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The Role of Cognitive Disengagement Syndrome Symptoms in the Association Between ADHD Symptoms and Sleep Problems: Findings from An Epidemiological Survey

DEHB Bulguları ve Uyku Problemleri Arasındaki İlişkide Bilişsel Kopma Sendromu Bulgularının Rolü: Epidemiyolojik Bir Çalışmadan Bulgular

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Öz

Yavaşlık ve gündüz düşleriyle karakterize bir tanılararası yapı olan Bilişsel Kopma Sendromu (BKS) Dikkat Eksikliği Hiperaktivite Bozukluğu (DEHB) ile ilişkilidir. Çalışmamızda bir Türkiye epidemiyoloji örnekleminde DEHB ve uyku bozuklukları arasındaki ilişkide BKS'nin aracı rolünün araştırılması amaçlanmıştır. Örneklemi Türkiye'deki dört şehirden 7-11 yaşları arasındaki 268 olgu oluşturmuştur. Ebeveynler DEHB bulguları için Turgay DEHB Ölçeği'nin dikkat eksikliği (DE) ve hiperaktivite/impulsivite (HI) alt ölçeklerini, BKS bulguları için Barkley Çocuk Dikkat Anketini (BÇDA) ve uyku problemleri için Çocuk Uyku Alışkanlıkları Anketini (ÇUAA) doldurmuşlardır. Korelasyon analizlerinde DE ve ÇUAA skorları arasında ($r=0.406$, $p=0.001$), HI ve ÇUAA skorları arasında ($r=0.381$, $p<0.001$) ve BÇDA ve ÇUAA skorları arasında ($r=0.404$, $p<0.001$) anlamlı ilişkiler saptandı. Regresyon modelleri BKS'nin DE bulguları ve uyku sorunları arasındaki ilişkiye tümüyle aracılık ettiğini ortaya koydu. BKS modele dahil edildiğinde DE'nin uyku problemleri üzerindeki etkisi anlamsızlaştı ($\beta=0.094$, $p=0.284$); ancak BKS anlamlı bir yordayıcı olarak kalmaya devam etti ($\beta=0.249$, $p=0.001$). Ancak HI bulguları uyku bozukluklarıyla doğrudan ilişkisini BKS'den bağımsız olarak sürdürdü ($\beta=0.304$, $p<0.001$). Anne yaşı ise ÇUAA skorlarıyla ters ilişkiyle koreleydi ($r=-0.148$, $p=0.033$); ancak bu ilişki regresyon analizinde anlamlı düzeyde değildi ($\beta=-0.092$, $p=0.144$). Bu bulgular, BKS'nin DE bulgularının uyku bozukluklarını nasıl etkilediği konusunda kritik bir mekanizma olarak işlev görebileceğini vurgulamaktadır. BKS'nin aracı rolü, dikkat güçlüklerinin uyku bozukluklarına nasıl katkıda bulunduğunu anlamak için tanı ötesi bir çerçeve sağlamakta ve DEHB'li çocuklarda uyku kalitesini iyileştirmeyi amaçlayan müdahalelerde BKS belirtilerini ele almanın kritik bir hedef olduğunu ortaya koymaktadır.

Anahtar Kelimeler: Bilişsel Kopma Sendromu, Dikkat Eksikliği/ Hiperaktivite Bozukluğu, Epidemiyoloji, Uyku Bozuklukları, Yavaş Bilişsel Tempo

Abstract

Cognitive Disengagement Syndrome (CDS), a transdiagnostic construct characterized by sluggishness and daydreaming, was associated with Attention-Deficit/ Hyperactivity Disorder (ADHD). Our study investigated the mediating role of CDS in the relationship between ADHD and sleep disturbances in a Turkish epidemiological sample. The sample consisted of 268 children aged 7-11 from four Turkish cities. Parents completed inattention (IN) and hyperactivity/impulsivity (HI) subscales of Turgay's ADHD Rating Scale IV for ADHD symptoms, Barkley's Child Attention Scale (BCAS) for CDS symptoms, and Children's Sleep Habits Questionnaire (CSHQ) for sleep problems. Correlation analyses revealed significant associations between IN and CSHQ scores ($r=0.406$, $p=0.001$), HI and CSHQ scores ($r=0.381$, $p<0.001$), and BCAS and CSHQ scores ($r=0.404$, $p<0.001$). Regression models demonstrated that CDS fully mediated the relationship between IN symptoms and sleep disturbances. When CDS was included in the model, the direct effect of IN on sleep problems became non-significant ($\beta=0.094$, $p=0.284$), whereas CDS remained a significant predictor ($\beta=0.249$, $p=0.001$). HI symptoms, however, retained a direct association with sleep disturbances ($\beta=0.304$, $p<0.001$), independent of CDS. Maternal age was inversely correlated with CSHQ scores ($r=-0.148$, $p=0.033$), but the relationship was not significant in regression analysis ($\beta=-0.092$, $p=0.144$). These findings emphasize that CDS may serve as a critical mechanism through which IN symptoms influence sleep disturbances. The mediating role of CDS provides a transdiagnostic framework for understanding how attentional difficulties contribute to sleep disturbances and underlines the importance of addressing CDS symptoms as a critical target for interventions aimed at improving sleep quality in children with ADHD.

Keywords: Cognitive Disengagement Syndrome, Attention-Deficit/Hyperactivity Disorder, Epidemiology, Sleep Disorders, Sluggish Cognitive Tempo

Introduction

Cognitive Disengagement Syndrome (CDS), previously referred to as Sluggish Cognitive Tempo (SCT), is characterized by symptoms such as frequent daydreaming, difficulty remaining alert, a perplexed demeanor, vacant stares, and sluggish movements (1,2). Historically categorized as a

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subtype of Attention-Deficit/Hyperactivity Disorder (ADHD), this conceptualization has been dismissed for over 15 years. Instead, researchers have advocated for recognizing CDS as a transdiagnostic construct (3). In response, a specialized working group on sluggish cognitive tempo proposed the terminological shift to "Cognitive Disengagement Syndrome" to better reflect its distinctiveness (4).

While CDS has gained recognition as either a syndrome or a transdiagnostic construct, it has yet to be integrated into international psychiatric classification frameworks such as the Diagnostic and Statistical Manual of Mental Disorders (DSM). Despite its growing recognition as a clinical entity that intersects with ADHD while remaining independent (5,6), the absence of formal diagnostic criteria poses significant challenges for its identification in clinical practice. This limitation is particularly concerning given the detrimental effects of CDS on various aspects of life, including interpersonal relationships (7), academic achievement (8,9), patterns of comorbidity (2), and exposure to stressful life events (10).

A significant portion of the literature has centered on exploring the relationship between CDS and ADHD. Research indicates that symptoms of CDS are present in 30%–63% of individuals with inattentive presentation of ADHD, and ADHD is diagnosed in up to 59% of individuals with CDS (11,12). Additionally, the frequent co-occurrence of CDS with internalizing disorders, such as anxiety and depression, has been well-documented (1,13,14). A recent study found that children diagnosed with CDS tend to exhibit higher levels of asocial behavior, shyness, and a lack of social interest compared to their peers without the condition (15).

Sleep problems in childhood population accompany most psychiatric and neurological conditions. Studies have shown that sleep difficulties have unique associations with behavioral problems, and are at elevated levels in children with developmental disabilities such as autism and intellectual disability (16–18). Another significant psychiatric condition to be associated with sleep problems is ADHD, which is often associated with sleep problems, with prevalence estimates for sleep problems in adolescents with ADHD ranging from 23% to 73% (19–21). There is no clear consensus in the literature as to which symptom dimension of ADHD is more associated with sleep problems. While some studies claim that hyperactivity/impulsivity presentation of ADHD (ADHD-HI) is less associated with daytime inadvertent napping compared to combined and inattentive presentations of ADHD (22), diverse studies document that chronic nocturnal snoring is seen more frequently in children with ADHD-HI (23).

Since the researchers have well documented the association between ADHD and CDS for the last 20 years, sleep problems, which have been well documented to be in relation to ADHD, have been started to be investigated for possible relationships with CDS by researchers. Sleep problems and daytime sleepiness in youth have been uniquely linked to CDS based on parent reports (24–26). Among college students and adults, CDS has been associated with overall sleep difficulties, reduced sleep duration, and greater daytime sleepiness (27,28). In a population-based sample of children, parent-rated CDS showed no significant correlation with 14 polysomnography sleep indices (29). For adolescents with and without ADHD, self-reported CDS symptoms were uniquely related to shorter sleep duration and later sleep onset, as measured by actigraphy, but were not linked to sleep efficiency or wake time (26). The sole study investigating CDS in relation to sleep disorder diagnoses found no associations with behavioral or psychophysiological insomnia, although other disorders such as parasomnia and delayed sleep phase syndrome were not examined (24).

A review of the literature reveals that the role of CDS symptoms as a key factor in the causal relationship between sleep problems and ADHD symptoms in children has not been sufficiently explored in epidemiological samples. Moreover, since the majority of existing studies have been conducted in Western countries, it is of critical importance to investigate the pivotal role of CDS in the association between ADHD and sleep problems within an epidemiological sample from a country like Turkey, which embodies a genetic harmony between Eastern and Western populations. Unveiling transdiagnostic constructs such as CDS that underlie the established association between ADHD and sleep problems will contribute to a deeper understanding of the neurodevelopmental nature of sleep disturbances in children and

adolescents with ADHD. From this perspective, the aims of our study were: (1) to investigate whether a significant relationship exists between ADHD and sleep problems in a childhood epidemiological sample in Turkey, and (2) if such a relationship is present, to elucidate the mediating role of CDS symptoms in this association. We hypothesized that significant associations would exist between ADHD and sleep problems in a Turkish childhood epidemiological sample, and that CDS symptoms would serve as significant mediators in these associations.

Material and Method

Study Design

This research was part of a broader investigation examining the epidemiological characteristics of CDS among Turkish children (30). Conducted as a multi-centered, cross-sectional study, it targeted second-, third-, and fourth-grade students residing in four metropolitan cities of Turkey: İzmir, Bursa, Kocaeli, and Kayseri. Ethical approval was obtained from the Ege University Ethical Committee of Clinical Research (decision no: 15-11/3, date: 04.12.2015).

Sample

Prior to participant recruitment, a power analysis was performed to calculate the minimum required sample size. Based on a CDS frequency of 4.96% (6), a variance level of 4%, an effect size (Cohen's w) of 0.80, and a 95% confidence interval, the minimum sample size was determined to be 265 children. To ensure representative sampling, a randomized stratification method was employed, incorporating socioeconomic status categories (low, middle, high) as classified by the Provincial Directorate of National Education in each city. Eleven schools and 42 classrooms were selected, and students placed fourth and multiples of four on class lists were chosen. After removing cases with incomplete data, the study sample comprised 268 children aged 7 to 11 years. The children (1) whose ages were between 7 and 11 and (2) attended second, third, and fourth grade of elementary school were included in the study. The children (1) who were outside the age of 7-11, or (2) did not attend second, third, and fourth grade of elementary school were excluded from the study. Due to the epidemiological nature of the sample, comorbid psychopathology was not used as an exclusion criterion to ensure that the natural representativeness of the sample was not compromised.

Measurement Tools

Barkley's Child Attention Scale (BCAS) was developed by Russell Barkley (2,5), This 12-item scale measures two dimensions of CDS: "sluggishness" and "daydreaming." The original version demonstrated excellent internal consistency (Cronbach's $\alpha = 0.934$) and high test-retest reliability ($r = 0.840$). The Turkish adaptation, validated in 2018 (31), showed internal consistency scores of 0.86 for the total scale, 0.83 for the daydreaming dimension, and 0.80 for the sluggishness dimension. Scores range from 12 to 48, and Barkley's symptom count method was used to identify cases with significant CDS symptoms. Participants were classified as meeting the CDS threshold if at least three items were rated as "often" or "very often" (2). The Cronbach's α value was measured as 0.877 for parent-rated BCAS items in the present study.

DSM-IV Disruptive Behavior Disorders Rating Scale (Turgay's ADHD Rating Scale IV – ADHD-RS-IV) was created by Turgay (32) based on DSM-IV criteria. This scale includes nine items for inattention, nine for hyperactivity/impulsivity, eight for oppositional defiance, and 15 for conduct disorder. Symptoms are rated on a four-point Likert scale (0 = not at all, 1 = just a little, 2 = quite a bit, 3 = very much). The Turkish adaptation, validated by Ercan (33), was used in this study to assess inattention and hyperactivity-impulsivity.

Children Sleep Habits Questionnaire (CSHQ) was designed by Owens et al. (34) to assess sleep-related problems in children. This 33-item questionnaire was adapted for Turkish populations by Perdahlı Fiş et al. (35). Items are scored on a three-point scale based on frequency: 3 (5-7 times per week), 2 (2-4 times per week), and 1 (0-1 times per week). Certain items (item 1, item 2, item 3, item 10, item 11, and item 26) are reverse-scored, and items 32 and 33 are scored uniquely. A score of 42 or higher indicates clinically significant sleep problems.

The Schedule for Affective Disorders and Schizophrenia for School-Aged Children, Present and Lifetime Version (K-SADS-PL) is a semi-structured interview designed to identify both current and past psychopathologies in children and adolescents. Diagnostic assessments are grounded in the criteria outlined in the DSM-IV. The tool is divided into three sections: an unstructured initial interview, a screening segment for diagnosis, and a general evaluation scale for children. Originally developed by Kaufman et al. (36), the Turkish version's validity and reliability were assessed by Gökler et al. (37).

Procedures

The study followed a structured process to collect data: First, parents of the participants were contacted and invited for a clinical interview. They were also asked to evaluate their children by completing the BCAS, the CSHQ and ADHD-RS-IV. Afterwards, the K-SADS-PL were conducted with the children and their parents to identify potential psychopathological conditions. Apart from

the K-SADS-PL, a separate psychiatric interview based on DSM-5 diagnostic criteria was conducted with the participants by senior child psychiatrists who were blinded to the K-SADS-PL assessment. In accordance with these two interviews, children's final psychopathology status was determined. This comprehensive approach ensured a robust evaluation of existing psychopathologies, CDS and related variables, incorporating input from caregivers alongside clinical assessments. Regardless of whether they had a diagnosis based on psychiatric interviews, the symptoms of CDS, ADHD, and sleep problems, as measured by the BCAS, CSHQ, and ADHD-RS-IV scales completed for all participants in the sample, were evaluated together.

Statistical Analysis

The statistical analyses were conducted using SPSS Version 26.0 (IBM Corporation, Armonk, NY). Data were first assessed for normality using the Kolmogorov-Smirnov and Shapiro-Wilk tests, with non-parametric tests applied due to deviations from normality. Descriptive statistics, including medians and interquartile ranges (IQR), were calculated for continuous variables, while frequencies and percentages were used for categorical data. Continuous variables between two groups were compared with two independent sample t-tests (mean ± standard deviation), if they are normally distributed; they were evaluated by the Mann-Whitney U-test, if not normally distributed. The relationships between quantitative variables were evaluated through bivariate Spearman correlation analyses. This approach was chosen given the ordinal nature of some scales and the lack of normal distribution for several variables. The variables found to be associated with CSHQ scores in these analyses were determined as independent variables in multiple linear regression analyses. To identify predictors of CSHQ scores, a series of hierarchical multiple linear regression models were constructed. Adjusted R^2 values were reported for each model to evaluate the proportion of variance explained, and the significance of individual predictors was determined using standardized β coefficients and corresponding p-values. All the multiple regression models did not have any issue on multicollinearity since all the variance inflation factors for each variable were less than 2.0 in all the analyses. Statistical significance was set at $p < 0.05$, and all tests were two-tailed.

Results

Participant Demographics

The study included a total of 268 children, comprising 144 boys (53.7%) and 124 girls (46.3%). The median age of participants was 9 years (IQR = 1). Mothers' median age was 35 years (IQR = 6), while fathers' median age was 38 years (IQR = 8). Parental education levels varied, with 38.2% of mothers and 22.6% of fathers having completed primary school, and 31.5% of mothers and 40.8% of fathers having completed high school. University education was attained by 10.1% of mothers and 15.5% of fathers. Psychopathology was more prevalent in mothers (9.6%) compared to fathers (3.7%). The psychopathology distribution of the sample was as follows: 68 children (25.3%) with ADHD, 6 (2.2%) with depression, 55 (20.5%) with any anxiety disorder, 2 (0.7%) with obsessive-compulsive disorder, 10 (3.7%) with oppositional defiant disorder, 6 (2.2%) with tic disorder, 2 (0.7%) with communication disorder, 19 (7%) with enuresis, 5 (1.8%) with encopresis, and 3 (1.1%) with post-traumatic stress disorder. Participant demographics is presented in Table 1.

Table 1. Participant Demographics

	n	%
Gender[1]		
Boy	144	53.7
Girl	124	46.3
Maternal Education[2]		
No education	5	1.9
Primary school	102	38.2
Secondary school	49	18.4
High school	84	31.5
University	27	10.1
Paternal Education[3]		
No education	2	0.8
Primary school	60	22.6
Secondary school	54	20.4
High school	108	40.8
University	41	15.5
Maternal Psychopathology[4]		
No	227	90.4
Yes	24	9.6
Paternal Psychopathology[5]		
No	236	96.3
Yes	9	3.7
	Median	IQR
Age	9.00	1.00
Maternal age	35.00	6.00
Paternal age	38.00	8.00

IQR: Interquartile range, 1n = 268; 2n = 267; 3n = 265; 4n = 251; 5n = 245

Possible Variables Associated with CSHQ

The bivariate Spearman correlation analysis revealed several significant relationships involving the CSHQ scores (Table 2). CSHQ scores showed a significant inverse correlation with maternal age ($r = -0.148$, $p = 0.033$), indicating that younger maternal age was associated with more severe sleep problems in children. BCAS scores were positively correlated with CSHQ scores ($r = 0.404$, $p < 0.001$), highlighting that greater CDS symptoms were linked to increased sleep disturbances. ADHD symptomatology, as measured by the ADHD-RS-IV subscales, was also significantly associated with CSHQ scores. Both IN scores ($r = 0.406$, $p < 0.001$)

Table 2. Bivariate Spearman Correlation Matrix

	1	2	3	4	5	6	7	8	9
1. age	-								
2. maternal age	0.092^{ns}	-							
3. paternal age	0.144*	0.817**	-						
4. maternal education	-0.012^{ns}	0.051^{ns}	0.055^{ns}	-					
5. paternal education	-0.006^{ns}	0.035^{ns}	0.013^{ns}	0.500**	-				
6. BCAS score	-0.002^{ns}	-0.133*	-0.099^{ns}	-0.011^{ns}	-0.073^{ns}	-			
7. ADHD-RS-IV IN score	-0.093^{ns}	-0.091^{ns}	-0.068^{ns}	0.038^{ns}	-0.055^{ns}	0.517**	-		
8. ADHD-RS-IV HI score	-0.117^{ns}	-0.091^{ns}	-0.122^{ns}	0.005^{ns}	-0.066^{ns}	0.325**	0.608**	-	
9. CSHQ score	-0.099^{ns}	-0.148*	-0.076^{ns}	0.125^{ns}	-0.028^{ns}	0.404**	0.406**	0.381**	-

BCAS: Barkley's Child Attention Scale; ADHD-RS-IV IN: Turgay ADHD Rating Scale-IV, Inattention subscale; ADHD-RS-IV HI: Turgay ADHD Rating Scale-IV, Hyperactivity-Impulsivity subscale; CSHQ: Children's Sleep Habits Questionnaire. ns: non-significant; *p<0.05; **p<0.01

and HI scores ($r = 0.381$, $p < 0.001$) were positively correlated with sleep problems. However, age, paternal age, and paternal education did not show significant correlations with CSHQ scores ($p = 0.152$, $p = 0.279$, $p = 0.689$, respectively). Regarding gender, no significant CSHQ score differences were observed across boys and girls ($Z = -0.077$, $p = 0.939$).

Regression Analysis

To further explore predictors of CSHQ scores, multiple linear regression models were conducted (Table 3). In the first model, IN and HI scores of ADHD-RS-IV were included as predictors, explaining 20.5% of the variance in CSHQ scores ($p < 0.001$). Both IN ($\beta = 0.237$, $p = 0.003$) and HI ($\beta = 0.281$, $p < 0.001$) scores emerged as significant predictors, suggesting that both IN and HI symptoms contribute to sleep disturbances. In the second model, BCAS scores were added as a predictor, which increased the explained variance to 24.7% ($p < 0.001$). In this model, BCAS scores were a significant predictor of CSHQ scores ($\beta = 0.249$, $p = 0.001$), while IN scores lost their significance ($\beta = 0.094$, $p = 0.284$). This indicated that CDS symptoms, measured by the BCAS fully mediated the relationship between IN scores and sleep disturbances, with the effect of inattention on sleep problems being indirect and channeled through attention difficulties as measured by the BCAS. HI scores remained significant in the second model ($\beta = 0.305$, $p < 0.001$), showing that HI directly impacted sleep problems. In the third model, maternal age was included as an additional predictor. While maternal age showed an inverse relationship with CSHQ scores ($\beta = -0.092$, $p = 0.144$), it did not significantly enhance the model's explanatory power, leaving the adjusted R^2 at 0.251 ($p < 0.001$). HI ($\beta = 0.304$, $p < 0.001$) and BCAS scores ($\beta = 0.238$, $p = 0.001$) remained the most robust predictors in the final model.

Table 3. Multiple Linear Regression Models to Predict Variables for Sleep Problems

Model	***Dependent variable: CSHQ score***	**Unstandardized Coefficients**		**Standardized Coefficients**		**p**	**Adjusted R^2**	**Model p value**
		B	Std. error	Beta	t			
1	(constant)	39.627	0.709		55.864	<0.001	0.205	<0.001
	ADHD-RS-IV IN score	0.330	0.110	0.237	2.989	0.003		
	ADHD-RS-IV HI score	0.379	0.107	0.281	3.543	<0.001		
2	(constant)	33.950	1.801		18.849	<0.001	0.247	<0.001
	ADHD-RS-IV IN score	0.131	0.122	0.094	1.074	0.284		
	ADHD-RS-IV HI score	0.412	0.105	0.305	3.939	<0.001		
	BCAS score	0.421	0.123	0.249	3.412	0.001		
3	(constant)	39.054	3.918		9.968	<0.001	0.251	<0.001
	ADHD-RS-IV IN score	0.126	0.122	0.090	1.032	0.303		
	ADHD-RS-IV HI score	0.411	0.104	0.304	3.938	<0.001		
	BCAS score	0.402	0.124	0.238	3.251	0.001		
	maternal age	-0.136	0.093	-0.092	-1.466	0.144		

BCAS: Barkley's Child Attention Scale; ADHD-RS-IV IN: Turgay ADHD Rating Scale-IV, Inattention subscale; ADHD-RS-IV HI: Turgay ADHD Rating Scale-IV, Hyperactivity-Impulsivity subscale; CSHQ: Children's Sleep Habits Questionnaire.

Discussion

This study highlights the distinct roles of ADHD symptom dimensions in their associations with sleep problems, mediated by CDS. Specifically, IN symptoms were found to be significantly associated with increased sleep disturbances, fully mediated by CDS symptoms. In contrast, HI symptoms

demonstrated a direct relationship with sleep problems, independent of CDS. Notably, these associations were observed regardless of demographic variables such as age, gender, and maternal age, underscoring the robustness of these findings. This differentiation between the pathways of ADHD symptom dimensions and their impact on sleep problems advances our understanding of the nuanced interplay between ADHD, CDS, and sleep disturbances, particularly within the unique cultural and genetic context of a Turkish epidemiological sample. By examining the mediating role of CDS, this study contributes to a growing body of evidence emphasizing transdiagnostic constructs in understanding neurodevelopmental disorders and their associated impairments.

The findings align with existing literature that identifies CDS as a transdiagnostic construct influencing various dimensions of functioning. Previous studies have established a strong connection between CDS and sleep disturbances, particularly daytime sleepiness and reduced sleep duration, across different populations (7). For instance, Langberg et al. (28) found that SCT, now reframed as CDS, was associated with daytime sleepiness, while Becker et al. (24) documented links between SCT symptoms and overall sleep difficulties in pediatric sleep disorder clinics. These studies, however, were predominantly conducted in Western populations, limiting their generalizability to diverse genetic and cultural backgrounds. The current study bridges that gap by focusing on a Turkish epidemiological study, a population with unique genetic and sociocultural characteristics. The results demonstrated that CDS symptoms, as measured by the BCAS, significantly mediated the relationship between ADHD and sleep disturbances. This finding is particularly relevant as it highlights the nuanced role of CDS in shaping the neurodevelopmental landscape of sleep problems.

Moreover, the identification of CDS as a mediator opens new avenues for targeted interventions. Recognizing and addressing CDS symptoms in children with ADHD could help alleviate associated sleep problems, ultimately improving the overall quality of life and functioning in affected individuals. Given that a decade ago CDS was defined as a disorder of cognitive arousal and awareness (2) and that neuropsychological assessments suggest CDS may be a disorder of vigilance and orientation (38), it can be anticipated that improvements in CDS symptoms would undoubtedly lead to enhancements in alertness/vigilance outcomes in affected individuals.

The interplay between ADHD, CDS, and sleep disturbances has been well-documented in previous studies. ADHD symptoms, particularly IN and HI, have been independently linked to sleep problems (19,22). However, this study provides additional insights by demonstrating that CDS symptoms mediate the relationship between ADHD inattention and sleep disturbances, suggesting that the attentional deficits associated with ADHD may indirectly exacerbate sleep problems through their impact on CDS. Supportively, it was documented that shorter sleep duration had associations IN symptoms rather than HI symptoms (39).

Interestingly, the current study found that HI symptoms retained a direct relationship with sleep disturbances even after accounting for CDS symptoms. This distinction aligns with findings by LeBourgeois et al. (23), who observed that HI symptoms were uniquely associated with chronic nocturnal snoring and other sleep disruptions. It is also well-known that HI symptoms are weakly associated or unassociated with CDS symptomatology, unlike IN symptoms (2,3,5). Considering this reality, CDS symptoms are expected not to have a mediating role in the relationship between HI symptoms and sleep problems, and our results indicate that HI symptoms have an independent effect from CDS. Such findings suggest that ADHD's symptom dimensions may influence sleep problems through distinct pathways, with CDS playing a critical mediating role for inattention but not hyperactivity/impulsivity. The current findings emphasize the importance of taking a dimensional approach to ADHD-related impairments. By disentangling the unique contributions of IN and HI to sleep problems, this study provides a more refined understanding of the underlying mechanisms. Such differentiation is essential for developing tailored therapeutic strategies that address specific symptom dimensions and their downstream effects.

The present study found a significant inverse correlation between maternal age and children's sleep problems in the correlation analysis, suggesting that younger maternal age is associated with higher sleep disturbance scores in children. However, this relationship lost its significance in the regression analysis when controlling for other variables. genetic and epigenetic factors may contribute to this relationship. Studies suggest that younger maternal age is often associated with increased risk for ADHD in the offspring (40). Given that the presence of ADHD is a risk factor for developing sleep disturbances in the offspring, it can be concluded that there might be an indirect association between younger maternal age and increased sleep problems in the offspring. These findings point to a complex interplay of environmental and genetic factors that may underlie the observed association.

The findings of this study have important implications for understanding the neurodevelopmental underpinnings of sleep problems in children with ADHD. By positioning CDS as a mediating construct, this study supports a transdiagnostic approach to understanding and

addressing sleep disturbances. This perspective aligns with the growing emphasis on transdiagnostic frameworks in mental health research, which seek to identify common underlying mechanisms across disorders rather than focusing solely on diagnostic categories (4,25). Additionally, the focus of the study on a Turkish epidemiological sample underscores the importance of considering genetic and cultural variability in neurodevelopmental research. Countries like Turkey, which embody genetic harmony between eastern and western populations, offer unique opportunities to investigate the interplay of genetic, cultural, and environmental factors in shaping neurodevelopmental disorders. Expanding this perspective to other transdiagnostic constructs, such as emotional regulation or executive functioning deficits, could further enhance our understanding of the complex interrelationships among ADHD, CDS, and sleep disturbances. Such an integrative approach would not only improve diagnostic accuracy but also inform the development of comprehensive, multi-faceted interventions.

Despite its contributions, the study has several limitations. First, the cross-sectional design precludes causal inferences about the relationship between ADHD, CDS, and sleep problems. Longitudinal studies are needed to confirm the temporal sequencing of these associations. Second, the reliance on parent-reported measures may introduce bias, particularly for subjective constructs like sleep problems. Future research should incorporate objective measures, such as actigraphy, polysomnography or quantitative electroencephalogram, to validate the findings. Moreover, the focus of the study on a specific population may limit its generalizability to other cultural and genetic contexts. Expanding research to include diverse populations and examining potential cultural moderators of the ADHD-CDS-sleep relationship would enrich the field. In addition, exploring the role of other potential mediators, such as emotional regulation difficulties or internalizing symptoms, could provide a more comprehensive understanding of the mechanisms underlying sleep problems in children with ADHD. Additionally, some of the participants included in the study sample had various psychiatric conditions, which might have caused a confounding effect on the accuracy and reliability of outcome measures such as sleep problems and CDS symptoms. Therefore, future studies should be conducted with more homogenized samples regarding psychopathology. Finally, the low sample size and inclusion of only four cities in Turkey caused poor sample representativeness. Future research should be conducted with larger and more appropriately determined samples.

Conclusion

This study advances the understanding of CDS as a critical transdiagnostic construct mediating the relationship between ADHD and sleep problems in children. Our findings demonstrate that IN symptoms are significantly associated with increased sleep disturbances, a relationship fully mediated by CDS symptoms. This indicates that the attentional deficits associated with ADHD exacerbate sleep problems indirectly through their impact on cognitive disengagement. The mediating role of CDS provides a transdiagnostic framework for understanding how attentional difficulties contribute to neurodevelopmental outcomes like sleep disturbances and underlines the importance of addressing CDS symptoms as a critical target for interventions aimed at improving sleep quality in children with ADHD. By focusing on a Turkish epidemiological sample, this study also highlights the importance of considering genetic and cultural variability in neurodevelopmental research. Future research should continue to explore the nuanced interplay of ADHD, CDS, and sleep disturbances, leveraging longitudinal designs and diverse populations to build on these findings.

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Conflict of interest statement

The authors have no competing interests to declare that are relevant to the content of this article.

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