Original Research

Sleep Problems and Language Disorders in Children with Autism Spectrum Disorder

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Abstract

Background and Objective: Language disorders are common in children with autism spectrum disorder (ASD). It seems that children who suffer from sleep problems usually suffer from more severe disturbances in other linguistic areas, as well. Accordingly, the aim of this study was to compare language disorders in children with autism with sleep problems to children with autism with no sleep problems.

Materials and Methods: This was a cross-sectional study. The statistical population for this study included all children with autism aged between 7 and 12 years. Purposeful sampling through Children's Sleep Habits Questionnaire (CSHQ) test was applied to select a sample of 38 subjects, which was divided into two groups of 19 according to presence of sleep problems. The subjects were then evaluated through continuous speech quality testing.

Results: Higher mean and standard deviation (SD) of scores of mean length utterance (2.93 ± 2.01), speech rate (74.13 ± 1.58), number of verbs (11.72 ± 2.61), lexical enrichment (16.00 ± 1.55), and echolalia (2.81 ± 1.10) was observed among children with autism with sleep problems as compared to children with autism without sleep problems ($P < 0.05$) The findings also showed that the difference in mean scores in subscale of the number of lexical words was not significant.

Conclusion: According to the findings of this study, it seems that sleep disorders may be one of the factors affecting language learning and continuous speech quality in children with autism.

Keywords: Autism spectrum disorder; Sleep; Language

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Introduction

Autism spectrum disorder (ASD) occurs with a delay or abnormal function in at least one of the areas of social interaction, language used in social communication, and imaginative or symbolic games. A child with ASD lives in his own world. Since establishment of a proper social communication requires reception and processing of sensory information and the appropriate behavior based on this information, in this internal world, the connection with the outside world is interrupted. The lack of reception of external sensory stimuli, the learning process, and communication disrupts her social suit (1).

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Autism also includes linguistic and cognitive problems (2). While genetics is one of the causes of autism, this disorder can be induced by any factor affecting the nervous system (3). Symptoms of autism are usually seen between 18 and 36 months of age (4).

Spontaneous speech or echo (repetition of words and sentences without understanding their meanings), word making, use of mock words instead of official names of objects, literal comprehension of words, linguistic severity and degrees, and use of spoken words that are subject to conditions are amongst the clinical symptoms. Their peripheral and social characteristics are not uncomfortable with the characteristics of those suffering from ASD (5). There are many individual differences in language development among people with ASD. Some of them never speak during

their lives; while others, although fluent, have difficulty understanding and using the language (6). Due to individual differences and severity of the illness, a range of disabilities from mild to severe autism is considered; whereas, one of the main differences among them is linguistic abilities of the individual (7). Patients with severe autism may be dumb or at least speak at the echo level. People with mild autism learn the language, but use words and phrases with their thinking and therefore, face difficult conversations (8). In addition, syntax errors can be seen in their speech (9). Sleep problems are of the common problems in children with autism spectrum disorder (ASD) (11). The International Classification of Sleep Disorders-third Edition (ICSD-3) categorizes more than 70 different sleep disorders into seven major categories: sleep-related breathing disorders, insomnia disorders, circadian rhythm sleep-wake disorders, sleep-related movement disorders, central disorders of hypersomnolence, parasomnias, and other sleep disorders (12).

The prevalence of sleep problems among normal developing children is approximately 25% (13), but in the ASD population, it is between 50 and 80 percent (14). Malow et al. (15) found that sleep problems were present in 71% of children with ASD; however, the prevalence of sleep disorders was less frequent (30%). Although sleep-onset issues and insomnia seem to be the most common sleep problems reported by parents of children with ASD, night awakenings, poor sleep routines, and parasomnia are also frequent in this population (16, 17).

Some studies suggest that age predicts sleep problems; so, young children usually experience more sleep problems (18). However, other reports, such as Goldman et al. (19), have shown that sleep problems in ASD are stable and vary with age (20). The authors evaluated a sample of 1859 children with ASD (3-18 years), and reported that there were sleep problems during childhood from early childhood to adolescence. In addition, the authors reported that a variety of problems tended to increase with age. In particular, in this study, parents of younger children reported more problems with sleep anxiety, sleep resistance, waking up at night, and parasomnia, while adolescent parents had more problems with sleep onset and sleep duration. Studies investigating clinical features (e.g., epilepsy, cognitive functioning) and sleep problems in children with ASD have reported mixed results (21). Taylor et al., for example, concluded that lower overall intellectual functioning was associated with fewer hours of sleep per night in children with ASD (22). By contrast, other studies have found that individuals with ASD report sleep problems regardless of their cognitive level (23). Because sleep and autism overlap nervously, children with autism are more likely to have sleep disorders (24). Sleep disorder and drowsiness may exacerbate the symptoms and behaviors of a child with autism (25). Sleep disturbance in children means decreased or increased excessive sleep, which is associated with age, abnormal sleep patterns, abnormal behavior, or abnormalities during sleep (26). These disorders can affect body, behavior, cognitive function, and long-term capabilities in children (27). The most serious complications of sleep disorders in children are cognitive problems that are often associated with anxiety, depression, and cognitive problems (26). Regarding the importance of sleep quality in children's mental health, cognitive function, and modulation of specific symptoms and behaviors of children with ASD, the purpose of this study was to investigate the effect of sleep problems on children's linguistic disorders in autism spectrum.

Materials and Methods

This study was a cross-sectional study. The statistical population of this study included all children with autism between 7 and 12 years of age who were referred to the Welfare Commission of Mashhad City, Iran, to determine the percentage of disability in 2018-2019. All children participated in the autism diagnostic process by a psychiatrist. Moreover, a psychologist administered the Children's Sleep Habits Questionnaire (CSHQ) to assess sleep problems in children with autism.

To achieve the estimated sample size according to the limitations and previous studies, parents of 43 children were willing to participate in this study; after which, the children were assessed on the basis of clinical interviews and the benchmarks in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5). Of them, 5 individuals were excluded due to lack of preparation. A sample of 38 children was then selected through purposeful sampling. Of them, 19 children had autism without sleep problems and 19 had both autism and sleep problems. Criteria for inclusion of participants were: physical

illnesses and taking hypnotic drugs that prevent testing. Also, exclusion criteria included physical and mental illnesses, not having epilepsy that prevents testing, children's unwillingness to continue tests, and restlessness. Furthermore, due to ethical considerations, after completing parents' informed consent, the whole process of testing was done individually. Data were analyzed using independent t-test and SPSS software (version 20, IBM Corporation, Armonk, NY, USA).

CSHQ: The standard CSHQ is a standard sleep questionnaire for children assessing how someone has slept during the last week which was filled in with the help of the child and his parents during the interview. The questionnaire has 8 subsamples and 33 phrases. A score above 41 indicates low sleep quality and higher scores imply weaker sleep quality (28). The Cronbach's alpha for the questionnaire was calculated as 0.80 by Wang et al. (29). This standard index was shown to be consistent in previous comparative laboratory trials using polysomnography (PSG) (30). The reliability of the index in the present study was calculated as Cronbach's alpha of 0.78.

Descriptive speech evaluation: Assessing quality of speech: A review of the quality and purpose of the language by recording a person's descriptive speech based on a series of images for all of the children was performed. In this assessment, the average speech length, vocabulary richness, number of verbs, speech rate, and echolalia were studied. Descriptive speech results of patients with normal speech metrics were reviewed and compared. Data analysis was performed using independent t-test and descriptive indicators at the significance level of $P < 0.05$ (31).

Results

The mean and standard deviation (SD) of age of the study groups with and without sleep problems was 8.52 ± 1.47 and 8.71 ± 2.32 years, respectively. All participants were boys with mild intellectual disability [intelligence quotient (IQ) between 50 and 70] and were educated in public schools for children with special needs.

To determine the extent of sleep problems in children with autism and categorization of the subjects into two groups based on the presence of sleep problems, a standard sleep test for children from both groups was obtained, the results of which are shown in table 1.

The average and SD of score of sleep disturbance was 56.58 ± 14.18 in children with autism without sleep problems and 61.75 ± 10.13 in children with autism with sleep disorders (P for difference < 0.005). From the 8 subscales of the CSHQ, the mean and SD of score in children with autism with sleep problems was estimated as 13.52 ± 1.24 for resistance to fall asleep, 9.45 ± 2.11 for daily sleepiness, 5.55 ± 2.26 for awakening nightly, 4.72 ± 3.89 for respiratory problems, 9.92 ± 1.97 for parasomnia, and 8.04 ± 1.35 for sleeping anxiety habits. On the other hand, the mean and SD of score in children with autism without sleep problems was estimated as 11.15 ± 1.13 for resistance to fall asleep, 8.21 ± 2.38 for daily sleepiness, 4.76 ± 1.37 for awakening nightly, 3.17 ± 1.29 for respiratory problems, 8.58 ± 3.21 for parasomnia, 7.75 ± 3.78 for sleeping anxiety habits, and 56.58 ± 14.18 for general sleep disorders with significant differences ($P < 0.005$) (Table 1).

Moreover, there was no significant difference in the duration of sleep and delayed onset of sleep between the two groups (Table 1).

Table 2 shows statistical changes of variables such as mean length utterance, speech rate, lexical richness, echolalia, and number of verbs related to two groups of children with autism with sleep problems and children with autism without sleep problems.

Table 1. The average subscales of sleep habits in children with autism according to the presence of sleep problems

Sleep problems	Without sleep problems (n = 19)	With sleep problems (n = 19)	P-value
Resistance to fall asleep	11.15 ± 1.13	13.52 ± 1.24	< 0.005
Daily drowsiness	8.21 ± 2.38	9.45 ± 2.11	< 0.001
Awakening during the night	4.76 ± 1.37	5.55 ± 2.26	< 0.001
Duration of sleep	5.88 ± 2.44	6.17 ± 1.57	NS
Respiratory problems	3.17 ± 1.29	4.72 ± 3.89	< 0.006
Parasomnia	8.58 ± 3.21	9.92 ± 1.97	< 0.001
sleep anxiety habits	7.75 ± 3.78	8.04 ± 1.35	< 0.002
Starting sleep latency	2.07 ± 2.14	2.06 ± 1.32	NS
General sleep disorders	56.58 ± 14.18	61.75 ± 10.13	< 0.005

The numbers in the table are mean and standard deviation (SD)
NS: Not significant

Table 2. Comparison of descriptive speech indices and echolalia speech indices

Descriptive speech indices	Without sleep problems (n = 19)	With sleep problems (n = 19)	P-value
Mean length utterance	3.34 ± 1.79	2.93 ± 2.01	< 0.001
Speech rate	82.83 ± 2.21	74.13 ± 1.58	< 0.003
Number of verbs	10.76 ± 2.29	11.72 ± 2.61	< 0.001
Lexical richness	17.00 ± 2.67	16.00 ± 1.55	< 0.003
Number of vocabulary	40.00 ± 2.21	42.00 ± 3.35	NS
Echolalia	1.28 ± 1.64	2.81 ± 1.10	< 0.001

The numbers in the table are mean and standard deviation (SD)
NS: Not significant

The autistic group with sleep problems had higher mean and SD of scores in subscales of length utterance (2.93 ± 2.01), speech rate (74.13 ± 1.58), number of verbs (11.72 ± 2.61), lexical enrichment (16.00 ± 1.55), and echolalia (2.81 ± 1.10) compared to children with autism without sleep problems, with the corresponding values of 3.34 ± 1.79, 82.83 ± 2.21, 10.76 ± 2.29, 17.00 ± 2.67, and 1.28 ± 1.64, with statistically significantly differences ($P < 0.005$). Therefore, the children with autism without sleep problems had better performance in descriptive speech variables than those with autism with sleep problems (Table 2).

Furthermore, the results showed that the mean score of the number of words did not show a significant difference between the two groups. Therefore, there was no difference in the use of the number of words in the speech between these two groups (Table 2).

Discussion

The aim of this study was to assess language disorders in two groups of children with autism with and without sleep problems. Based on the findings of this study, linguistic disorders were observed in almost all children with autism. However, children with autism who had problems with sleep, suffered from more severe linguistic disorders, including disorders in mean length utterance, speech speed and fluency, lexical richness, and echo. According to the previous studies, speech echoes can be seen in nearly 75% of patients with autism who are able to speak (32). In this study, children with autism and sleep problems had a higher deficiency of vocal richness than children with autism without sleep problems. Defected treasury and lexical richness are generally seen in children with autism (33). Semantic and functional disorders have been observed in patients with autism in various forms such as shortcomings in conversation, inability to maintain the topic under discussion, and difficulties in pursuing subjects (34). It seems that for a child with autism, words have the same meaning which they have learned at the first level and preserved the same. Therefore, instead of corrected mistakes in naming and word-wrapping in a normal child, these errors persist for several years in a child with autism. Continuous speech is the ability to encrypt speech production, and in fact, speaking is the use of linguistic knowledge in a situational context (35).

The results of speech review of children with autism in a study revealed that some children had difficulty in production of multi-syllable compositions and consonants (33). Moreover, by comparing the ability to rely on repetitive syllables that were not necessarily meaningful, it was previously found that there was a significant difference between people with autism and healthy people (36).

In this study, children encountered a lot of problems in the use of verbs, and the match between the subject and the verb was not observed. Adaptation refers to the relationship among elements, whereby the use of a particular form of a word requires a special form of other words in a sentence (37). No compound sentences were found in the production of all children with autism. These children produced short sentences containing two or three words. Additionally, there was no usage of conjunctions and pronouns, which is the result of grammatical disabilities in children with autism. Studies have shown that children can use an average of six words in each sentence at age of 5 (38). The number of words used by children with autism and especially those with sleep problems, however, is much lower than normal. Accordingly, mental and speech speed of these children is very weak. Therefore, it can be concluded that common language problems are more complicated in ASDs and more acute in children with more severe sleep problems. This is due to the role of sleep in emotional, cognitive, and behavioral setting. In 2012, a study was conducted to investigate the relationship between sleep problems and behavioral disorders in chil-

dren with autism. The parents of 109 children with autism reported on their children's sleep status. According to their findings, there is a direct and positive relationship between delayed onset of sleep and duration of sleep with autism symptoms. Sleep onset delay was the strongest predictor of communication deficits, stereotyped behavior, and autism severity (39). Sleeping enables preservation of perceptual abilities such as memory, speaking, and creative thinking at the optimal level (40).

In other words, sleep plays an important role in development of brain skills, and its lack reduces brain abilities. Lack of sleep in the long run negatively affects linguistic abilities, memory, planning, and other areas of executive function (41). The results of a systematic review of several cognitive studies about the role of sleeping on the rest of the brain and its molecular mechanisms showed that chemical neurological changes, especially cholinergic changes that occur during unpredictable sleep in hippocampus of the brain, triggered a signal to hippocampal memory sector and to reinforce and consolidate information (42). Therefore, it can be concluded that sleep disturbances in children with autism who have a sleeping problem, make it difficult to process the data storage and consolidation, which consequently leads to damages in storage of information and vocabulary and learning. These children face serious problems. Sleep disturbances in patients with autism also play a role in some physiological factors that can be considered as some of the most effective nerve carriers in sleep and consciousness, with disturbance in their settings. Disturbances in sleep, consciousness, memory, learning, and emotional regulation have serious problems. Consequently, the language, which is a great expression of knowledge and the output of mind and brain, will also be affected by these serious complications. Some of the neurotransmitters including serotonin, dopamine, norepinephrine, and gamma-aminobutyric acid (GABA) play an important role in adjustment of sleep and autism (43).

Recently, a link has been identified between genetic variation in the serotonin transporter gene and insomnia (44). Serotonin is a precursor to the production of melatonin, which has a sedative effect and leads to sleep. Disturbances in the synthesis of melatonin have been observed in patients with autism (45). Other evidence of autism is also supported by an infection in the serotonin system in the development of autism. These include increased levels of total blood serotonin, changes in the serotonin carrier gene, and changes in the enzyme responsible for serotonin degradation (46).

GABA system, as primary inhibitor of the body, is other carrier that plays an important role in the inhibition system, autism, and sleep disorders. The GABA system also plays an important role in the development of the cerebral cortex. The evolutionary defect observed in autism may be largely related to the GABA system (47). Based on the results of this study and a review of various studies, sleep, autism, and language are neurologically overlapping and sleep problems can exacerbate the symptoms of autism and language disorders associated with the disease (24).

The limitations of this study can be stated as the study on only boys with autism. Moreover, due to the limitations in recruiting participants and their special circumstances, it is suggested that more subjects should be used in future studies. In addition, these children may have different outcomes depending on educational, cultural, and social conditions. Children with autism participating in this study were not representatives of all children with autism in general population.

Conclusion

According to the findings of this study, it seems that sleep disorders may be one of the factors affecting language learning and continuous speech quality in children with autism.

Conflict of Interests

Authors have no conflict of interests.

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