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Evaluating Sleep Disorders amongst Children with Attention Deficit/ Hyperactivity Disorder (ADHD)

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Abstract

Background: The attention deficit/ hyperactivity disorder (ADHD) is one of the most compromising mental disorders of childhood and adolescence. Subsequently, different studies in recent years were conducted on the relationship between sleep disturbances and ADHD in children. About 30% of children and 60% to 80% of adults with ADHD develop sleep disorders, which may result in cognitive and behavioral changes in the patients. The current study aimed at comparing sleep disorders in children with ADHD and their normal peers in Tabriz, Iran.

Materials and Methods: The current case-control study was conducted on the target population of children within the age range of 6 to 12 years, which included 50 children with ADHD receiving medication, 55 children with ADHD symptoms without receiving any medication, and 71 normal children, all of which screened from the school students of Tabriz using the child symptom inventory-4 (CSI-4) and selected by the multi-stage cluster sampling method. The children's sleep habits questionnaire (CSHQ) was completed by their mothers and data were analyzed using the multivariate analysis of variance (MANOVA).

Results: According to the results of the current study, a significant number of children with ADHD showed sleep disorder that can accounts for some degree of their behavioral dysregulation. There was a significant difference among the study groups regarding the subscales of sleep resistance and sleep duration, daytime sleep, parasomnia, and sleep apnea ($p<0.05$). However, evaluation of the sleep onset delay, anxiety, and nighttime awakening hypotheses showed no significant difference between ADHD and normal children ($P> 0.05$).

Conclusion: Since children with ADHD usually have more sleep problems, considering the sleep quality in such children is of great importance; in the treatment of such children their sleep problems should be considered particularly.

Key Words: Attention Deficit/ Hyperactivity Disorder, Children, Hyperactivity, Sleep Disorder.

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1- INTRODUCTION

The attention deficit/hyperactivity disorder (ADHD) is the most common childhood neurodevelopmental disorder. The etiology of the disease is unknown and genetic as well as environmental factors are involved on its occurrence (1). The ADHD diagnosis definitely depends on the reports of parents and teacher and no laboratory test can predict its prognosis (2). The 5th Diagnostics manual of mental disorders (DSM-5) classified the disease as neuro-developmental disorders with 3 subtypes: 1. Predominantly hyperactive-impulsive, 2. Predominantly inattentive, and 3. The combined type (3). To evaluate a subject for ADHD, some symptoms should be developed before the age of 12 years old and also to confirm the diagnosis, the damage caused by hyperactivity, inattention, and impulsive should be observed at least in 2 different situations and should interfere with social and educational performances, or outside school activities appropriate to the child's development (4). The global prevalence of ADHD was reported 5.29% (5).

The incidence rate of ADHD in the USA ranges from 2% to 20% among the primary school students. The conservative rate is 3% to 7% in the premature primary school children (6). The ADHD male/female ratio ranges from 2:1 to 9:1 (7). The prevalence of AHDH was reported 3% to 6% among the children in Tehran, Iran, within the age range of 7 to 12 years (4). Different studies indicated that about 30% of children and 60% to 80% of adults with ADHD have sleep disorders (7). The most common symptoms in such patients are daytime sleepiness, insomnia, delayed sleep phase syndrome, interrupted sleep, restless legs syndrome, and sleep-disordered breathing (SDB) (8). The most common sleep disorders among such children are delay in sleep onset, sleep resistance or refuse to go to bed, long-time tiredness after awakening, and daily sleepiness. In addition, the prevalence of sleep disorders such as restless legs syndrome, periodic limb movement disorder, and SDB was higher in the population of children with ADHD, compared with the control population (9, 10). Besides, such children mostly develop complications such as dyssomnia, sleep resistance, and sleep-onset problems; however, the prevalence of morning awakening problems, abnormal sleep behaviors, and insomnia is high among them (11). Mothers of children with ADHD reported the following symptoms in their children compared with the ones with normal children: sleep resistance, sleep-onset delay, anxiety, parasomnia, sleepwalking, daytime sleepiness, and shorter sleep duration (12, 13). More investigations were made on the role of sleep disorders in the incidence of ADHD and the role of ADHD in sleep disorders. Sleep deprivation in patients with ADHD causes the development of symptoms such as impairment of cognitive function, sleepiness, exhaustion, and deficits in emotional functions, and in general worsens ADHD symptoms. Further investigations should be conducted on the children with ADHD to reveal the phenotype of the disease and its sleep-associated symptoms during 24 hours (9).

Nevertheless, the associations between sleep and attention-deficit/hyperactivity disorder (ADHD) are complicated and are frequently ignored by practitioners. It is assumed that when sleep is reduced or disrupted, this can have an effect in the brain and behavior (14). The collective evidence points to the vital function of sleep in brain development and functioning. In ADHD, which is a disorder being characterized by developmentally inappropriate behavior, sleep can have a great influence on the development of normal neuro-behavior. For instance, some studies have indicated that sleep hygiene in ADHD patients can improve their attention

and concentration capabilities on doing different tasks (15, 16). So, undoubtedly the relationship between ADHD and childhood sleep requires more attention and study. On the other hand, there is substantial evidence supporting an overlap in those areas of central nervous system that regulate sleep and also those that control and regulates attention, suggesting that disruptions in one system might well have similar effects on the other (17, 18). As a result, the following study was outlined to evaluate the relationship between ADHD and sleep disorder in children from Tabriz, Iran. In this study three groups of children were selected which were: 1. children with ADHD disorder who were on medication taking Ritalin under psychiatrist supervision, 2. children diagnosed with ADHD who were not taking any medication yet, and 3. Control group, which consisted of normal developing children without ADHD. The reason to use two groups of patients was to study the possible effect of Ritalin on the sleep disorder. However, the main objective of the study was to investigate a relation between ADHD and sleep disorder as well as highlighting the role of sleep in ADHD patients as a possible future treatment tool for practitioner in our region.

2- MATERIALS AND METHODS

The current case-control study was conducted on all male and female students within the age range of 6 to 12 years diagnosed with ADHD in Tabriz, Iran. Participants included 105 children, who were diagnosed with ADHD by child psychiatrist, referred to Sheikh-al-Raise Clinic in Tabriz. Among these children 50 of them received medication (Ritalin) under doctor's written direction and the other 55 children had developed ADHD symptoms, but did not take medicine yet. Another 71 healthy children were also selected by the multi-stage cluster sampling method in this study from local schools, which were around same age. Healthy participants were also examined to rule out any neurological, psychiatric, or learning problems. Furthermore, none of these children was on medication and this information was gathered from one of their parents. Parents and children of all three groups were informed in detail about the study and the importance of their participation. The Research and Ethics Committee of Tabriz medical university of Science approved this investigation (ethical code: tbzmed.rec.1384.772), and the parents of the participating children signed the informed consent. Data collection tools of the current study included the CSI-4 completed by the mothers of the primary school children to distinguish the healthy children. The CSI-4 is an inventory for behavior rating developed by Sprafkin and Gadow to screen behavioral and emotional disorders in children within the age range of 5 to 12 years with 2 forms for teachers and parents (19, 20).

The CSI-4 is implemented simply and is easy to understand. Simple terms are substituted for technical and psychological terms. The CSI-4 is recommended for the clinical applications and it is used for the psychopathological purposes by a constructed interview, collecting more information on growth and development history, environmental pressures, medical history, physical health, and family history (21). The scales of CSI-4 facilitate the implementation of a regular and general interview and significantly assist the reduction of errors in the diagnosis of the disorder. It takes parents 10 to 15 minutes to complete CSI-4. Items 1 to 18 focus on AHDH (22). All the participants screened using CSI-4 in order to reduce any possible error in the diagnosis. Qualified clinical psychologist supervised completion of this questionnaire. To assess participant's sleep pattern, the children's sleep habits questionnaire (CSHQ) was

used. The CSHQ was developed by Owen, Spirito, and McGuinn in 2000 and used in different studies (23); it was designed to screen children with sleep disorders within the age range of 3 to 12 years. The items are multi-optional; the parents were asked to choose usually and give the score 3, if the behavior was repeated 5 to 7 times per week; choose sometimes and give the score 2 if it was repeated 2 to 4 times per week, and choose rarely and give the score 1 if it was repeated 0 to 1 time weekly.

The CSHQ includes 8 components and 33 items. The components include lack of sleep, sleep resistance; parasomnia, sleep habits, insufficient sleep duration, night awakening, SDB, and delay in sleep onset and high scores indicate more sleep problems. The alpha Cronbach's index of the questionnaire in the aforementioned 2 studies were 77% and 79%, respectively (24). At the end, Multivariate analysis of variance (MANOVA) was used to compare sleep disorder variables amongst groups. The SPPS ver. 14.0 software was utilized.

3- RESULTS

The population sample included 50 children with ADHD using drugs, 55 children with ADHD not getting any medication groups were 9.02 years old with standard deviation (SD) of 1.73, consisting of 41 females, 64 males. The control group was also selected in the same age range (mean= 9.42 years, SD= 1.49, female=23, male=48).at this stage, and finally 71 healthy participants. Mean age of ADHD. The results obtained from CSHQ were analyzed and the descriptive results for each subclasses of sleep are shown in the following table. According to the data presented in **Table.1**, the mean score of the ADHD group using medicine, was higher than those of without medicine usage and control group in resistance, anxiety, and night awakening subscales, which indicated that no medicine and control groups had better situations, compared with the group taking the medicine, in the evaluated subscales. The scores of such subscales in sleep disorders in the group taking the medicine were higher than those of the two other groups. But the mean score of without medicine group was higher than those of with medicine and control groups in the subscales of lack of sleep, duration of sleep, night awakening, parasomnia, and SDB (sleep-disordered breathing). It seems that with medicine and control groups had better circumstances in such subscales, compared to the without medicine group. The results presented in **Table-2**, indicates the total impact of the study group variable on the Sleep Disorders variable.

Based on the results shown in the **Table.2**, the total impact of the intergroup relationships was statistically significant; in other words, there was a significant difference among the groups regarding the integrated variables of sleep disorders. To distinguish the significant differences in the variables among the study groups, the results of intergroup impact analysis are shown in **Table.3**. Based on the data shown in **Table.3**, there was a significant difference among the study groups regarding the subscales of sleep resistance and sleep duration ($P<0.05$); in another word, it seems that ADHD can affect sleep resistance in children. There was also a significant difference in sleep duration between the drug and non-drug ADHD groups, as well as the non-drug and normal groups ($P< 0.05$), suggesting a significant difference between ADHD and normal children in terms of sleep duration. Moreover, there was a significant difference between normal and non-drug ADHD children in terms of daytime sleep ($P< 0.05$), indicating a significant difference between ADHD and normal children regarding daytime sleep. Furthermore, there was a significant difference in terms of parasomnia between

the drug ADHD and normal groups, as well as the non-drug ADHD and normal groups (P< 0.05), showing a significant difference between ADHD and normal children in terms of parasomnia. As the results revealed, there was a significant difference in sleep apnea between the non-drug ADHD and normal groups (P< 0.05), indicating a significant difference between ADHD and normal children in terms of sleep apnea. Evaluation of the sleep onset delay, anxiety, and nighttime awakening hypotheses showed no significant difference between ADHD and normal children (P> 0.05).

Table-1: Descriptive Results of the Three Study Groups

Subscales	Group	Mean	Standard Deviation	Number
Sleep resistance	Non-medicine	1.6040	0.48401	50
	Medicine	1.5818	0.35334	55
	Control	1.4338	0.38245	71
	Total	1.5284	0.41084	176
Anxiety	Non-medicine	1.9067	0.69998	50
	Medicine	1.6970	0.72655	55
	Control	1.7746	0.74488	71
	Total	1.7879	0.72713	176
Lack of sleep	Non-medicine	1.4000	0.63888	50
	Medicine	1.5273	0.74173	55
	Control	1.4225	0.68997	71
	Total	1.4489	0.69092	176
Sleep duration	Non-medicine	1.4400	0.51920	50
	Medicine	1.6848	0.57527	55
	Control	1.4789	0.50625	71
	Total	1.5322	0.53946	176
Night awakening	Non-medicine	1.7667	0.36422	50
	Medicine	1.6667	0.46259	55
	Control	1.6808	0.34011	71
	Total	1.7008	0.38886	176
Parasomnia	Non-medicine	1.3086	0.24888	50
	Medicine	1.3610	0.26635	55
	Control	1.2133	0.23767	71
	Total	1.2856	0.25669	176
sleep-disordered breathing	Non-medicine	1.1867	0.38780	50
	Medicine	1.2788	0.46154	55
	Control	1.1174	0.33852	71
	Total	1.1875	0.39786	176
Daytime sleepiness	Non-medicine	1.6600	0.32246	50
	Medicine	1.7886	0.39738	55
	Control	1.6109	0.39672	71
	Total	1.6804	0.38283	176

Table-2: Wilks Lambda Test Results to determine the total Impact of the Study Group Variables on the Sleep Disorders Variable

Test	Amount	F	No. of Degree of Freedom	Error Degree of Freedom	P-value
Wilks Lambda	0.832	1.998	16.000	332.000	0.13

Table-3: Results of the Intergroup Impact Analysis Testing

Dependent Variable	Sum of the Squares	Degree of Freedom	Mean of the Squares	F	P-value
Resistance	1.078	2	0.539	3.277	0.040
Anxiety	1.173	2	0.586	1.110	0.332
Delay in sleep onset	0.507	2	0.253	0.528	0.591
Sleep	1.909	2	0.954	3.368	0.037
Night awakening	0.310	2	0.155	1.024	0.361
Parasomnia	0.711	2	0.355	5.681	0.004
Sleep-disordered breathing	0.808	2	0.404	2.597	0.077
Daytime sleepiness	1.008	2	0.504	3.538	0.31

4- DISCUSSION

The main objective of the present investigation was to compare sleep disorders among normal children, ADHD children under drug therapy, and ADHD children without drug therapy. Overall, the results showed a significant difference among these groups, regarding sleep disorders. In consistence with the present study, O'Brien and Gozal showed that 77% of children with significant ADHD symptoms and 70% of children with mild ADHD symptoms had sleep disturbances, as reported by the parents (13). Owen (2009) concluded that ADHD children had significantly higher mean scores on Children's Sleep Habit Questionnaire, compared to the controls. In this study, reports of sleep disorders by parents and children were consistent (25). In other words, there was a significant positive correlation between the scores of parents and children regarding sleep disorders. In this regard, consistent results have been reported by Gruber and Hvolby (26, 27). The majority of meta-analyses on sleep disorders and ADHD (mostly based on parental reports) have revealed that children with ADHD have significantly more sleep problems than normal children (28). Moreover, in a previous study, persistence of sleep disorders was reported in 72.4% of anxious children with ADHD after 18 months of follow-up in clinical settings (29). On the other hand, sleep deprivation in ADHD patients causes problems, such as cognitive dysfunction, drowsiness, burnout, and emotional dysfunction; overall, it can deteriorate ADHD symptoms. Furthermore, the results of this study showed a significant difference between ADHD and normal children in terms of sleep resistance. The findings showed a significant difference between these groups regarding sleep resistance. The difference was significant between the normal and drug ADHD groups, as well as the normal and non-drug ADHD groups. As the findings revealed, normal children showed better performance in terms of sleep resistance, compared to the drug and non-drug ADHD groups. Comparison of the mean scores of groups showed more problems in the drug ADHD group, compared to the other groups; overall, it seems that medications have negative effects on sleep resistance.

The mentioned results are in line with the findings reported by O'Brien and his associates showing more sleep resistance, sleep onset delay, anxiety, nighttime awakening, and daytime drowsiness in ADHD children, as well as shorter sleep duration (30). In addition, according to studies by Hvolby et al. (2009), Corkum et al. (2008), Owens et al. (2000), sleep disorders are more common in ADHD children, compared to their non-ADHD counterparts (8, 12, 10, 31). In consistence with these studies, scores of sleep

resistance, anxiety, and nighttime awakening in the present study were higher in children with ADHD than the controls.In the study by O'Brien and his colleague (2003) on sleep and neurobehavioral characteristics of children with ADHD, 77% and 70% of cases with significant and mild ADHD symptoms had sleep disorders, respectively (as reported by the parents); on the other hand, 43% of non-ADHD children reported sleep disturbances (30). In addition, parents of children with ADHD reported the following problems more frequently: 1) sleep resistance, 2) sleep onset latency, 3) anxiety, 4) nighttime awakening, 5) daytime drowsiness, and 6) shorter sleep duration (31). The results of the present study also suggest a significant difference among ADHD and normal children in terms of sleep onset latency. This finding is in line with a study by Sung et al. (2008), which showed that 30% and 45% of ADHD children had mild and significant sleep problems (e.g., anxiety, sleep resistance, nighttime awakening, sleep apnea, and fatigue after sleep), respectively (32). O'Brien and Gozal (2003), as well as Hvolby et al. (2009), has reported consistent findings, while Derakhshanpour et al. (2014) have shown inconsistent results (30, 8, 33).

The effect of stimulant drugs on ADHD patients varies from one person to another; this issue complicates the relationship between ADHD and sleep disturbances. Evidence suggests an association between stimulants and sleep disorders in patients with ADHD (34, 35). In this regard, a clinical study on ADHD children reported increased sleep onset latency and reduced sleep duration via objective analysis and drug therapy (32). Moreover, the results of the current study indicated a significant difference between the groups in terms of sleep duration. In addition, there was a significant difference between the drug and non-drug ADHD groups, as well as the non-drug ADHD and normal groups. Comparison of the groups showed higher mean scores in the non-drug ADHD group, compared to others. In addition, the mean scores of drug ADHD group were lower and better than the other groups. Based on these findings, medications have positive effects on sleep duration in children with ADHD, while patients who do not use these drugs experience more sleep problems. In a study by Stein (1999) on sleep problems in children with ADHD, almost one-third of treated ADHD children showed increased sleep onset latency or insomnia versus 10% of untreated children with ADHD (35). In similar studies, Barkley et al. (1990) and Ahmann et al. (1993) concluded that stimulant drugs are associated with insomnia, while Pataki et al. revealed no major association between stimulant medications and insomnia (36, 37, 38) . These findings are in accordance with studies by Owens (2000), Corkum (2008), O'Brien et al. (2003), Gruber et al. (2011), and Sung et al. (2008) (10, 12, 13, 26, 30, 32).

Recent studies have shown that short sleep duration is correlated with behavioral symptoms of ADHD, as reported by parents and teachers (39). In addition, inadequate sleep in children results in neurocognitive, neurobehavioral, and functional consequences, which are similar to the core features of ADHD (24, 39). In addition, inadequate sleep affects cognitive function and attention (40), as well as neurobehavioral functions (41). The present results showed no significant difference between the groups in terms of anxiety. These findings are in line with studies by Hvolby et al. (2009), Sangal et al. (2005), Wiggs et al. (2005), and Derakhshanpour et al. (2014) (8, 32, 42, 43). On the other hand, there was a significant difference between ADHD and normal children in terms of daytime drowsiness. In fact, the results indicated a significant difference between the groups

in terms of daytime drowsiness. A significant difference was found between the non-drug ADHD and normal groups, while the normal and drug using ADHD groups showed no significant difference. It seems that medications have positive effects on daytime drowsiness in children with ADHD. These findings are in line with studies by Lim et al. (2008), Sung et al. (2008), and O'Brien et al. (2003) (30, 32, 44). Moreover, the results of the present study indicated no significant difference between the groups in terms of nighttime awakening. These findings are in consistence with studies by Sung et al. (2008) and Derakhshanpour et al. (2014) and in contrast to a study by O'Brien et al. (2003). (31- 33). Additionally, the results showed a significant difference in parasomnia between the groups.

The follow-up also showed a significant difference between the drug ADHD and normal groups, as well as the non-drug ADHD and normal groups; comparison of the mean scores of the groups confirms this finding. Overall, it seems that ADHD children have many sleep-related problems. The mentioned findings are in line with studies by Sung et al. (2008) and Hvolby et al. (2009), which showed that ADHD children obtained higher scores in comparison with the controls on the subscales of sleep disorder in children (8, 32). These subscales include sleep resistance, sleep talking, anxiety, bruxism, and daytime self-awakening. However, the results were inconsistent with those reported by O'Brien et al. (2003) (31). Based on the results, there was a significant difference between ADHD and normal children in terms of sleep apnea. The results indicated a significant difference between the groups in terms of sleep apnea. The follow-up also showed a significant difference between the non-drug ADHD and normal groups. It seems that non-drug ADHD children have many sleep-related problems, while there was no significant difference between the drug ADHD and normal groups; in fact, medications can improve sleep apnea in these children. The discussed results are consistent with the findings reported by Cortese et al. (2005), which showed that snoring is more common among children with ADHD, compared to those without ADHD (as reported by the parents) (28) . O'Brien et al. (2003) and Cortess et al. (2009) separately reported a high frequency of obstructive sleep apnea in children with ADHD (31, 45). Similar results have been reported by Cortese et al. (2005), Weiss and Salpekar (2010), and Liu et al. (2005) (9, 28, 46). On the other hand, these results are inconsistent with those reported by O'Brien et al. (2003) and Hvolby et al. (2009) (8, 31). Finally, it can be concluded that there is a significant difference in sleep disorders among normal and ADHD children. In addition, sleep disorders are associated with cognitive and neurological disorders, including attention deficit and ADHD-like symptoms (39, 40, 47). According to a systematic review, the prevalence of sleep apnea in patients with ADHD is 25-30% higher than the general population (48). Furthermore, in an interventional study, treatment of sleep apnea in children had a significant association with improved neurological behaviors (40). Another study also revealed a significant association between treatment and improved educational performance and ADHD-like symptoms (48).

5- CONCLUSION

The present study showed the high prevalence of sleep disorders in children with ADHD, which has been neglected so far. This lack of attention can have an adverse effect on the health and school functioning of children. Therefore, in order to prevent further problems, more attention should be directed towards these disorders in the treatment and evaluation of ADHD children. Based on the current findings,

sleep problems are relatively common among children with ADHD and attention deficits. Since sleep problems can cause drowsiness, reduce daily functions, and exacerbate the symptoms of ADHD in children, monitoring of the early symptoms of sleep disorders is recommended during patient visits. This study also highlighted the importance of sleep disorder assessment as part of ADHD screening; in fact, management and treatment of patients depend on the accuracy of diagnostic evaluations. Since sleep problems can cause drowsiness, reduce daily functions, and exacerbate the symptoms of ADHD in children, clinical professionals, physicians, psychiatrists, and psychologists are advised to monitor the early signs of sleep disorders during patient visits; it should be noted that sleep quality is just as important as eating habits for mental and psychological health.

During sleep, the body regains its energy, neural cells are revived, and body is protected against fatigue. However, sleep is not only a neurophysiological phenomenon. In fact, the positive psychological effects of sleep are so significant that tense and nervous people are recommended to sleep for treatment purposes. Additionally, in the evaluation of the etiology of neuropsychiatric disorders in children and adults, insomnia and sleep deprivation are normally encountered. Therefore, sleep disorders should be identified in children and adolescents with ADHD; as such diagnosis can improve the patient's condition. According to a study by Yoon et al. (49), parents are recommended to leave poor sleep habits (e.g., exposure to TV or computer within at least an hour before bedtime), and adjust their sleeping time at the beginning of treatment for ADHD children with sleep problems. Finally, it is suggested that a larger sample be recruited in future studies, and gender differences be taken into account. In addition, future research should focus on the effects of drug therapy on sleep of children with ADHD.

6- CONFLICT OF INTEREST: None.

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