order to address feasibility of the swimming intervention, we used descriptive statistics to compute attendance and parent satisfaction with the program. To examine differences in sleep behavior post-intervention, we first investigated descriptive statistics of CSHQ in the sample. We then used the Mann Whitney U Test to determine changes in sleep behavior. We used a differential response analysis to examine child characteristics associated with improvements in sleep behavior following the intervention.

Results

This study aimed to answer the following research questions: 1) What is the feasibility of an eight-week swim program for children with ASD?, 2) To what extent do child sleep behaviors change over the intervention period?, and 3) Are there specific characteristics of children who show decreased sleep disturbance in response to intervention? Results are reported in response to each question.

Intervention Feasibility and Acceptability

All children who began Sensory Enhanced Aquatics completed the eight-week session. Of these families, four children (40%) missed no lessons, four (40%) missed one lesson, one missed (10%) two lessons, and one (10%) missed three due to illness. Other parent reported reasons for nonattendance included weather, attending Major League Baseball team playoffs, and school activities. Families drove up to 49 miles one way to attend the 30-minute lessons, indicating the intervention is highly desirable to families. Parent surveys indicated high satisfaction; the majority of parents (93.3%) were very satisfied overall with the program. Parents were very satisfied with individualized support (100%), number of participants in lessons (100%), structure of lessons (93.3%), and time to communicate with instructors (93.3%). A majority of families indicated that their children were more active both during and outside of Sensory Enhanced Aquatics lessons (64.3%). With regard to qualitative comments, 80% of parents noticed improvements in their children as a result of Sensory Enhanced Aquatics; 60% indicated improved sleep after swimming. Other improvements included improved eating (20%), willingness to potty train (10%), readiness for physical activity (10%), and increased listening skills (10%).

Sleep Behaviors

Descriptive statistics showed that all children enrolled in the intervention demonstrated clinically elevated sleep disturbance scores at baseline (*mean*=71.2, *SD*=6.71, *range*=60–71). Post-intervention sleep disturbance scores showed an

increase (*mean*=71.7, *SD*=7.56, *range*=60–87). Given the increased SD and range of sleep disturbance scores post-intervention, we investigated individual change scores of participants. Results showed that 4/10 children showed improvements in sleep behavior (*mean*=-.375, *SD*=1.25, range=-2.0 to -5.0), while 1/10 showed exact pre- and post-intervention scores, and 5/10 children showed increased sleep disturbance post-intervention (*mean increase*=3.33; *SD*=2.16; *range*=2.0 to 5.0). We ran a *t*-test to determine if those that showed decreased sleep disturbance post-intervention (responders; *n*=4) versus those that did not (nonresponders; *n*=6) demonstrated differences at baseline. Results showed no differences between groups at baseline ($t[8]=.478$, $p=.645$). We then used a Mann-Whitney *U* test to investigate differences between responders and nonresponders. Results showed that responders significantly differed in sleep change scores versus nonresponders (Mann–Whitney $U = -2.566$, $p<.05$). Empirical evidence (Koegel, Shirotova, & Koegel, 2009; Sherer & Schreibman, 2005), intervention theory, and evidence in ASD (Dawson, 2008; Remington et al., 2007; Rogers, Hemmeter, & Wolery, 2010; Rogers & Vismara, 2008), and the Interagency Autism Coordinating Committee (IACC, 2011) suggests that the variability of behavioral presentation in the disorder necessitates an examination of behavioral characteristics that may best respond to intervention. Therefore, we investigated the extent to which children who responded to the intervention (i.e., showed improvements in sleep behaviors) differed from nonresponders (i.e., showed no differences/ increased sleep disturbance post-intervention).

Characteristics of Children Responding to Intervention

Responders tended to be older, have decreased autism severity, and attended more swimming sessions than nonresponders. Responders also showed a unique profile of sensory processing characteristics (decreased sensory seeking and increased sensory sensitivity and avoiding). Cohen's *d* showed the effect size was large for differences in sensory sensitivity. Effect sizes were moderate for differences in age, number of sessions attended, autism severity, sensory seeking, and sensory avoiding (See Table 1).

Discussion

This study examined the feasibility and acceptability of an eight-week swim program for children with ASD, change in child sleep behaviors over the intervention period, and specific characteristics of children who show decreased sleep disturbance in response to intervention. Novel findings from the current study suggest that specific child characteristics were associated with decreased sleep disturbance in ASD as a result of a swimming physical activity intervention. Responders had a specific profile of sensory processing characteristics (high sensory sensitivity, avoidance, and low sensory seeking). Previous studies show that behavioral and physiological measures of sensory sensitivity are associated with sleep disturbance in ASD (Mazurek & Petroski, 2015; Reynolds et al., 2012), suggesting the contribution of hyperarousal to poor sleep. Given the lack of differences in sleep scores at baseline between responders and nonresponders, the swimming intervention may help children with high sensitivity to counteract hyperarousal. Children with high sensory sensitivities and avoidance may benefit from swimming; this specific activity may help children with high sensitivity regulate arousal through the proprioceptive and tactile input provided by

Table 1
Mean Differences and Effect Sizes for Responders and Nonresponders to Swimming Intervention

	Mean (SD)	Cohen's *d*
Age (in months)		
Responders	99.75 (33.55)	.573
Nonresponders	82.17 (27.61)	
Autism Severity		
Responders	156.00 (24.86)	-0.683
Nonresponders	168.5 (7.26)	
Sessions Attended		
Responders	7.25 (0.96)	.631
Nonresponders	6.50 (1.38)	
Sensory Patterns*		
Low Registration		
Responders	54.33 (12.66)	.054
Nonresponders	53.67 (11.78)	
Seeking		
Responders	94.67 (18.58)	.492
Nonresponders	86.50 (14.37)	
Sensitivity		
Responders	59.67 (9.07)	-1.444
Nonresponders	71.67 (7.47)	
Avoiding		
Responders	97.67 (2.52)	-.625
Nonresponders	102.67 (11.03)	

Note. † = Cohen's *d* Small=0.2, Medium=0.5, Large=0.8
*Lower scores indicate greater severity

water. In addition to the possibility of fatigue with physical activity, the mechanisms of improvements in sleep for children with sensory sensitivities warrant further investigation.

Results suggest the intervention is highly feasible and acceptable. Parents were highly satisfied with the intervention. Findings suggest that children with greater adherence to the intervention (i.e., fewer absences) were more likely to have improved sleep. The intervention was offered once per week for 30 minutes, which is below government recommended physical activity guidelines for children (CDC, 2015). Therefore, it may be that improved sleep in those that had higher attendance was not solely a result of the limited physical activity time. Children with ASD function best with structure and routine (Mayes & Calhoun, 2009); if poor sleep habits, bedtime routines, and night interactions are not recognized and addressed, other sleep interventions are less likely to be successful (Johnson, Giannotti, & Cortesi, 2009). Children who had high attendance may have benefitted from the weekly routine of attending the swim program. Routine attendance may be indicative of consistency across contexts, including bedtime routines.

Children who responded to the intervention were older and had decreased autism severity. Children develop the ability to self-regulate as they age (Raffaelli, Crockett, & Shen, 2005), and self-regulation supports engagement in physical activity (Anderson, Wojcik, Winett, & Williams, 2006). Also, older children are developmentally ready to learn more complex aquatic skills than younger children (Parker & Blanksby, 1997).

Young children are most likely to learn water orientation and basic locomotion skills, while older children can benefit from stroke technique and endurance training. It is possible that swimming generated greater sleep improvements for older children because they were better able to self-regulate, allowing them to better attend to lessons and perform more physically demanding swim skills.

With regard to autism severity, some studies have reported associations between autism severity and sleep disturbance (DeVincent, Gadow, Delosh, & Geller, 2007; Mayes & Calhoun, 2009; Schreck et al., 2004). Additionally, autism severity is inversely related to IQ (Hus, Bishop, Gotham, Huerta, & Lord, 2013; Lord et al., 1999; Richdale, 1999), and low-functioning children with ASD experience the greatest sleep disturbance (Williams et al., 2004). It may be that children with increased autism severity have greater difficulties with arousal patterns; children with increased autism severity may require more intensive physical activity as well as behavioral supports to improve sleep. The complex interactions of autism severity, IQ, and physical activity participation are not well understood and warrant further study.

Limitations and Future Directions

This study had a number of limitations. The small sample size limited analysis to computing means, standard deviations, and effect sizes. While this allowed exploration of factors that might contribute to responsiveness to the swimming intervention, it does not allow for definitive conclusions about the effects of swimming on sleep. Additionally, we did not control for children's sleep routines and physical activity outside of Sensory Enhanced Aquatics, both of which might have influenced results. Lastly, the intervention was limited to 30 minutes once per week, which is below government recommendations for physical activity. It is possible that once weekly swimming is not enough physical activity to improve sleep for some children, particularly those with increased autism severity.

Future research should examine the factors contributing to a positive response to the swimming intervention (i.e., age, autism severity, sensory patterns, and intervention dosage) with a larger sample size. Interventions are less likely to be effective if poor sleep habits and routines are not addressed; future research should also investigate the effects of swimming in combination with behavioral interventions promoting healthy bedtime routines. Additive effects of a behavioral intervention (e.g., sleep hygiene training with parents) in combination with physical activity may be a promising avenue. Given that the nonresponders to intervention showed profiles of increased autism severity, these children may need more intensive physical activity. Future research should offer swimming at least two to three times weekly to determine if some children need a greater dosage of physical activity to improve sleep.

Implications for Recreational Therapy Practice

Children with ASD engage in physical activity less than typically developing peers and experience more barriers to participation. Recreational therapists are experts in adapting community programming to create welcome, inclusive environments. This intervention was feasible and highly desirable to parents, suggesting a need for additional aquatics programming for this population. As recreational therapists develop aquatics programs for children with autism spectrum disorders, they should consider providing sensory modifications individualized to children's sensory needs. For example, visual

supports may help children with sensitivity know what stimulation to expect (i.e., a picture of kicking prepares a child to be splashed), while scheduled breaks to submerge underwater may help sensory avoiders block out stimuli so they can refocus on lessons. Children who are seekers like to splash and move about vigorously, so it may be helpful to provide them space away from other children. Additionally, recreational therapists should systematically measure the effects of problems co-occurring with ASD, such as sleep disturbance.

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