







Evaluation of the Relationship Between Attention Deficit Hyperactivity Disorder Symptoms and Chronotype

Dikkat Eksikliği Hiperaktivite Bozukluğu Belirtileri ile Kronotip Arasındaki İlişkinin İncelenmesi

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ABSTRACT

Introduction: The aim of the study is to investigate the relationship between circadian characteristics and behavioral problems in children with Attention Deficit Hyperactivity Disorder (ADHD) (n=53), and to compare this group with healthy controls (n=38).

Method: Fifty-three medication-free children with ADHD, aged 6-12 years, and 38 healthy children, age and sex matched, participated. Parents completed the Conners' Parent Rating Scale-Revised, the Children's Chronotype Questionnaire (CCTQ), and the Children's Sleep Habits Questionnaire (CSHQ) to assess sleep variables.

Results: ADHD children had more sleep-onset problems and parasomnias (in CSHQ) compared to healthy controls. However,

circadian preferences did not differ between the groups in CCTQ scores. Another important finding was a mild correlation between parasomnia, bedtime on schooldays, and ADHD symptoms.

Conclusion: Our study showed that children with ADHD showed more resistance to going to bed than did controls on school days. However, in contrast to our hypothesis, morningness/eveningness preference did not differ from controls in ADHD children.

Keywords: ADHD, sleep-wake cycle, sleep habits, circadian preference

ÖZ

Amaç: Bu çalışmada, Dikkat Eksikliği Hiperaktivite Bozukluğu (DEHB) tanılı çocuklar (n=53) ve sağlıklı kontrollerde (n=38) sirkadyen özellikler ve davranışsal sorunlar arasındaki ilişkinin incelenmesi ve karşılaştırılması amaçlanmıştır.

Yöntem: DEHB tanısı alan, daha önce tedavi almamış, 6-12 yaş arası 53 çocuk ile yaş ve cinsiyet açısından benzer özellikte olan 38 sağlıklı çocuk çalışmaya alınmıştır. Uyku ile ilgili değişkenlerin incelenmesi için ebeveynler Conners Anababa Dereceleme Ölçeği Yenilenmiş Uzun Formu, Çocuk Kronotip Ölçeği (CKÖ) ve Çocuk Uyku Alışkanlıkları Ölçeklerini (ÇUAÖ) doldurmuştur.

Bulgular: DEHB tanılı çocuklarında sağlıklı kontrollere göre daha fazla uykuya dalma ve parasomni şikayetleri vardır. Ancak, CKÖ'ye göre sirkadyen

tercihleri açısından her iki grup arasında anlamlı fark bulunmamıştır. Parasomni ve okul günleri yatakta uyku için geçirilen zaman ile DEHB belirtileri arasında orta derecede korelasyon bulunmuştur.

Sonuç: Çalışmamızda DEHB tanılı çocuklarda okul günlerinde daha fazla uykuya direnç görülmektedir. Ancak, çalışmanın hipotezinin aksine, Sabahlılık/akşamılık yönelimi açısından DEHB ile sağlıklı kontroller arasında anlamlı farklılık bulunmamıştır.

Anahtar kelimeler: DEHB, uyku alışkanlıkları, uyku-uyanıklık döngüsü, sirkadyen yönelim

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INTRODUCTION

The presence of sleep-wake problems in ADHD appears to be well established (1, 2). Circadian rhythm disruptions have a significant influence on symptoms and functioning (3). The association between the sleep-wake cycle and an individual's chronotype is known (4). One study

found an association between chronotype and manifestation of ADHD in healthy children (5). Eveningness – a tendency to sleep in later hours, and have difficulty in getting up in the morning – was associated with more externalization and inattention problems in boys. In adults, it was

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reported that eveningness is correlated with ADHD (6–8). Studies found associations between eveningness and anxious/depressive symptoms, emotional/behavioral problems (such as inattention, conduct problems, rule-breaking behaviors, substance abuse, suicidal behavior, and social problems) (9–11). On the other hand, morningness is correlated with lower depressive symptoms, attention problems, and delinquent behaviors (9, 11, 12). In summary, there might be a relationship between chronotype and ADHD.

Sleep problems were reported in approximately three-quarters of children diagnosed with ADHD (13–17). Moreover, parents complained about sleep problems in their children with ADHD, ranging between 55% and 74% (1, 15, 18–20). The sleep problems in ADHD included resistance to bed, delayed sleep onset, daytime sleepiness, tiredness (18, 21–23); frequent night waking (23–25); frequent motor movements during sleep (21); morning/daytime fatigue (23, 26); and restlessness and snoring (1, 18). Moreover, impaired or inadequate sleep in children often affects their daytime alertness, concentration, behavior, and academic performance (13, 17).

Objective measures of sleep, like actigraphy or polysomnography (PSG), have revealed mixed results (1). Neurophysiological studies have reported that children diagnosed with ADHD had abnormal patterns of sleep timing, abnormal nocturnal sleep, changed sleep, and rapid eye movement (REM) latencies (14, 23, 27). Nevertheless, despite the inconsistent results regarding objective sleep parameters, subjective reports imply significant sleep problems in ADHD.

Difficulties of sleep onset and delayed bedtime in ADHD are present either due to behavioral problems or chronotype (28). The link between ADHD and eveningness is thought to reflect the delayed timing of optimal arousal levels (3). This might represent a delay in the circadian rhythm and awakening (29, 30). Therefore, children diagnosed with ADHD may have impairment of arousal, and other factors could also disturb sleep or bedtime behavior (28).

The aim of this study was to investigate circadian preferences, sleep habits (such as bedtime resistance and sleep-onset insomnia), and ADHD symptoms in children with ADHD. In our study, we assumed that children with ADHD who were eveningness types had more inattention problems.

METHODS

Participants and Procedure

Children who had ADHD, but who were not taking medication, were recruited from the Department of Child and Adolescent Psychiatry, Istanbul University Cerrahpaşa Medical School and Kanuni Sultan Süleyman Education and Research Hospital, Clinic of Child and Adolescent Psychiatry. Controls were recruited from İstanbul Medipol University, Outpatient Clinic of Pediatrics. The study was approved by the İstanbul Medipol University Ethics Board. Consent forms were taken from all children and their parents in the study.

Fifty-three children (mean age=9.21 years, SD=1.28 years) and 38 controls aged 7–11 years (mean age=9.07 years, SD=1.43 years) were recruited. Children with ADHD were diagnosed according to DSM-IV criteria, using the Schedule for Affective Disorders and Schizophrenia for School-Age Children –Present and Lifetime Version (Kiddie-SADS) (31, 32). Exclusion criteria from the study were diagnosis of autism, Tourette's syndrome, mental retardation, and psychosis. In our study sample, 21 of 53 patients (38.2%) with ADHD received an Oppositional Defiant Disorder (ODD) diagnosis, and six of the patients (10.8%) had ADHD with other psychiatric disorders (anxiety, depression, etc.). The ADHD and healthy control group were selected from children who were not taking any medication, because this could lead to sleep problems. ADHD subtypes and comorbidity of

patients are shown in Table 1. Also, the control group, which underwent routine assessment and had no psychological or physical problems reported by their parents, was recruited from pediatric clinics. All control participants were clinically examined by pediatricians to exclude the possibility of any diseases. Twenty-eight age- and sex-matched children from pediatric clinics in the İstanbul Medipol University were assigned to the normal control group.

Psychiatric evaluations of patient and Kiddie-SADS were administered by child and adolescent psychiatry specialists enrolled in the study. After psychiatric examination, children with ADHD were asked to participate, and their parents filled out a demographic questionnaire, a Conners' Parent Rating Scale-Revised to assess ADHD (33, 34), a Children's Sleep Habits Questionnaire (CSHQ) (35), and a Children's Chronotype Questionnaire (CCTQ) scale (36), as well as a consent form.

Questionnaires

Conners' Parent Rating Scale Long Form-Revised (CPRS-R:L)

The CPRS-R:L comprises 80 items that are subdivided into 14 subscales, and assesses both internalizing and externalizing problems in children between ages 3 and 17 (33). All subscales have moderate to very good internal consistency, ranging from 0.80 to 0.85 in the Turkish population (34).

The Children's Chronotype Questionnaire (CCTQ)

The CCTQ involved questions measuring the chronotype of children. It has 27 items and a five-point chronotype (CT) score (36). The questionnaire contains: 16 items on sleep/wake parameters (e.g., bedtime, lights-off time, sleep latency, wake-up time, rising time, fully alert time, regular naps) for scheduled and free days; a 10-item M/E scale (range, 10–48); and a single-item on chronotype (CT) (range, 1–5). The CCTQ also includes a total score from the morningness/eveningness (M/E) scale (MES), which is the sum of scores of items, and ranges from 10 to 48. The scores are used to classify individuals as: morning type, intermediate type, and evening type (scores of ≤ 23 , 24–32, and ≥ 33 , respectively). It has been shown that internal consistency and external validity of the Turkish version of CCTQ were found to be sufficient to assess M/E preference (37).

Sleep Habits Questionnaire (CSHQ)

The Sleep Habits Questionnaire (CSHQ), a 33-item questionnaire, includes items exploring a number of key sleep domains and shows good validity and reliability (35). The CSHQ had eight subscales: 1) bedtime resistance (comprising six items); 2) sleep-onset delay (one item); 3) sleep duration (three items); 4) sleep anxiety (four items); 5) night waking (three items); 6) parasomnia (seven items); 7) sleep-disordered breathing (three items); and 8) daytime sleepiness (eight items). A higher score was associated with increased sleep disturbance. The Cronbach alpha coefficient was found to be 0.78, and the test-retest correlation coefficient was 0.81 in a Turkish validity study (38).

Statistical Analysis

According to the Kolmogorov-Smirnov tests, the CSHQ and CCTQ were not distributed normally. Continuous variables were analysed with the Mann-Whitney U Test and categorical variables with Chi-square analysis. Spearman correlation analysis was used for continuous variables. SPSS 20 (Statistical Package for the Social Sciences Inc; Chicago, IL, ABD) was employed in all statistical tests.

RESULTS

Demographic and clinical characteristics of the ADHD and the control groups are shown in Table 1. For age and sex, no significant differences were found between the groups ($p > 0.05$). By contrast, the mean scores of

Table 1. Demographic and clinical characteristics of the ADHD and control groups

	Case (n=53)	Control (n=38)	p
Age	9.21 (1.28)	9.07 (1.43)	0.612
Male (%)	45 (81.8)	28 (70)	0.178
ADHD combined type	40 (75.5)	-	
ADHD inattentive type	11 (20.8)	-	
ADHD hyperactivity type	2 (3.8)	-	
ADHD with ODD	21 (38.2)	-	
ADHD with other psychiatric disease*	6 (10.8)	-	
Intermediate type	2	1	NS
Eveningness	47 (95.9)	35 (97.2)	

ADHD: Attention Deficit Hyperactive Disorder
 ODD: Oppositional Defiant Disorder
 * depression, anxiety or any other disorder

Table 2. Mean scores of Conners' Parent Rating Scale (Revised Long Version) in the ADHD and control groups

Conners' Subscales	ADHD (SD)	Control (SD)	p
Oppositional	18.8 (6.5)	8.1 (5.6)	<0.05
Cognitive Problems/Inattention	24.8 (7.5)	9.4 (6.7)	<0.05
Hyperactivity	16.4 (5.7)	6.8 (5.1)	<0.05
Anxious-Shy	10.4 (4.8)	7.3 (5.1)	<0.05
Perfectionism	6.5 (3.8)	7.1 (3.6)	<0.05
Social Problems	5.3 (2.6)	2.6 (2.0)	<0.05
Psychosomatic	5.2 (4.2)	3.0 (2.4)	<0.05
ADHD Index	26.9 (6)	11.2 (7.4)	<0.05
Global Index	19.0 (6)	8.2 (6.4)	<0.05

all items in the Conners' Parent Rating Scale (Revised, Long Version) were significantly different between the ADHD and control groups (Table 2).

Tables 3 and 4 show the mean scores of CSHQ and CCTQ in children with ADHD and the controls. In CSHQ, the ADHD group had higher scores for bedtime resistance (U=713.5, N=91, p=0.023), parasomnias (U=587.5, N=87, p=0.003), and total sleep problems (U=593.5, N=85, p=0.018). In CCTQ, there were no significant differences between the ADHD and the healthy control group. In addition, no significant difference was found between M/E preferences (p >0.05). The eveningness type was mostly reported in the ADHD group (95.9%; n=47) and the control group (97.2%;

Table 3. Mean scores of Child Sleep Habit Questionnaire (CSHQ) between the ADHD and control groups

	ADHD (SD)	Control (SD)	p*
Bedtime resistance	12.5 (2.5)	11.3 (2)	0.023
Sleep-onset delay	2.6 (0.4)	2.7 (0.4)	NS
Sleep duration	6.9 (0.7)	6.8 (0.7)	NS
Sleep anxiety	7 (2.2)	6.2 (2.3)	NS
Night wakings	4.2 (1.4)	3.8 (1.2)	NS
Parasomnias	9.5 (2)	8.2 (1.5)	0.003
Sleep disordered breathing	3.6 (1)	3.4 (0.6)	NS
Daytime sleepiness	15.4 (3.2)	14.9 (2.6)	NS
Total sleep problems	61.9 (7.7)	57.7 (7.4)	.018

*Mann-Whitney Analysis

Table 4. Mean scores of Children Chronotype Questionnaire (CCTQ) between the ADHD and control groups

	ADHD (SD)	Control (SD)	p*
Morningness/Eveningness score	50.3 (14.1)	49 (9.8)	NS
Sleep period in scheduled days (h: min)	8:47 (1:18)	8:54 (1:13)	NS
Sleep period in free days (h: min)	9:21 (1:11)	9:45 (1:12)	NS
Time in bed in scheduled days (h: min)	9:37 (1:14)	9:21 (0:59)	NS
Time in bed in free days (h: min)	9:43 (1:36)	10:28 (1:38)	NS
Sleep inertia in scheduled days (min)	23 (23)	17 (20)	NS
Sleep inertia in free days (min)	25 (22)	18 (20)	NS

*Mann-Whitney Analysis

n=35), but the morningness type was not. Only two patients in the ADHD group and one child were reported as intermediate types.

The Spearman correlation coefficients for the ADHD group indicated that the symptoms of ADHD were mostly weakly associated with sleep habits and chronotype features (Table 5). In contrast to our hypothesis, there were no significant correlations between the MES score and the symptoms of ADHD. Hyperactivity had a significant positive correlation with Parasomnia (r=0.522; p<0.001), Sleep Anxiety (r=0.311; p<0.01), Total Sleep Problems (r=0.539; p<0.001), and a negative one with Bedtime on Scheduled Days (r=-0.444, p<0.001). Anxious-Shy was correlated

Table 5. Correlation analysis of sleep habits, chronotype preferences and ADHD symptoms in the ADHD group

	MEQ	BR	P	SD	SA	TSP	WSD	GSD	ASD	SOF	BSD
ODD	0.153	0.071	0.302	0.258	0.171	0.313	-0.031	0.018	0.011	0.120	-0.162
INAT	0.032	0.008	0.231	0.014	-0.179	0.110	-0.208	-0.209	-0.133	0.133	-0.303*
HA	0.066	0.502**	0.522**	0.158	0.311*	0.539**	-0.304	-0.232	-0.208	0.203	-0.444**
AS	0.130	0.261	0.092	0.067	0.458**	0.347	-0.196	-0.265	-0.213	-0.033	-0.164
IMP	0.009	0.130	0.518**	0.182	0.050	0.272	-0.189	-0.147	-0.105	0.195	-0.420**
CI	0.011	0.076	0.482**	0.056	0.020	0.282	-0.261	-0.222	-0.204	0.049	-0.291

* p<0.01; ** p<0.001

ODD: Conners' Oppositional Defiant Disorder; INAT: Conners' Cognitive Inattention; HA: Conners' Hyperactivity; AS: Conners' Anxious-Shy; IMP: Conners' Impulsivity; CI: Conners' Attention Deficit Hyperactivity Disorder Index; MEQ: Morningness/Eveningness Questionnaire score; BR: Bedtime Resistance; P: Parasomnias; SD: Sleep Duration; SA: Sleep Anxiety; TSP: Total Sleep Problems; WSD: Wake-up on Scheduled Days; GSD: Get-up (rise) on Scheduled Days; ASD: Fully Awake on Scheduled Days; SOF: Sleep Onset on Free days; BSD: Bedtime on Scheduled Days

with Sleep Anxiety ($r=0.458$; $p=0.001$) and Impulsivity with Parasomnia ($r=0.518$, $p<0.0005$). There was a significant negative correlation between impulsivity and Bedtime on Scheduled Days ($r=-0.420$, $p<0.001$). Inattention was negatively correlated with Bedtime on Scheduled Days ($r=-0.303$; $p<0.01$). There was also a positive correlation between ADHD index scores and Parasomnia ($r=0.482$; $p<0.001$).

DISCUSSION

In this study, we investigated whether chronotype preferences were correlated with ADHD symptoms. Inconsistent with our hypothesis, M/E preference did not differ significantly between ADHD and controls in our study. However, our study revealed more resistance to bed in children with ADHD than in controls. Another important finding was that ADHD symptoms were mildly correlated with parasomnia and bedtime to sleep.

In studies focusing on circadian rhythms in ADHD, inconsistencies were reported regarding circadian characteristics such as time of falling asleep, disturbed sleep phases, time of awakening, and daytime sleepiness. In transition from childhood to adolescence, there is an emerging delayed phase of sleep such as falling asleep later, and difficulty in waking up early (39). As children get older, they go to bed later; most adolescents have great difficulty in waking up on school mornings (40). It was thought that there might be an association between ADHD symptoms and biological rhythm shift (3). In line with this, a study suggested that melatonin releasing at night, which indicates circadian function, was delayed in children with ADHD (30). In adult ADHD, the severity of symptoms was correlated with eveningness, and light therapy ameliorated scores of neuropsychological scales (8, 41). Gruber et al. (28) suggested that resistance to bedtime is related to delayed circadian rhythms in children with ADHD. In contrast to our hypothesis, medication-free children with ADHD did not differ significantly from control group according to circadian preferences. Contrary to the above-mentioned consideration, our result might have been due to that a circadian shift did not appear in children younger than 12-year-old.

Some authors described more difficulties with awakenings in the morning (17, 21, 42). Likewise, our findings supported the finding that delayed wake-up time was seen in children with ADHD. Although we did not find any circadian preferences in ADHD, delayed awakening might reflect an impaired sleep-wake cycle. The tendency to wake up late may result in or exaggerate ADHD symptoms because of the need for longer sleep or maladaptation of social life requirements, such as problems of getting ready for school in morning.

In children with ADHD, disturbance in initiating (e.g., delayed sleep onset) and maintaining sleep (e.g., night waking) were sleep problems that their parents frequently complained about (15, 39, 40). In our study, resistance to bed, delayed bedtime, and total sleep problem significantly differed from the control group, but we did not find an association with night waking. Similar to Yürümez et al. (17), sleep problems were correlated with hyperactivity in our study. In addition, we found that bedtime on scheduled days was negatively correlated with hyperactivity and impulsivity symptoms. Although there were greater sleep problems regardless of differences in chronotype, this might have been associated with “oppositional-defiant disorder”. In ODD, there were seen more problems to get ready for bed (1, 43).

There were several limitations in this study. First of all, small sample size of our study made it difficult to generalize our findings. Secondly, the Turkish version of CCTQ might not have had enough sensitivity and specificity to assess preferences of morningness and eveningness. The third limitation was that in both groups, almost all parents reported their children as eveningness type. This might have resulted from inadequate

sensitivity and specificity of CCTQ. Another important limitation was that the assessment of sleep parameters were only gathered from subjective parent-forms rather than objective measures such as actigraphy. In rating scales, there were no questions related to the use of the internet, which may have an influence on sleep-wake cycle. Comorbid disorders with ADHD such as depression, anxiety etc., were not analysed statistically because of inadequate number of comorbid cases.

Overall, our findings did not support chronotype preferences in ADHD children who are medication-free. There is not enough data to support a correlation between circadian preferences and ADHD symptoms. Despite of limitations mentioned above, our study revealed problems in sleep habits consistent with the literature.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of İstanbul Medipol University (07/11/2014, 250)

Informed Consent: Written informed consent was obtained from parents of patients who participated in this study.

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Author Contributions: Concept - MCT, MTK, FE; Design - MCT, MTK; Supervision - FE, UMA; Resource - MCT, GAG; Materials - MTK, MCT; Data Collection and/ or Processing - MCT, GAG, FE; Analysis and/ or Interpretation - BÇP, MCT, MT; Literature Search - GAG, MCT; Writing - MCT, MTK; Critical Reviews - FE, BÇP, UMA.

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