Sleep disturbances, chronotype, and functional impairment in inattentive and restrictive presentations of attention-deficit/hyperactivity disorder

Hande Emine Sabah Barış[1], Sibel Fatma Durak[2], Nagihan Cevher Binici[3], Mert Coban[4]
[1]M.D., Bingol State Hospital, Bingol, Türkiye https://orcid.org/0009-0005-4083-6608
[2]M.D., Behçet Uz Training and Research Hospital for Child Health and Diseases and Pediatric Surgery, Child and Adolescent Psychiatry Department, Izmir, Türkiye https://orcid.org/0000-0003-0205-4654
[3]Assoc. Prof., Dokuz Eylul University, Faculty of Medicine, Department of Internal Medicine, Division of Child and Adolescent Psychiatry, Izmir, Türkiye https://orcid.org/0000-0002-4715-1768
[4]M.D., Cigli Training and Research Hospital, Child and Adolescent Psychiatry, Izmir, Turkiye https://orcid.org/0000-0003-4788-7836

SUMMARY

Objective: This study examined functional impairment, sleep disturbances, and chronotype characteristics in children with the Predominantly Inattentive Presentation of ADHD (ADHD-PI), the Restrictive ADHD phenotype (ADHD-R), and typically developing controls.

Method: A cross-sectional study was conducted with 104 children aged 7–12 years: ADHD-PI (n=34), ADHD-R (n= 36), and Control group (n=34). Parent-rated measures included the CSHQ (The Children's Sleep Habits Questionnaire), CCQ (Children's Chronotype Questionnaire) , and WFIRS-P (Weiss Functional Impairment Rating Scale – Parent Form). All participants had an IQ above 80 and were free of comorbid psychiatric or medical conditions. Subgroup analyses were performed based on functional impairment status, and group comparisons were made on sleep-related and chronotype variables.

Results: Functional impairment was significantly more common in both ADHD groups (ADHD-PI: 67%, ADHD-R: 61%) compared to control group (5.9%) ($p < .001$). Both clinical groups showed greater daytime sleepiness. Although no statistically significant group differences were found in eveningness scores, the ADHD-R group exhibited higher eveningness tendencies compared to both the ADHD-PI and healthy control groups. In ADHD-PI, functional impairment was associated with delayed sleep onset, parasomnia, and sleep-disordered breathing. In ADHD-R, higher sleep disturbance, parasomnia, and longer sleep duration were observed in the impaired group. However, these variables did not significantly predict impairment. Oppositional defiant behavior scores significantly predicted functional impairment within the ADHD-R group.

Discussion: Sleep problems—particularly parasomnias—are associated with greater functional impairment in ADHD. Addressing sleep disturbances may contribute to improving daily functioning and quality of life in affected children.

Key Words: ADHD subtypes, Restrictive ADHD, Sleep disorders, Functionality, Chronotype

INTRODUCTION

The clinical presentation of ADHD has historically been categorized into three distinct subtypes: inattentive (ADHD-PI), hyperactive/impulsive (ADHD-H), and combined (ADHD-C) (1). Among children presenting to clinics, the most common type of ADHD is ADHD-C, whereas in population-based samples, ADHD-PI has been reported as the predominant subtype (2). The Restrictive phenotype has been proposed to describe children who exhibit few or no hyperactivity symptoms, distinguishing it from the Inattentive subtype" (3,4). There is growing evidence indicating that the ADHD-R phenotype may differ from ADHD-PI in its genetic, neuropsychological, and neurobiological features (3,5).

Research on sleep problems in children with ADHD has often involved heterogeneous participant groups (6-10). Consequently, existing knowledge primarily reflects findings from children with ADHD-C (5). Evidence suggests that children with ADHD experience significant difficulties not only in attention and behavior but also in their sleep patterns. Both objective measurements and parent

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reports highlight a range of sleep problems in these children, including delayed sleep onset, shorter sleep duration, nighttime awakenings, difficulty waking in the morning, excessive daytime sleepiness, and sleep-disordered breathing (11,12). Among ADHD-affected children, disrupted sleep contributes to greater behavioral difficulties, impaired cognitive performance, and lower overall quality of life (13,14). One study highlighted that unaddressed sleep problems can substantially intensify behavioral symptoms in children with ADHD, negatively impacting their daily functioning and overall family quality of life (15). Furthermore, poor sleep quality has been shown to significantly impact executive functioning, which is already frequently impaired in children with ADHD (16,17). Research examining whether sleep disturbances differ among ADHD subtypes has produced inconsistent findings. Although certain studies report no subtype-related differences, some findings suggest that children with Inattentive presentation may exhibit greater daytime sleepiness than those with the combined type (6,18-22). Increases in inattention and sluggish cognitive tempo (SCT) symptoms have also been linked to increased daytime sleepiness (23). Moreover, youth with ADHD-PI often present with a drowsy and tired demeanor and tend to exhibit co-occurring internalizing disorders, both of which have been significantly linked to sleep disturbances (24). Evaluating sleep disturbances in children with ADHD-PI is important, as such problems have been shown to predict functional impairment in this population (13,21,22,25-27). Chronotype describes a person's innate tendency to be more active at certain times of the day and is commonly classified as morning, evening, or intermediate type. ADHD has been associated with a preference for eveningness (28,29). Evidence suggests that eveningness is more common among individuals with ADHD, particularly those with inattentive features, and this tendency is related to reduced sleep quality and heightened symptom severity (30-32). Findings regarding circadian rhythm disturbances across ADHD subtypes are mixed. While some studies argue that eveningness is more pronounced in ADHD-C, others associate circadian rhythm disruptions and evening chronotype with the inattentive subtype (31). Each ADHD subtype is associated with increased levels of functional impairment relative to typically developing peers (33). Studies examining the ADHD–functionality relationship have demonstrated that both core symptoms and comorbid psychopathologies contribute to functional outcomes (33-39). Craig et al. found that sleep disturbances accounted for about 12% of the variance in functional impairment (13). Those diagnosed with ADHD-PI are particularly susceptible to sleep difficulties such as daytime sleepiness, trouble falling asleep, and poor sleep quality (20,23). Furthermore, these individuals are more likely to experience circadian rhythm disturbances and a preference for eveningness, both of which may negatively affect academic performance and daily functioning (30, 31). Recognizing sleep problems is crucial for improving functionality and quality of life in children who exhibit an inattentive presentation. Previous studies have reported a significant association between eveningness preference and inattentive symptoms(31,40). It has been proposed that eveningness tendency might be particularly associated with the inattentive presentation of ADHD (31). Investigating the effects of chronotype preferences and sleep disturbances on functional outcomes in ADHD-PI and ADHD-R subtypes may provide valuable insights that could contribute to improving functionality through targeted clinical interventions.

We hypothesized that children with ADHD-PI and ADHD-R who exhibit functional impairment would display higher sleep disturbance scores and a stronger eveningness preference compared to those without impairment. However, the existing literature provides limited evidence regarding the relationship between eveningness tendency, sleep disturbances, and functional impairment in these subtypes. The present study aimed to investigate distinctions in sleep disturbances and eveningness preference between ADHD-PI and ADHD-R groups, as well as their impact on functional outcomes, while controlling for factors such as comorbid psychiatric disorders, increased CDS (Cognitive Disengagement Syndrome) symptoms, psychostimulant use, and cognitive ability.

METHOD

Sample

Seventy children aged 7–12 years with a diagnosis of ADHD (34 with ADHD-PI and 36 with ADHD-R) were consecutively recruited according to the inclusion and exclusion criteria from patients either newly admitted to the clinic or already under follow-up for ADHD-PI or ADHD-R, with no psychotropic medication use in the last 3 months. All participants were primary or secondary school students. ADHD subtype classification was determined based on DSM-5 criteria following clinical interviews and scale assessments completed by both parents and teachers. Using the Turgay DSM-IV based ADHD rating Scale (T-DSM-IV-S). According to the T-DSM-IV-S scale, children exhibiting six or more symptoms of inattention along with two or fewer symptoms of hyperactivity/impulsivity were classified into the ADHD-R group, whereas those with three to five symptoms of hyperactivity/impulsivity were classified into the ADHD-PI group. In the T-DSM-IV-S, symptom scores of two or higher were considered clinically significant. Children with comorbid psychiatric (excluding Oppositional Defiant Disorder-ODD) or chronic medical conditions and those using psychostimulants were excluded. Thirty-four typically developing children who presented to the clinic and were not given any psychiatric diagnosis after evaluation constituted the control group. Informed consent forms were received from the participants and their caregivers.

Statistical Analyses

The sociodemographic characteristics of the ADHD groups and the control group were analyzed using one-way ANOVA. Chi-square tests were employed to compare chronotype preferences, the prevalence of sleep disturbances, and the proportion of individuals with functional impairment among the groups. The severity of inattention, hyperactivity/impulsivity, oppositional defiant, and conduct disorder symptoms, as well as Barkley functional impairment scores, were compared using the Kruskal-Wallis test due to non-normal distributions. As the WISC-R (Wechsler D.: Manual for the Wechsler Intelligence Scale for Children-Revised) verbal, performance, and total IQ scores were normally distributed, they were analyzed using one-way ANOVA. For variables showing significant group differences, post-hoc analyses (Bonferroni test) were conducted to identify which groups differed from each other. In both the ADHD-R and ADHD-PI groups, participants were divided into two subgroups based on the presence or absence of functional impairment, and comparisons were made regarding sleep duration, sleep onset times, total and subscale scores of the CSHQ, chronotype scores, and behavioral symptom scores. To identify predictors of functional impairment based on total WFIRS-P scores, binary logistic regression analyses were conducted separately for the ADHD-R and ADHD-PI groups. The regression models included CSHQ total score, sleep duration, parasomnias, sleep-disordered breathing, inattention and oppositional defiant symptom scores, and the Barkley functional impairment score. For each variable, odds ratios (Exp(B)) and 95% confidence intervals were reported. All analyses were conducted using SPSS version 25.0.

Sample Characteristics

Specific learning disorder, intellectual functioning, and psychiatric comorbidities (excluding ODD) were evaluated using the Schedule for Affective Disorders and Schizophrenia for School-Age Children – Present and Lifetime Version (K-SADS-P) and the WISC-R (41-43). Children scoring ≥23 on the Barkley Child Attention Scale, which screens for CDS, were excluded.

Of the total sample (n = 104), 57% were male and 43% were female. The mean ages were 9.53 ± 1.9 years in the ADHD-PI group, 9.67 ± 1.6 years in the ADHD-R group, and 9.18 ± 1.42 years in the control group. The distribution of participants was as follows: 32% ADHD-PI, 34% ADHD-R, and 32% controls.

ADHD Symptoms. ADHD symptoms were assessed using a T-DSM-IV-S . This instrument translates DSM-IV diagnostic criteria into question format and consists of forty-one items: nine assessing inattention, six hyperactivity, three impulsivity, eight oppositional defiant disorder , and fifteen conduct disorder (CD) (43). It is completed by parents or teachers of children suspected to have ADHD. Items are rated on a 4-point Likert scale (0 = none, 1 = mild, 2 = moderate, 3 = severe) The Turkish validity and reliability study was conducted by Ercan et al. (2001) (44-46)

Cognitive Disengagement Syndrome (CDS). The Barkley Child Attention Scale was used to screen for CDS symptoms. Developed by Russell Barkley, the 12-item scale is completed by parents or teachers . The cutoff score was determined to be 23. In the Turkish validity and reliability study conducted by Fırat and colleagues, the Cronbach's alpha coefficient was found to be 0.86, indicating that the scale is valid and reliable (47,48)

Sleep and Chronotype. CSHQ is a 33-item parent-report measure that evaluates the child's sleep behaviors over the past week. It assesses various domains including bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night wakings, parasomnias, sleep-disordered breathing, and daytime sleepiness (49). The Turkish adaptation of the scale was validated by Perdahlı Fiş et al. in 2010 (50). Chronotype was assessed using the CCQ (50). CCQ is completed by parents. Items 17, 18, 24, and 25 are reverse-coded. Chronotype was determined using the total score from 10 items, with scores of 23 or below indicating a morning type, scores between 24 and 32 indicating an intermediate type, and scores of 33 or above indicating an evening type. Average sleep duration was estimated based on reported sleep onset and wake times. Napping was included in the total sleep duration. Sleep duration was averaged across the week by calculating five times the school day value plus two times the free day value, divided by 7 .The Turkish version was validated by Dursun et al. (51).

Functionality. Functional impairment was assessed using the WFIRS-P (52). Parents rated their child's functioning in six domains—family, school, life skills, self-concept, social activities, and risky behaviors—on a scale from 0 to 4. A mean score of 1.5 or higher in any domain was considered indicative of impairment in that area. Children who showed impairment in at least two domains were classified as having overall functional impairment. The adaptation conducted in our country by Tarakçıoğlu et al. yielded a Cronbach's alpha of 0.93 for the total scale, indicating excellent reliability (53).

Intelligence. WISC-R was used to assess cognitive functioning (42). In Turkey, validity and reliability studies conducted by Savaşır and Şahin led to the adaptation of the WISC-R to Turkish culture (42).

Psychiatric Comorbidities. Comorbid psychiatric diagnoses were screened using the (K-SADS-PL), and those with additional diagnoses were excluded from the study. The validity and reliability study in Turkey was conducted by Gökler and colleagues. (41).

RESULTS

Age, height, weight, and the ages of the mother and father did not differ significantly between the groups (p>.05); however, significant differences were observed in parental education levels, with both maternal and paternal education reaching statistical significance (p=.003 and p=.001, respectively). (Table 1). The groups did not differ significantly in developmental milestones such as age of first word, first sentence, walking, or toilet training (p>.05). Likewise, no significant differences were found in birth weight (p=.510) or breastfeeding duration (p=.393).

Table 1. Sociodemographic Characteristics of Children with ADHD-PI, ADHD-R, and Controls

Sociodemographic Variables	ADHD-PI (n = 34)	ADHD-R (n = 36)	Control (n = 34)	p-value	P (Bonferroni)	n^2p
Age (years), M – SD	9.5 ± 1.9	9.6 ± 1.6	9.1 ± 1.4	0.507	0.507	0.01
Height (cm), M – SD	139.7 ± 15.9	138.2 ± 12.8	136.9 ± 9.8	0.770	0.770	0.01
Weight (kg), M – SD	35.3 ± 13.9	36.8 ± 13.8	33.9 ± 11.9	0.691	0.691	0.01
Maternal age, M – SD	38.9 ± 5.2	38.4 ± 5.3	37.1 ± 4.0	0.302	0.302	0.02
Paternal age, M – SD	42.5 ± 5.7	42.6 ± 6.7	37.1 ± 4.0	0.590	0.590	0.01
Maternal education (years), M – SD	12.5 ± 3.1	11.2 ± 3.2	13.8 ± 2.9	**0.003**	**0.021**	0.09
Paternal education (years), M – SD	14.2 ± 3.1	12.3 ± 3.2	14.8 ± 2.3	**0.001**	**0.007**	0.12

Note. M = Mean; SD = Standard deviation. *p*-values indicate statistically significant results. Note. Analyses were conducted using a one-way ANOVA across three groups. A total of seven variables were examined, and Bonferroni correction was applied for multiple comparisons (adjusted significance level: p < .007). Effect size was reported as partial eta squared (n^2p).

Table 2. Chronotype Preferences and Presence of Sleep Disturbances in Children with ADHD-PI, ADHD-R, and Control Groups

	ADHD-PI(n =34)	ADHD-R (n = 36)	Control (n = 34)	p-value	x†	df	q (FDR)	Cramer□s V
Chronotype Preference				0.64	0.87	4	0.647	0.09
Morning type	6 (17.6%)	3 (8.3%)	4 (11.8%)	0.42			0.63	0.10
Intermediate type	18 (52.9%)	17 (47.2%)	18 (52.9%)	0.83			0.83	0.04
Evening type	10 (29.4%)	16 (44.4%)	12 (35.3%)	0.46			0.63	0.12
Sleep Disturbances				0.08	5.03	2	0.12	0.23
Absent	11 (32.4%)	12 (33.3%)	19 (55.9%)					
Present	23 (67.6%)	24 (66.7%)	15 (44.1%)					
Daytime Sleepiness	58.88	58.42	39.85	**0.01***	8,98			

Note. Sleep disturbances are classified based on a total CSHQ score ≥ 41. Note. Analyses were conducted using Pearsons Chi-square test. Group comparisons for the Daytime Sleepiness subscale of the CSHQ were conducted using the Kruskal-Wallis test. Multiple comparisons were adjusted using the Benjamini□Hochberg False Discovery Rate (FDR) correction (two tests; q< 0.05). Effect size was reported as Cramers V (small = 0.10, medium = 0.30, large = 0.50).

There were no significant group differences regarding chronotype preference or the occurrence of sleep disturbances (p=.64 and p=.08, respectively). (Table 2). Among the CSHQ subscales, only the daytime sleepiness subdomain showed a significant difference. Both the ADHD-PI (p< .001) and ADHD-R (p=.01) groups exhibited greater daytime sleepiness compared to controls, whereas no difference was found between the two ADHD groups (p=.94). However, no significant difference in daytime sleepiness was observed between the ADHD-R and ADHD-PI groups (p=.94).

Comparison of the T-DSM-IV-S

Group comparisons showed significant differences in inattention, hyperactivity, oppositional behavior, and conduct problem scores across the ADHD-PI, ADHD-R and control groups (p<.05 for all). Subsequent post-hoc analyses demonstrated that individuals in the Inattentive presentation group exhibited higher levels of hyperactivity (p=.00), oppositionality (p=.01), and conduct-related issues (p=.03) compared to those in the ADHD-Rgroup. (Table 3). The control group outperformed both ADHD subgroups on verbal, performance, and full-scale IQ scores measured by the WISC-R (Table 3).

Comparison of WFIRS-P Scale Scores

Both ADHD groups demonstrated significantly higher rates of functional impairment compared to the control group in the domains of family functioning (Cramer's V=0.28, moderate effect), school functioning (Cramer's V=0.62, large effect), life skills (Cramer's V=0.49, moderate-to-large effect), risky behaviors (Cramer's V=0.37, moderate effect), and overall functioning, defined as impairment in at least two domains (Cramer's V = 0.56, large effect). (Table 4).

In the ADHD-R group, children with functional impairment had significantly higher scores in total sleep disturbance (CSHQ total score) (p<.00), sleep duration (p=.03), parasomnia (p=.01), inattention (p=.01), oppositional behavior (p<.00),

Table 3. Comparison of Turgay Scale Total Scores (Inattention, Hyperactivity/Impulsivity, Oppositional Defiant, and Conduc Disorder), the Barkley Child Attention Scale Total Score, and WISC -R Scores (Verbal, Performance and Total) among the ADHD-PI, ADHD-R, and Control Groups

	ADHD-PI (n=34)	ADHD-R (n=36)	Control (n=34)	F/x^2	p-value	(Bonferroni)	(n^2 / r)	Post-Hoc Analysis
Inattention Total Score	72.35	63.28	21.24	56.201	0.000**	<.006	0.68	(PI> C, R> C) (p<.00)
Hyperactivity Total Score	77.53	43.18	37.34	37.192	0.000**	<.006	0.55	(PI> C, PI> R) (p<.00)
Oppositional Defiant Total Score	69.60	52.56	35.34	23.399	0.000**	<.006	0.47	(PI> C) (p<.00), (PI> R, R>C)(p=.01)
Conduct Disorder Total Score	64.90	48.78	44.04	18.969	0.000**	<.006	0.39	(PI> R, PI> C) (p<.00)
Barkley	62.84	64.27	28.53	31.723	0.000**	<.006	0.44	(PI> C, R> C)(p<.00)
WISC-R Verbal	93.8 – 13	90.1 – 14	108.5 – 10	19.620	0.000**	<.006	0.32	(C> PI, C> R) (p<.00)
WISC-R Performance	101.9 – 15	103.5– 14	113.5 – 12	11.605	0.000**	<.006	0.28	C> PI (p<.00), C> R (p=.02)
WISC-R Total	97.4 – 13	96.3 – 15	111.7 – 11	13.100	0.000**	<.006	0.35	(C> PI, C> R) (p<.00)

Notes. Kruskal-Wallis test was applied for comparison analyses. * p <0.05, ** p < 0.01. ANOVA was used for WISC-R verbal and total scores. PI=ADHD-PI (Predominantly Inattentive Presentation of ADHD); R = ADHD-R (Restrictive Presentation of ADHD); C = Controls. Multiple comparisons were adjusted using the Bonferroni correction ($alfa_a d_j$ = 0.00625). Effect sizes were reported as partial eta squared (n^{2}p) for ANOVA and r for Kruskal -Wallis tests (small = 0.10, medium = 0.30, large = 0.50; Cohen, 1988).

Table 4. Distribution of Functional Impairment Across WFIRS-P Domains in ADHD-PI, ADHD-R, and Control Groups

Functional Impairment (WFIRS-P)	ADHD-PI (n = 34)	ADHD-R (n = 36)	Control (n = 34)	p-value	x^2	q (FDR)	Cramer□s V
Family Functioning				.014*	8.565	.035*	0.28
No Impairment	24 (70.6%)	24 (66.7%)	32 (94.1%)				
Impairment	10 (29.4%)	12 (33.3%)	2 (5.9%)				
School Functioning				.000**	37.136	.003*	0.62
No Impairment	12 (35.3%)	14 (38.9%)	34 (100%)				
Impairment	22 (64.7%)	22 (61.1%)	0 (0%)				
Life Skills				.000**	18.529	.003*	0.49
No Impairment	10 (29.4%)	15 (41.7%)	27 (79.4%)				
Impairment	24 (70.6%)	21 (58.3%)	7 (20.6%)				
Self-Perception				.048*	9.611	.072	0.24
No Impairment	24 (70.6%)	29 (80.6%)	33 (97.1%)				
Impairment	10 (29.4%)	7 (19.4%)	1 (2.9%)				
Social Activities				.085	4.937	.092	0.19
No Impairment	27 (79.4%)	31 (86.1%)	33 (97.1%)				
Impairment	7 (20.6%)	5 (13.9%)	1 (2.9%)				
Risky Behaviors				.003**	11.874	.009*	0.37
No Impairment	26 (76.5%)	34 (94.4%)	34 (100%)				
Impairment	8 (23.5%)	2 (5.6%)	0 (0%)				
Total (≥2 Impaired Domains)				.000**	31.816	.003*	0.56
No Impairment	11 (32.4%)	14 (38.9%)	32 (94.1%)				
Impairment	23 (67.6%)	22 (61.1%)	2 (5.9%)				

Note. Analyses were conducted using Pearsons Chi-square test across seven subdomains. Multiple comparisons were adjusted using the Benjamini□Hochberg False Discovery Rate (FDR) correction (k=7; adjusted significance threshold: q<0.05). Effect sizes were reported as Cramers V (small = 0.10, medium = 0.30, large = 0.50).

and CDS total score (Barkley Child Attention Scale) (p<0.00)(Table 5). Nevertheless, none of these variables were found to be significant predictors of functional impairment in logistic regression analysis: total CSHQ score (p= .14), sleep duration (p=.12), parasomnia (p=.21), inattention (p= .85), and CDS (p=.25). The oppositional behavior total score approached statistical significance (p=.05), indicating a possible trend toward increased risk of functional impairment (Table 6).

In the ADHD-PI group, comparisons between participants with and without functional impairment revealed that those with impairment had significantly higher scores in sleep duration on free days (p=.01), parasomnia (p=.01), and sleep-disordered breathing (p = .04) according to the CSHQ subscales (Table 7). However, binary logistic regression analysis showed that these variables did not significantly predict functional impairment: sleep duration on free days (p= .07), parasomnia (p = .15), and sleep-disordered breathing (p = .14) (Table 8).

Table 5. Comparison of Chronotype scale total score, CSHQ total score and subscale scores, Turgay Scale Total Scores (Inattention, Hyperactivity/Impulsivity, Oppositional Defiant, and Conduct Disorder), the Barkley Child Attention Scale Total Score in relation to overall functional impairment (WFIRS-P) in the ADHD-R group

Variable	Impairment Present (n=22)	No Impairment (n=14)	Z/t	p-value	q (FDR)	(d / r)
Sleep Onset Time on Scheduled Days	9.02	9.68	1.768⁺	.086	.112	0.28
Sleep Onset Time on Free Days	10.00	10.21	0.552⁺	.585	.625	0.08
Total Sleep Duration	9.26	9.79	1.566⁺	.127	.153	0.23
Chronotype Scale Score	32.45	29.43	-1.476⁺	.149	.170	0.21
CSHQ Total Score	46.91	40.43	-3.122⁺	.004*	.024*	0.41
Bedtime Resistance	20.70	15.04	-1.596	.111	.135	0.25
Sleep Duration Problems	20.84	14.82	-2.119	.034*	.045*	0.33
Sleep Anxiety	20.11	15.96	-1.173	.241	.267	0.17
Sleep Onset Delay	19.80	16.46	-1.342	.180	.210	0.19
Night Wakings	19.82	16.43	-1.042	.297	.323	0.15
Parasomnias	21.66	13.54	-2.425	.015*	.045*	0.36
Sleep Disordered Breathing	19.95	16.21	-1.507	.132	.158	0.22
Daytime Sleepiness	12.77	11.64	-0.873⁺	.389	.420	0.14
Inattention Total Score	16.86	12.92	-2.579	.015*	.045	0.36
Hyperactivity/Impulsivity Total Score	20.55	13.69	-1.932	.053	.070	0.30
Oppositional Defiant Total Score	6.77	2.08	-3.733	.001**	.007*	0.49
Conduct Disorder Total Score	19.48	15.50	-1.512	.130	.156	0.22
Barkley Child Attention Scale Total Score	20.29	16.14	-2.630	.006*	.027*	0.38

Note. ⁺t-test was applied for variables marked with a plus sign; Mann-Whitney U test was applied for the others.
Note. Functional impairment was defined as a mean score ≥1.5 on WFIRS-P subscales; impairment in ≥ 2 subscales was classified as overall functional impairment. Multiple comparisons were adjusted using the Benjamini□Hochberg False Discovery Rate (FDR) correction. *p < .05; **p < .01.

Table 6. Binomial logistic regression analysis of CSHQ Total Score, Sleep Duration Problems, Parasomnia Scores, Inattention/Oppositional Defiant Total Score and the Barkley Child Attention Scale Total Score predicting functional impairment in the ADHD-R group

Weiss Total Functional Impairment (Present/Absent)	B	S.E.	Wald	df	Sig.	q (FDR)	Exp(B)	95% C.I. for Exp(B)
								Lower
CSHQ Total Score	0.254	0.173	2.155	1	.142	.158	1.289	0.918
Sleep Duration Problems	2.378	1.530	2.417	1	.120	.144	10.782	0.538
Parasomnias	1.100	0.893	1.519	1	.218	.218	3.005	0.522
Inattention Total Score	0.037	0.201	0.034	1	.854	.854	0.964	0.650
Oppositional Defiant Total Score	0.475	0.242	3.846	1	**.050**	**.050**	1.608	1.000
Barkley Child Attention Scale Total Score	0.363	0.318	1.304	1	.254	.254	1.438	0.771

Note. *p<.05; *p<.01

DISCUSSION

This study aims to examine the rates of functional impairment in ADHD-R and ADHD-PI groups, as well as factors that may affect this impairment, including ADHD symptom severity, ODD scores, sleep disturbances, and chronotype characteristics. The current definition of ADHD-PI allows inclusion of children with ADHD-C who exhibit subthreshold hyperactivity/impulsivity symptoms. Increasing evidence suggests that the ADHD-R phenotype may differ from ADHD-PI in genetic, neuropsychological, and neurobiological characteristics (3,5). Therefore, it is important to evaluate a more homogeneous group that does not exhibit H/I symptoms separately. Previous studies have linked inattention with eveningness and found that the ADHD-PI group experiences greater daytime sleepiness than other subtypes (6,11,12,18–22,31). This study is the first to subjectively assess functionality, chronotype preferences, and sleep disturbances in children diagnosed with ADHD-R. By controlling confounding variables such as psychiatric comorbidities, elevated CDS symptoms, cognitive level, and medication use, the relationships among chronotype preferences, sleep disturbances, and functional outcomes were comprehensively examined in both ADHD-R and ADHD-PI groups. Previous studies have reported an association between inattentive symptoms and eveningness tendency(31,40). However, the present study, differing methodologically, did not focus on the correlation between inattentive symptoms and eveningness. Instead, we compared the prevalence of eveningness across the ADHD-PI, ADHD-R, and control groups and identified the intermediate chronotype as the most common preference. Although this finding has been reported in some studies, the results in the literature remain inconsistent(40,54,55) Such inconsistency may be attributed to differences in sample age ranges and the predominant focus on the ADHD-C in previous research.

Our findings demonstrated that both ADHD groups exhibited significantly greater functional impairment compared to control group, and that sleep disturbances were associated with specific

Table.7 Comparison of Chronotype scale total score, CSHQ scores, Turgay Scale Total Scores (Inattention, Hyperactivity/Impulsivity, Oppositional Defiant, and Conduct Disorder), the Barkley Child Attention Scale Total Score in relation to overall functional impairment (WFIRS-P) in the ADHD-PI group

Variable	Impairment Present (n=23)	No Impairment (n=11)	Z/t	p-value	q (FDR)	(d / r)
Sleep Onset Time on Scheduled Days(minutes)	9.04	8.73	-0.806⁺	.426	.455	0.13
Sleep Onset Time on Free Days(minutes)	20.22	11.82	-2.349	.019*	.045*	0.34
Total Sleep Duration	9.39	8.89	-1.388⁺	.175	.195	0.22
Chronotype Scale Score	30.57	28.82	-0.807⁺	.426	.455	0.13
CSHQ Total Score	18.28	15.86	-0.664	.507	.525	0.10
Bedtime Resistance	18.50	15.41	-0.860	.390	.412	0.16
Sleep Duration Problems	15.48	21.73	-1.929	.054	.072	0.29
Sleep Anxiety	17.30	17.91	-0.170	.865	.875	0.03
Sleep Onset Delay	16.63	19.32	-0.892	.372	.398	0.14
Night Wakings	17.70	17.09	-0.190	.849	.865	0.03
Parasomnias	20.28	11.68	-2.526	.012*	.032*	0.37
Sleep Disordered Breathing	19.48	13.36	-2.028	.043*	.049*	0.29
Daytime Sleepiness	12.52	11.73	-0.703⁺	.487	.512	0.11
Inattention Total Score	17.35	16.18	-0.862	.396	.422	0.13
Hyperactivity/Impulsivity Total Score	9.74	10.00	0.190	.530	.555	0.09
Oppositional Defiant Total Score	6.35	5.18	-0.724	.095	.112	0.27
Conduct Disorder Total Score	18.17	16.09	-0.657	.511	.534	0.10
Barkley Child Attention Scale Total Score	17.43	20.55	1.572	.136	.156	0.23

Note. ⁺*t-test was applied for variables marked with a plus sign; Mann-Whitney U test was applied for the others.* *p < 0.5; **p<0.01 Note. Functional impairment was defined as a mean score ≥ 1.5 on WFIRS-P subscales; impairment in ≥ 2 subscales was classified as overall functional impairment.

Table 8. Binomial logistic regression analysis of Sleep Onset Time on Free Days, Parasomnia Scores and Sleep -Disordered Breathing Score predicting functional impairment in the ADHD-PI group

Weiss Total Functional Impairment (Present/Absent)	B	S.E.	Wald	df	Sig.	q (FDR)	Exp(B)	95% C.I. for Exp(B) Lower
Sleep Onset Time on Free Days(minutes)	1.063	0.598	3.155	1	.076	.114	2.894	0.896
Parasomnias	1.096	0.768	2.038	1	.153	.183	2.992	0.664
Sleep-Disordered Breathing	1.339	0.927	2.086	1	.149	.183	3.815	0.620

Note. *p<0.5; *p<0.01. Note. Parasomnia scores and Sleep-Disordered Breathing scores are subscales of the CSHQ.

domains of functional impairment. Consistent with prior literature, our study found that children with ADHD-PI tend to exhibit more pronounced daytime sleepiness than those with controls (13,18). However, in our sample, daytime sleepiness was not directly associated with functional impairment.

The absence of a statistically significant difference in the prevalence of sleep disturbances between the ADHD and control groups may be explained by the composition of the control group, which consisted of children recruited from outpatient clinics who may have had subthreshold psychopathologies, increasing their likelihood of experiencing sleep problems. Additionally, previous research suggests that anxiety and CDS symptoms may influence sleep functioning in the ADHD-PI subtype (24). Since children with comorbid anxiety disorders or CDS , as well as those with hyperactive or combined ADHD subtypes, were excluded from the present study, this methodological choice may also account for the lack of significant differences in sleep disturbances between groups.

In terms of functional domains, our study compared the ADHD-R and ADHD-PI groups with the control group across family, school, life skills, self-concept, social activities, and risky behaviors. The ADHD-PI group showed significantly higher functional impairment across all domains compared to controls. Notably, the ADHD-PI group exhibited greater impairment in risky behaviors than the ADHD-R group, which may be explained by hyperactivity/impulsivity symptoms contributing to aggressive or oppositional behaviors (5). Children in the ADHD-R group demonstrated significant impairment in school, life skills, and self-concept compared to controls. Inattentive symptoms in ADHD are associated with poor academic performance due to difficulties in focusing and completing tasks (56). Academic challenges may also contribute to social difficulties, peer rejection, isolation, frustration, and lowered self-esteem (38,57). In our study, functional impairment in at least two domains was found in 67.6% of the ADHD-PI group, 61.1% of the ADHD-R group, and only 5.9% of the control group—highlighting substantial functional deficits in both ADHD subtypes.

There were no significant group differences in the distribution of chronotype categories. However, the ADHD-R group had the highest proportion of evening-type individuals (44%) and was found to have later bedtimes and wake-up times on scheduled days compared to the other groups. This suggests a delayed circadian rhythm possibly associated with eveningness in the ADHD-R group. In the ADHD-R group, children with functional impairment exhibited higher levels of sleep disturbance (CSHQ total score), longer sleep duration, more parasomnias, more pronounced inattention and oppositional symptoms, and higher CDS scores. However, these variables did not independently predict functional impairment in regression analyses. It is possible that the increased total sleep duration—calculated including naps—may reflect higher levels of daytime sleepiness, which could indirectly contribute to functional difficulties in the ADHD-PI subtype. Additionally, parents in the ADHD-R group had significantly lower levels of education compared to other groups. Lower socioeconomic status and lifestyle factors are known to be associated with poor sleep in children (35). Suboptimal parenting practices may also contribute to increased sleep difficulties in this group.In the ADHD-PI group, children with functional impairment had longer sleep durations on free days, more parasomnias, and more sleep-disordered breathing; however, these variables did not significantly predict impairment. The limited number of cases particularly affects the regression analyses, reducing their statistical power and consequently limiting the generalizability of the findings. Variability in sleep patterns on weekdays, possibly due to insufficient sleep hygiene, may have led to compensatory longer sleep on weekends. Of particular interest, parasomnia scores were higher among functionally impaired children in both ADHD subtypes. This finding underscores the need for more objective sleep assessments in children with ADHD-PI. The key finding of this study is that even after controlling for psychiatric comorbidities, CDS symptoms, intellectual ability, and medication use, sleep disturbances remained significantly associated with overall functional outcomes. Previous studies using the same functional impairment scale (WFIRS-P) support this relationship. Virring et al. found a significant relationship between sleep problems, as measured by the CSHQ, and functional impairment assessed via the WFIRS-P in children with ADHD (22). In line with this, Craig et al. reported that sleep disturbances could predict approximately 12% of the variance in functional difficulties (13). Addressing sleep disturbances is essential to improving the overall quality of life and daily functioning in children with ADHD. Particularly in the ADHD-PI subgroup, where both pharmacological and non-pharmacological treatments may be insufficient, clinicians should routinely assess for sleep problems, parasomnias, and total sleep duration. Interventions aimed at improving sleep hygiene and resolving sleep-related issues hold promise for enhancing functional outcomes in children with ADHD.

Limitations

This study has several strengths, including the use of a homogenous clinical sample, the exclusion of psychiatric comorbidities and medical diagnoses, the inclusion of only psychotropic-naïve participants, and the exclusion of individuals with low IQ. Furthermore, the inclusion of a well-matched healthy control group and the use of well-validated tools to systematically assess sleep, chronotype, and functional impairment enhance the study's methodological rigor. However, certain limitations should be considered. The control group consisted of children who presented to the clinic but did not receive any psychiatric diagnosis. The possible presence of subclinical psychopathology in this group, which may have influenced sleep problems and sleep hygiene, is considered one of the study’s limitations. The limited sample size, particularly within subgroups, may have reduced the statistical power of the regression analyses and restricts the genera-lizability of the findings. The exclusion of all psychiatric comorbidities (excluding ODD) in the ADHD group limits the generalizability of the findings, as such ‘pure ADHD’ cases are rarely encountered in clinical practice. Since the sample was drawn from outpatient clinic admissions, its representativeness of the general population is limited. Another major limitation is the exclusive reliance on subjective parent-reported questionnaires for assessing sleep parameters, without incorporating objective measures such as actigraphy, the Multiple Sleep Latency Test (MSLT), or polysomnography (PSG). However, although actigraphy-based sleep measures did not differ significantly between 212 children with ADHD and 212 healthy controls, parent-reported sleep problems were associated with behavioral difficulties (58). Additionally, chronotype assessment was based on questionnaire data rather than biological markers such as salivary melatonin levels or basal body temperature, which may offer more direct physiological indicators of circadian preference. The rating scales used in this study did not include specific questions regarding the timing and duration of internet use, which could affect the sleep–wake cycle. Moreover, pubertal development was not assessed using the Tanner staging system, and thus adolescents were not excluded from the sample. Given the increased eveningness and greater prevalence of sleep problems associated with hormonal changes during puberty, this may have influenced the results. Finally, the cross-sectional design of this study precludes causal inferences. Longitudinal studies are needed to examine the developmental trajectory of eveningness and sleep disturbances in children with ADHD-R and ADHD-PI.

This is the first study to evaluate functional impairment, chronotype, and sleep disturbances in children with the ADHD-R. Our findings contribute to the growing literature by comparing children with ADHD-PI with and without hyperactivity symptoms, examining their chronotypic and sleep profiles, and highlighting their associations with functional outcomes.

Correspondence address: M.D., Hande Emine Sabah Baris, Bingöl State Hospital, Bingol, Türkiye
dr.handesabah@gmail.com

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