

RESEARCH

Open Access



The relationship between disease symptoms and restless legs syndrome in adult attention-deficit hyperactivity disorder without iron deficiency

Seda Kiraz^{1*} , Arif Çipil² and Nurbanu Ergün³

Abstract

Background: This study aimed to investigate the frequency of restless legs syndrome (RLS) and the affecting factors in the attention-deficit hyperactivity disorder (ADHD) group without iron deficiency. Drug-naïve ADHD patients were included in the study. Patients without iron deficiency filled out the adult ADHD Self Reporting Scale, the Wender Utah Rating Scale, the Beck Depression Inventory, and the Beck Anxiety Inventory. Scale scores were compared in ADHD patients with and without RLS. Univariate and multivariate binary logistic regression analyses were used to determine the risk factors associated with RLS.

Results: A total of 120 ADHD patients participated in the study; 53 were predominantly inattentive ADHD patients (ADHD-I), and 67 were ADHD combined type (ADHD-C). RLS incidence was found to be 31.6%. ADHD symptoms, anxiety, and depression were found to be significantly more severe in patients with ADHD accompanying RLS. Also, anxiety and the presence of ADHD predicted RLS.

Conclusions: The presence of ADHD and accompanying anxiety was effective on RLS, regardless of iron deficiency. RLS is a comorbidity that frequently accompanies ADHD, and its diagnosis and treatment should not be ignored. This is the first study to investigate the frequency of RLS and accompanying factors by excluding iron deficiency in the ADHD group.

Keywords: Attention-deficit hyperactivity disorder, ADHD, Adult, Restless legs syndrome, Iron deficiency

Background

Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder that begins in childhood or adolescence and can extend into adulthood, characterized by signs of inattention, increased mobility, and impulsivity [1]. Its frequency in school-age children is determined to be between 5 and 8%. A total of 60–85% of the cases diagnosed in childhood continue to meet

the diagnostic criteria in adolescence. The prevalence of ADHD in adults is estimated to be around 2–4% [2, 3]. This disease often causes impairment in social and interpersonal relationships, emotion regulation, and academic functionality [4]. Genetic and neuroimaging studies show that ADHD has a biological origin. The neurotransmitter most associated with ADHD symptoms is dopamine [1].

ADHD often occurs with sleep disorders such as restless legs syndrome (RLS), sleep apnea, and insomnia [5]. RLS is a neurological sensorimotor disorder characterized by an irresistible inner urge to move the legs and by sensory discomfort in the lower legs [6]. Previous studies have shown that there is a relationship between RLS and

*Correspondence: drsedakiraz@gmail.com

¹ Department of Psychiatry, Hitit University Erol Olçok Research and Training Hospital, Çorum, Turkey
Full list of author information is available at the end of the article

ADHD, which are neuropsychiatric disorders, whose etiology has not been elucidated yet. Several theories have been proposed on this issue. The dopaminergic system caused by iron deficiency in the central nervous system is thought to play a role in the pathophysiology of RLS, as in ADHD [7]. Iron is a cofactor for tyrosine hydroxylase that is needed to convert tyrosine into levodopa, a precursor to dopamine. Dopaminergic medication is used in the treatment of both ADHD and RLS. Treatment of both diseases through the dopaminergic system may indicate a similar underlying etiological cause. Furthermore, it is well known that disorders that cause sleep problems can lead to or contribute to behavioral problems related to mood and inattention [8]. Therefore, it is possible that RLS may cause ADHD or ADHD-like symptoms. Moreover, a case-control study showed that a high proportion of children with ADHD suffered from a periodic limb movement disorder (10.2%), while no children in the control group suffered from such a disorder [9]. Studies have reported that RLS patients are more likely to experience impaired cognitive function and psychosocial distress, including problems with social activities, family life, and professional life, due to fatigue after sleep interruptions, as with ADHD [10]. While RLS can be seen alone, it can also occur with certain diseases such as peripheral polyneuropathy, diabetes mellitus, kidney failure, Parkinson's disease, or with the use of certain drugs such as antiepileptics, antidepressants, and dopamine agonists. Also, like RLS, ADHD has been associated with other neuropsychiatric disorders such as depression and migraine [11, 12].

In our study, we excluded the iron deficiency confounding factor, which significantly affects RLS. The aim of the study is to compare the prevalence of RLS in the newly diagnosed drug-naïve ADHD group and to evaluate its relationship with ADHD subtypes without iron deficiency.

Methods

Study sample

The study was carried out in the Hitit University Erol Olçok Training and Research Hospital, Department of Psychiatry. This prospective study was approved by the Hitit University Clinical Research Ethics Committee.

The study sample consisted of 120 drug-naïve adult ADHD individuals. The criteria to be included in the study were being over 18 years of age, under 65 years of age, and literate, agreeing to participate in the study, and meeting the criteria for adult ADHD diagnosis for the patient group. In the patient group, those with other disorders that could cause secondary restless leg syndrome, such as iron deficiency, anemia, kidney dysfunction, diabetes mellitus, multiple sclerosis, rheumatological

diseases, hypertension, any metabolic disease, epilepsy, stroke, and malignant diseases, were excluded from the study. In order to exclude iron deficiency and anemia, we included those with a ferritin level of 30 ng/mL and above, a hemoglobin value of 12 g/dL and above in women, and 13 g/dL and above in men, according to complete blood count values. Also, the study excluded those with psychotic disorder/mood disorder with psychotic characteristics, mental retardation, alcohol, and substance use disorder, and those using antipsychotic drugs and stimulants.

After the subjects who met the inclusion criteria were informed about the research, those who accepted to participate in the study signed the Informed Volunteer Consent Form. Then, a diagnostic interview for attention-deficit/hyperactivity disorder (DIVA) was applied to the patient group by the researcher in the study. The age of onset of the disease and the number of symptoms were determined according to the DSM-5 diagnostic criteria. ADHD subgroups were determined according to DIVA. Adult ADHD patients were divided into two as predominantly inattentive ADHD type (ADHD-I) and the combined type, in which hyperactivity, impulsivity, and attention deficiency co-exist (ADHD-C). Other psychiatric disorders were screened through the DSM-5 Structured Clinical Interview (SCID-5) in the patient group. The cases were diagnosed by the researcher-physician through a clinical interview. The adult ADHD groups completed a sociodemographic data form, the Wender Utah Rating Scale (WURS, the short form with 25 items), the Adult ADHD Self-Report Scale Symptom Checklist (ASRS), the Beck Depression Inventory (BDI), and the Beck Anxiety Inventory (BAI). Then, RLS diagnostic criteria were questioned for each patient. The RLS severity scale was used for patients meeting the RLS diagnostic criteria.

Data collection

The sociodemographic data form

The sociodemographic data form, prepared by the researchers, questioned the demographic details and alcohol and substance use by the participants.

Structured Clinical Diagnostic Interview (SCID-5)

SCID is a semi-structured clinical interview for the *Diagnostic and Statistical Manual of Mental Disorders — Fifth Edition* (DSM-5) diagnoses developed by First 2015 [13]. Turkish validity and reliability studies were conducted by Elbir et al. [14].

Diagnostic interview for ADHD in adults (DIVA)

The DIVA is a semi-structured diagnostic interview based on the DSM-IV diagnostic criteria for adult ADHD

[15]. It was translated to the Turkish language by Mukad-des et al. [16]. It consists of three parts, each of which is applied to childhood and adulthood: (1) criteria for attention deficit (A), (2) criteria for hyperactivity/impulsivity (HI), and (3) dysfunction caused by symptoms. For diagnosis, there should be at least two of the functional areas and at least moderate impairment. For the A and HI symptom groups, the criteria in childhood and adulthood are collected separately. If a sufficient number of criteria are met, ADHD is diagnosed, and the predominant clinical picture in the last 6 months is stated.

Adult ADHD Self-Report Scale (ASRS)

The ASRS was developed by the World Health Organization (WHO) to screen adults for ADHD symptoms. The scale consisting of eighteen items is scored between 1 and 4 Likert type [17]. It has two subscales, as attention deficit and hyperactivity/impulsiveness. The validity and reliability of the ASRS in the Turkish language were determined by Doğan et al. [18].

Wender Utah Rating Scale-25 (WURS)

This scale developed by Ward and Wender [19] evaluates the presence and severity of childhood ADHD symptoms in adults. The Turkish validity and reliability study was conducted by Öncü et al. [20]. The WURS is a 5-point Likert type self-report scale consisting of 25 items. Each item is scored between 0 and 4, and the cutoff score of the scale is 36. When the cutoff point is 36 and above, sensitivity was 82.5%, and specificity was 90.8% [20].

Beck Depression Inventory (BDI)

The BDI is a self-evaluation scale of 21 questions, which was developed to measure somatic, emotional, cognitive, motivational, and psychomotor symptoms observed in depression and the level and change in severity of depressive symptoms [21]. Validity and reliability studies have been made on the Turkish form of the scale [22]. The scoring of each item is from 0 to 3 points, and a total score is obtained.

Beck Anxiety Inventory (BAI)

The BAI is a self-evaluation scale of 21 questions each one scored from 0 to 3, which was developed by Beck et al. [23]. Adaptation to Turkish was made by Ulusoy et al. [24]. It is used to determine the level of anxiety and distribution and severity of symptoms. High total points indicate a high level of anxiety.

Assessment of RLS

The diagnosis of RLS is mainly based on clinical history. The 2012 revised International Restless Legs Syndrome Study Group diagnostic criteria (2012 revised IRLSSG

diagnostic criteria) were used by the interviewer for the diagnosis of RLS [25]. Five diagnostic criteria focused on the characteristic features of RLS. Patients who meet all criteria are diagnosed with RLS. These are as follows:

- 1) The need to move the legs due to or with uncomfortable or unpleasant sensations in the legs
- 2) The need for movement or uncomfortable sensations begin or worsen at rest.
- 3) The need for movement or uncomfortable sensations are partially or totally relieved by movements such as walking or stretching.
- 4) The need for movement or uncomfortable sensations worsen during the day, in the evening, or at night or occur only in the evening or at night.
- 5) The features listed above cannot be considered solely in relation to primary symptoms or other medical or behavioral conditions (e.g., myalgia, venous stasis, leg edema, leg cramps, habitual foot shaking) [25].

Evaluation of RLS severity

This scale is used to numerically determine the most disturbing symptom and the severity of the disease in RLS. Developed by the International HBS Working Group in 2003, disease severity scale is considered the gold standard. It consists of 10 questions, each graded from 0 to 4. While the first 5 questions are about the severity of the symptoms, the last 5 questions are about the effects of RLS on activities of daily living or quality of life. The score obtained in total reflects the severity of the disease. The maximum score is 40, with 1–10 as mild, 11–20 as moderate, 21–30 as severe, and 31–40 as very severe disease [26].

Statistical analysis

Statistical analyses were performed using SPSS (Version 22.0, SPSS Inc., Chicago, IL, USA, Hitit University Licensed) package program. Descriptive statistics were presented as mean \pm standard deviation and median (min-max) and categorical data as number and percentage (%) in accordance with the data distribution. The distribution of normality was analyzed using Kolmogorov-Smirnov and Shapiro-Wilk tests. In comparing the means of two independent samples for continuous variables, the *T*-test was used for normally distributed data, and the Mann-Whitney *U*-test was used for non-normally distributed data. In proportion comparisons between categorical variables, the chi-square (chi-square) test or the Fisher's exact test was used depending on the sample size of the cells in the crosstab. Relationships between numerical variables were analyzed with the Spearman correlation coefficient for non-normally

distributed data. Univariate and multivariate binary logistic regression analyses were used to determine the risk factors associated with RLS. Odds ratio (OR) and their 95% CIs calculated for each parameter were found to be statistically significant in logistic regression analysis. Statistical significance was evaluated at $p < 0.05$.

Results

In the study, there were a total of 120 patients with ADHD, 53 of whom were predominantly inattentive ADHD patients, and 67 were the combined type ADHD patients. There was not a statistically significant age difference between the ADHD groups ($p = 0.162$). Gender, marital status, education level, psychiatric disorders comorbidity, WURS, BDI, and BAI scale scores were statistically similar between the ADHD groups ($p = 0.336$, $p = 1.000$, $p = 0.070$, $p = 0.853$, $p = 0.089$, $p = 0.324$, $p = 0.106$). It was determined that 35 (29.1%) of 120 patients with ADHD had another psychiatric disorder, whose symptoms were not included in the exclusion criteria according to SCID-5. The comorbidities were

classified as follows: 16 cases of depression, four cases of specific phobia (SP), two cases of generalized anxiety disorder (GAD), five cases of unspecified anxiety disorder, two cases of obsessive-compulsive disorder (OCD), four cases of panic disorder (PD), and two cases of post-traumatic stress disorder (PTSD). RLS and ASRS were statistically significantly different between the ADHD groups ($p = 0.002$, $p < 0.001$). RLS accompanied 31.6% of ADHD cases; 23.7% of the patients with restless legs were in the ADHD-I group and 76.3% in the ADHD-C group (Table 1).

Comparisons of demographic characteristics, ADHD subgroups, comorbidity of depression and/or anxiety disorder, ASRS, WURS, BDI, and BAI scale scores between the ADHD patients with and without RLS are presented in Table 2. Age, gender, marital status, education level, and comorbidity were statistically similar among those with RLS ($p = 0.648$, $p = 0.804$, $p = 0.499$, $p = 0.154$, $p = 0.091$). However, ADHD subgroups, ASRS, WURS, BDI, and BAI scale scores showed statistically significant differences in ADHD patients with

Table 1 Comparison of demographic characteristics, RLS, comorbidity, ASRS, WURS, BDI, and BAI scale scores between ADHD groups

		ADHD groups		Test istatistiği (Chi-square value)	p-value
		ADHD-I S = 53 (44.2%) S (%)	ADHD-C S = 67 (55.8%) S (%)		
Gender	Female	23 (39.7%)	35 (60.3%)	0.927	0.336a
	Male	30 (48.4%)	32 (51.6%)		
Marital status	Married	5 (45.5%)	6 (54.5%)	3.274	1.000b
	Single	48 (44%)	61 (56%)		
Education level	High school and below	18 (58.1%)	13 (41.9%)	9.461	0.070a
	University	35 (39.3%)	54 (60.7%)		
RLS	Have not RLS	44 (53.7%)	38 (46.3%)	0.034	0.002a
	Have RLS	9 (23.7%)	29 (76.3%)		
Comorbidity of depression and/or anxiety disorder	No	38 (44.7%)	47 (55.3%)	2037.5	0.853a
	Yes	15 (42.9%)	20 (57.1%)		
		Mean ± SD Median (min-max)	Mean ± SD Median (min-max)	Test statistics (t-value, Mann-Whitney U-value)	p-value
Age		24 (18–30)	25 (18–28)	2691	0.162d
		23.64 ± 3.29	24.45 ± 2.48		
ASRS		44 (27–63)	55 (23–71)	–1.713	< 0.001d
		44.96 ± 7.88	52.86 ± 10.19		
WURS		47.98 ± 16	53.08 ± 16.39	–0.990	0.089c
		46 (17–84)	53 (20–91)		
BDI		18.05 ± 9.89	19.98 ± 11.10	2081	0.324c
		18 (3–44)	20 (3–56)		
BAI		14 (0–42)	17 (0–51)	20.61 ± 13.03	0.106d
		16.28 ± 10.09	20.61 ± 13.03		
Serum ferritin level		59.8 ± 17.3	55.2 ± 21.2		
Hemoglobin		12.7 ± 1.1	12.8 ± 0.8		

^a Chi-square test, ^bFisher's exact test, ^cStudent's t-test, ^dMann-Whitney U

Table 2 Comparison of demographic characteristics, ADHD, depression and/or anxiety disorder comorbidity, ASRS, WURS, BDI, and BAI scale scores between RLS groups

		Have not RLS S = 82 (68.3%)	Have RLS S = 38 (31.7%)	Test statistics	p-value
		n (%)	n (%)		
Gender	Female	39 (67.2%)	19 (32.8%)	0.062	0.804a
	Male	43 (69.4%)	19 (30.6%)		
Marital status	Married	9 (81.8%)	2 (18.2%)	2.037	0.499b
	Single	73 (67%)	36 (33%)		
Education level	High school and below	18 (58.1%)	13 (41.9%)	9.461	0.154a
	University	64 (71.9%)	25 (28.1%)		
ADHD	ADHD-I	44 (83%)	9 (17%)	2.860	0.002a
	ADHD-C	38 (56.7%)	29 (43.3%)		
Comorbidity of depression and/or anxiety disorder	No	62 (72.9%)	23 (27.1%)	1638	0.091a
	Yes	20 (57.1%)	15 (42.9%)		
		Mean \pm SD Median (min-max)	Mean \pm SD Median (min-max)	Test statistics (t-value, Mann-Whitney U-value)	p-value
Age		24 (18–30) 23.98 \pm 3.11	25 (18–28) 24.34 \pm 2.34	–3.544	0.648d
ASRS		47.26 \pm 9.41 48 (23–64)	53.92 \pm 9.87 55 (30–71)		
WURS		47.23 \pm 14.47 46 (17–81)	58.60 \pm 17.63 60.5 (17–91)	–3.731	< 0.001c
BDI		16.97 \pm 9.02 16 (3–45)	23.78 \pm 12.23 21.5 (3–56)		
BAI		13 (0–47) 15.20 \pm 9.83	22.5 (7–51) 26.23 \pm 12.80	2335.5	< 0.001d
Serum ferritin level		58 \pm 20.5	56 \pm 22.7		
Hemoglobin		12.6 \pm 1.2	12.4 \pm 0.9		

^a Chi-square test, ^bFisher's exact test, ^cStudent's *t*-test, ^dMann-Whitney *U*. ADHD, adult attention-deficit hyperactivity disorder; ADHD-I, inattention predominant type; ADHD-C, combined type predominant type. WURS, Wender Utah RatingScale; ASRS, Adult ADHD Self Report Scale; BDI, Beck Depression Inventory; BAI, Beck Anxiety Inventory

Table 3 Relationship between RLS severity and ASRS, WURS, BAI, and BDI in ADHD group

		ASRS	WURS	BAI	BDI
RLS severity	<i>r</i>	0.172	0.324*	0.210	–0.013
	<i>p</i>	0.302	0.047	0.205	0.936
	<i>s</i>	38	38	38	38

Spearman's Rho. ADHD, adult attention-deficit hyperactivity disorder; WURS Wender Utah RatingScale, ASRS Adult ADHD Self Report Scale, BDI Beck Depression Inventory, BAI Beck Anxiety Inventory

RLS compared to those without RLS ($p = 0.002$, $p = 0.001$, $p < 0.001$, $p = 0.001$, $p < 0.001$; Table 1).

The relationship between RLS severity and ASRS, WURS, BAI, and BDI in the ADHD group is presented in Table 3. A weakly positive statistically significant

correlation was found between the severity of RLS and WURS ($p = 0.047$, Table 3, Fig. 1).

Univariate and multivariate binary logistic regression analyses were performed to determine the effective risk factors and odds rates in the presence of RLS, and the results are presented in Table 4. The variables of ADHD, ASRS, WURS, BDI, and BAI ($p = 0.003$, $p = 0.001$, $p = 0.001$, $p = 0.002$, $p < 0.001$; Table 4), which were statistically significant in the univariate model, were included in the multivariate model. In the univariate model, non-statistically significant gender, marital status, education level, comorbidity, and age ($p = 0.804$, $p = 0.324$, $p = 0.156$, $p = 0.094$, $p = 0.516$) were not included in the multivariate model. The variables ASRS ($p = 0.481$), WURS ($p = 0.254$), and BDI ($p = 0.841$), which were significant in the univariate model but were not significant in the multivariate model, were also not included in the final model. The latest model established with ADHD



Fig. 1 Scattering graph and regression curve related to the relationship between HBS severity and WURS

Table 4 RLS predictors by regression analysis in ADHD group

	Univariate		Multivariate	
	<i>p</i> -values	Odds ratio (<i>CI</i> 95%)	<i>p</i> -values	Odds ratio (<i>CI</i> 95%)
Gender				
Male	0.804	0.907 (0.420–1.958)	Not included	
Marital status				
Married	0.324	2.219 (0.456–10.810)	Not included	
Education level				
High school and below	0.156	0.541 (0.231–1.266)	Not included	
ADHD				
Combine type	0.003*	3.731 (1.571–8.858)	0.014*	3.191 (1.260–8.084)
Comorbidity				
No	0.094	2.022 (0.888–4.604)	Not included	
Age	0.516	1.046 (0.913–1.199)	Not included	
ASRS	0.001*	1.079 (1.031–1.130)	Ns	
WURS	0.001*	1.047 (1.020–1.076)	Ns	
BDI	0.002*	1.065 (1.023–1.109)	Ns	
BAI	< 0.001*	1.087 (1.046–1.130)	< 0.001*	1.084 (1.041–1.129)

Nagelkerke R square = 0.301, classification: 74.2%. *ns* Not significant, *CI*, confidence interval. Reference value for *gender*: female. Reference value for education level, university. Reference value for marital status, single. Reference value for ADHD, attention-deficit dominant type. Reference value for comorbidity, yes. *ADHD*, ault attention-deficit hyperactivity disorder; *WURS*, Wender Utah RatingScale; *ASRS*, Adult ADHD Self Report Scale; *BDI*, Beck Depression Inventory; *BAI*, Beck Anxiety Inventory

and BAI, which was significant in the multivariate model, is presented in Table 4.

According to the results of the multivariate model, the possibility of having RLS was 3.191 (*CI*: 1.260–8.084) times higher in the ADHD-C group than in the ADHD-I group ($p = 0.014$). Increasing the anxiety scale (BAI) score by 1 unit increased the likelihood of RLS by 1.084 (*CI*: 1.041–1.129) times ($p < 0.001$).

Discussion

In this study, the frequency of RLS and the factors affecting the presence of RLS in ADHD groups were investigated in detail, excluding the causes related to iron metabolism. We found the prevalence of RLS to be 31.6% in the group consisting of 120 drug-naïve ADHD patients. Also, 43.3% of RLS cases were in the ADHD-C group, and 17.7% were in the ADHD-I group. Although

there was no difference between the ADHD-C group and the ADHD-I group in terms of demographic data, the frequency of RLS and the ASRS scale scores was found to be significantly higher in the ADHD-C group. Consistent with the literature, the frequency of RLS was found to be high [27], and it was found to be statistically significantly higher in the ADHD-C group. This suggested that RLS may be seen more frequently in patients with ADHD-C than with ADHD-I, due to the fact that sleep problems are more common [28] or RLS symptoms may overlap with hyperactivity and impulsivity.

The WURS scores measuring the severity of ADHD symptoms in childhood and the ASRS scores measuring the severity of symptoms in adulthood were found to be significantly higher in ADHD patients with RLS. There was a positive correlation between RLS severity and the severity of ADHD symptoms in childhood. In the literature, a significant positive correlation was found between ADHD symptom severity and RLS severity [29]. RLS symptom severity was found to be more closely related to childhood ADHD symptoms than to adult ADHD symptoms in our study.

While there was no difference between ADHD subgroups in terms of diagnosis of major depression and anxiety disorders or BAI and BDI scales measuring anxiety and depression symptom severity, anxiety and depression symptoms were found to be statistically significantly higher in ADHD patients with RLS. While there was no difference in the co-diagnosis of anxiety disorder and/or depression in ADHD cases accompanied by RLS, depression and anxiety symptoms were found to be significantly higher, suggesting that RLS is affected by internal symptoms such as depression, anxiety, and ADHD's own attention-deficit and hyperactivity symptoms. In a group of 103 Turkish adults with RLS obtained from a population sample of 3234, depression and anxiety symptoms were significantly higher in the RLS group than in the control (p 0.001 for both variables) [30]. Moreover, according to the multivariate model regression analysis, diagnosis of ADHD-C type and anxiety symptoms were found to be significantly higher among the factors affecting RLS in our study. The fact that anxiety is more prominent than depression makes us think that anxiety may be a factor reflecting the subjective experience of the dysphoric feeling of restless legs. So far, in the literature, the effect of anxiety, which is a common internalizing symptom that accompanies ADHD, on RLS has not been addressed in RLS-related studies conducted in the ADHD group. Based on the results of our study, frequent accompaniment of internalizing symptoms such as anxiety can be cited as one of the reasons for the high probability of RLS in the ADHD group. However, whether RLS increases anxiety and ADHD symptoms, or ADHD

and accompanying anxiety symptoms increase RLS, the cause-and-effect relationship cannot be determined exactly. It is seen that cause-and-effect studies are needed in this regard.

In the literature, the etiology of RLS in the ADHD group is mostly evaluated over iron metabolism [31]. We excluded confounding causes of iron deficiency and anemia in our study. So, we investigated factors other than iron affecting RLS in the ADHD group. Apart from iron deficiency, we found that the frequency of RLS was still high in the ADHD group. This can be interpreted as either that psychiatric comorbidities often accompany ADHD (one of these diseases is RLS) or that ADHD symptoms are a facilitating factor in diagnosing RLS. Our study differs from other studies in that it concludes that the core symptoms of ADHD and internalizing symptom anxiety significantly affect RLS.

The limitations of our study are having an observational cross-sectional design, using self-report screening scales, and having the comorbidities of depression and anxiety disorders. Longitudinal studies that determine the cause-and-effect relationship can be more explanatory. Although it is possible that studies conducted with the non-comorbid ADHD group may lead to different results, this makes our study more realistic because the general ADHD population often has internalizing symptoms. We did not research other sleep-related disorders in our study. On the other hand, the relatively large sample size, the use of strict exclusion criteria to eliminate confounding factors, the evaluation of the diagnosis of ADHD based on a detailed clinical interview with DIVA, and the inclusion of drug-naïve patients are the strengths of our study.

Conclusions

We showed that ADHD often accompanied RLS even without iron deficiency. We found that the core symptoms of ADHD and accompanying anxiety were effective on RLS as the reason for this. This situation reveals that we should not ignore RLS when looking for comorbidities in ADHD patients. It is thought that there is a need for studies that need to clarify the cause-and-effect relationships in the etiology of ADHD and RLS.

Abbreviations

RLS: Restless legs syndrome; ADHD: Attention-deficit/hyperactivity disorder; DIVA: A diagnostic interview for attention-deficit hyperactivity disorder; ADHD-I: ADHD attention-deficit dominant type; ADHD-C: Hyperactivity, impulsive, and attention deficit; DSM-5: *Diagnostic and Statistical Manual of Mental Disorders — Fifth Edition*; SCID-5: DSM-5 Structured Clinical Interview; WURS: The Wender Utah Rating Scale (short form with 25 items); ASRS: The Adult ADHD Self-Report Scale Symptom Checklist; BDI: The Beck Depression Inventory; BAI: The Beck Anxiety Inventory; IRLSSG: International Restless Legs Syndrome Study Group.

Acknowledgements

Not applicable

Authors' contributions

SK, study conception and design, data collection, interpretation of data, drafting, and analyzing. AÇ, interpretation of data, drafting, and revision of the manuscript. NE, study conception and design and revision of the manuscript. The author(s) read and approved the final manuscript.

Funding

The study had no funding source.

Availability of data and materials

All data can be accessed via the Internet, available from references.

Declarations**Ethics approval and consent to participate**

Ethical approval of this study was received from the Hitit University Ethics Committee (dated 20 January 2021 and numbered 389).

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

Author details

¹Department of Psychiatry, Hitit University Erol Olçok Research and Training Hospital, Çorum, Turkey. ²Private Practice, İstanbul, Turkey. ³Department of Psychiatry, Rize Kaçkar State Hospital, Rize, Turkey.

Received: 29 May 2022 Accepted: 13 July 2022

Published online: 09 August 2022

References

- American Psychiatric Association (2013) Diagnostic and Statistical Manual of Mental Disorders, 5th edn. American Psychiatric Association, Washington, DC
- Kiraz S, Sertcelik S, Erdogan Taycan S (2021) The relationship between alexithymia and impulsiveness in adult attention deficit and hyperactivity disorder. *Turk Psikiyatri Derg* 32(2):109–117. <https://doi.org/10.5080/u23775>
- Kessler RC, Lane M, Stang PE, Van Brunt DL (2009) The prevalence and workplace costs of adult attention deficit hyperactivity disorder in a large manufacturing firm. *Psychol Med* 39(1):137–147. <https://doi.org/10.1017/S0033291708003309>
- Kiraz S, Sertcelik S (2021) Adult attention deficit hyperactivity disorder and early maladaptive schemas. *Clin Psychol Psychother* 28(5):1055–1064. <https://doi.org/10.1002/cpp.2569>
- Walters AS, Silvestri R, Zucconi M, Chandrashekariah R, Konofal E (2008) Review of the possible relationship and hypothetical links between attention deficit hyperactivity disorder (ADHD) and the simple sleep related movement disorders, parasomnias, hypersomnias, and circadian rhythm disorders. *J Clin Sleep Med* 4(6):591–600. <https://doi.org/10.5664/jcsm.27356>
- Allen RP (2014) Restless legs syndrome/Willis Ekbom disease: evaluation and treatment. *Int Rev Psychiatry* 26(2):248–262. <https://doi.org/10.3109/09540261.2014.904279>
- Lyu S, Doroodchi A, Xing H, Sheng Y, DeAndrade MP, Yang Y et al (2020) BTBD9 and dopaminergic dysfunction in the pathogenesis of restless legs syndrome. *Brain Struct Funct* 225(6):1743–1760. <https://doi.org/10.1007/s00429-020-02090-x>
- Konofal E, Lecendreux M, Cortese S (2010) Sleep and ADHD. *Sleep Med* 11(7):652–658. <https://doi.org/10.1016/j.sleep.2010.02.012>
- Huang Y-S, Chen N-H, Li H-Y, Wu Y-Y, Chao C-C, Guilleminault C (2004) Sleep disorders in Taiwanese children with attention deficit/hyperactivity disorder. *J Sleep Res* 13(3):269–277. <https://doi.org/10.1111/j.1365-2869.2004.00408.x>
- Magnavita N, Garbarino S (2017) Sleep, health and wellness at work: a scoping review. *Int J Environ Res Public Health* 14(11). <https://doi.org/10.3390/ijerph14111347>
- Didriksen M, Thøner LW, Erikstrup C, Pedersen OB, Paarup HM, Petersen M et al (2019) Self-reported restless legs syndrome and involuntary leg movements during sleep are associated with symptoms of attention deficit hyperactivity disorder. *Sleep Med* 57:115–121. <https://doi.org/10.1016/j.sleep.2019.01.039>
- Fasmer OB, Halmoy A, Oedegaard KJ, Haavik J (2011) Adult attention deficit hyperactivity disorder is associated with migraine headaches. *Eur Arch Psychiatr Clin Neurosci* 261(8):595–602. <https://doi.org/10.1007/s00406-011-0203-9>
- First MB (2015) Structured Clinical Interview for the DSM (SCID). The Encyclopedia of Clinical Psychology, First press. RL Cautin, SOLilienfeld (Ed), Wiley-Blackwell
- Elbir M, Alp Topbaş Ö, Bayad S, Kocabaş T, Topak OZ, Çetin Ş et al (2019) Adaptation and reliability of the structured clinical interview for DSM-5-disorders - clinician version (SCID-5/CV) to the Turkish language. *Turk Psikiyatri Derg* 30(1):51–56. <https://doi.org/10.5080/u23431>
- Kooij JJS, Francken MH (2010) Diagnostic interview for ADHD in adults 2.0 (DIVA 2.0). Adult ADHD: Diagnostic assessment and treatment 33–99. https://doi.org/10.1007/978-1-4471-4138-9_3
- Mukaddes NM, Öncü B, Bron A, van Bussel M, Kooij J. DIVA 2.0 Yetişkinlerde DEHB için tanılabilir görüşme [DIVA 2.0 diagnostic interview ADHD in adults] 2013. (downloaded from http://www.divacenter.eu/Content/VertalingPDFs/DIVA_2_Turks_FORM.pdf).
- American Psychiatric Association (1994) Diagnostic and Statistical Manual of Mental Disorders, 4th edn. American Psychiatric Association, Washington, DC
- Doğan S, Öncü B, Varol Saraçoğlu G, Küçüköncü S (2009) Erişkin Dikkat Eksikliği Hiperaktivite Bozukluğu Kendi Bildirim Ölçeği (ASRS- v1.1): Türkçe formunun geçerlilik ve güvenilirliği/ Validity and reliability of the Turkish version of the adult ADHD Self- Report Scale (ASRS- v1.1). *Anadolu Psikiyatri Derg* 10(2):77–87
- Ward MF, Wender PH, Reimherr FW (1993) The Wender Utah Rating Scale: an aid in the retrospective diagnosis of childhood attention deficit hyperactivity disorder. *Am J Psychiatry* 150(6):885–890
- Öncü B, Olmez S, Sentürk V (2005) Validity and reliability of the Turkish version of the Wender Utah Rating Scale for attention-deficit/hyperactivity disorder in adults. *Turk Psikiyatri Derg* 16(4):252–259
- Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J (1961) An inventory for measuring depression. *Arch Gen Psychiatry* 4(6):561–571
- Hisli N (1988) Beck Depresyon Ölçeği'nin bir Türk örnekleminde geçerlilik ve güvenilirliği. *Psikoloji Dergisi* 6:118–122
- Beck AT, Epstein N, Brown G, Steer RA (1988) An inventory for measuring clinical anxiety: psychometric properties. *J Consult Clin Psychol* 56(6):893–897
- Ulusoy M, Sahin NH, Erkmen H (1988) Beck Anxiety Inventory: psychometric properties. *J Cogn Psychother* 12:162–167
- Allen RP, Picchietti DL, Garcia-Borreguero D, Ondo WG, Walters AS, Winkelman JW et al (2014) International Restless Legs Syndrome Study Group. Restless legs syndrome/Willis-Ekbom disease diagnostic criteria: updated International Restless Legs Syndrome Study Group (IRLSSG) consensus criteria—history, rationale, description, and significance. *Sleep Med* 15:860–873. <https://doi.org/10.1016/j.sleep.2014.03.025>
- Walters AS, LeBrocq C, Dhar A, Hening W, Rosen R, Allen RP et al (2003) Validation of the International Restless Legs Syndrome Study Group rating scale for restless legs syndrome. *Sleep Med* 4(2):121–132. <https://doi.org/10.1016/j.sleep.2007.03.022>
- Lopez R, Micoulaud Franchi J-A, Chenini S, Gachet M, Jaussent I, Dauviliers Y (2019) Restless legs syndrome and iron deficiency in adults with attention-deficit/hyperactivity disorder. *Sleep* 42(5). <https://doi.org/10.1093/sleep/zsz027>
- Snitselaar MA, Smits MG, Spijker J (2016) Prevalence of restless legs syndrome in adult ADHD and its subtypes. *Behav Sleep Med* 14(5):480–488. <https://doi.org/10.1080/15402002.2015.1018386>
- Zak R, Couvadelli BV, Fisher B, Moss NM, Walters AS (2009) Preliminary study of the prevalence of restless legs syndrome in adults with attention

deficit hyperactivity disorder. *Percept Mot Skills* 108(3):759–763. <https://doi.org/10.2466/pms.108.3.759-763>

30. Sevim S, Dogu O, Kaleagasi H, Aral M, Metin O, Camdeviren H (2004) Correlation of anxiety and depression symptoms in patients with restless legs syndrome: a population based survey. *J Neurol Neurosurg Psychiatry* 75(2):226–230. <https://doi.org/10.1136/jnnp.2003.017467>
31. Kapoor V, Ferri R, Stein MA, Ruth C, Reed J, DelRosso LM (2021) Restless sleep disorder in children with attention-deficit/hyperactivity disorder. *J Clin Sleep Med* 17(4):639–643. <https://doi.org/10.5664/jcsm.8984>

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Submit your manuscript to a SpringerOpen[®] journal and benefit from:

- Convenient online submission
- Rigorous peer review
- Open access: articles freely available online
- High visibility within the field
- Retaining the copyright to your article

Submit your next manuscript at ► [springeropen.com](https://www.springeropen.com)
