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ABSTRACT

OBJECTIVE: This study aimed to compare the attention levels, of Turkish children and adolescents with Attention Deficit/Hyperactivity Disorder (ADHD) in on-line education classes with healthy controls.

METHODS: This study is a cross-sectional, internet-based, case-control study that recruited 6–18 years old patients diagnosed with ADHD and receiving treatment and healthy controls from eight centers. The measurements used in the study were prepared in the google survey and delivered to the participants via Whatsapp application.

RESULTS: Within the study period, 510 children with ADHD and 893 controls were enrolled. Parent-rated attention decreased significantly in both groups during on-line education classes due to COVID-19 outbreak ($p < 0.001$; for each). Children and adolescents with ADHD had significantly elevated bedtime resistance, problems in family functioning difficulties than control children according to parental reports ($p = 0.003$; $p < 0.001$; $p < 0.001$, respectively). Furthermore, bedtime resistance and comorbidity significantly predicted attention levels in on-line education.

CONCLUSION: Our findings may underline the need to augment student engagement in on-line education both for children without attention problems and those with ADHD. Interventions shown to be effective in the management of sleep difficulties in children as well as parent management interventions should continue during on-line education.

Keywords: ADHD; COVID-19 outbreak; on-line education.

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The novel coronavirus disease (COVID-19), first diagnosed in December 2019, has rapidly spread worldwide and disrupted daily lives of billions. Social distancing interventions which were needed to control the outbreak led to limits on most activities that typically engage young people's lives. Schooling, extracurricular activities, and socializing with peers moved to electronic-based platforms. It is predicted that the COVID-19 outbreak and the associated societal response will have far-reaching effects on youth development and mental health [1].

Social distancing, implemented to reduce the spread of COVID-19 in society, has created a turning point for on-line education [2, 3]. It was previously seen as complementary to traditional face-to-face education, mainly due to the concerns of students and their educators [4]. However, it is now recognized as the main way for students to socialize, connect with peers and teachers, and continue learning [3]. Along with its merits, common challenges of on-line education were reported as the potential to cause a feeling of isolation and disconnection with other classmates (also called 'losing the human touch') and the risk that some students lose interest in their courses/programs [5, 6]. Within the scope of COVID-19 outbreak measures, on-line education has been also started as of 23 March 2020 in Türkiye and as of 03 April 2020, our government declared confinement for children and young people under the age of 20. The 2020–2021 education year was also planned to start with on-line classes with gradual introduction of traditional classes [7].

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterized by developmentally inappropriate and impairing symptoms of inattention, hyperactivity and impulsivity [8]. It is one of the most common disorders of childhood with a global prevalence of 5.29% [9]. ADHD prevalence was found to be 13.4% in Türkiye [10]. Children diagnosed with ADHD are particularly vulnerable to the distress caused by a pandemic and social distancing measures and may exhibit increased behavioral problems. The loss of daily routines and boundaries, the absence of interpersonal and social interactions and lack of opportunities for physical activity may be especially deleterious for those children [11, 12].

Sleep problems, reductions in quality of life, and problems in family functioning were previously described in children with ADHD [1–16]. However, data on the ef-

Highlight key points

- Parents of children with ADHD reported more bedtime resistance, family functioning problems than control children during the COVID-19 outbreak
- Bedtime resistance and comorbidity was found to be the most predictive of attention levels in on-line education during the COVID-19 epidemic process.
- Our findings may underline the need to augment student engagement in on-line education both for children without attention problems and those with ADHD.

fects of COVID-19 pandemic on those variables as well as their relationship with attention levels in on-line education is still limited.

Therefore, this study aimed to compare the attention levels, of Turkish children with ADHD in the on-line education process with healthy controls. Secondary aims we evaluating the effects of COVID-19 pandemic measures on sleep, quality of life and executive functioning of children. Additionally, we aimed to evaluate the predictive value of those variables on attention levels during on-line education.

MATERIALS AND METHODS

Study Center, Sampling and Ethics

This study is a cross-sectional, internet-based, case-control study that recruited patients diagnosed with ADHD and receiving treatment along with healthy controls from eight centers (Bolu Abant İzzet Baysal University Child and Adolescent Psychiatry Department, Dokuz Eylül University Child and Adolescent Psychiatry Department, İzmir Katip Celebi University Child and Adolescent Psychiatry Department, Medeniyet University Child and Adolescent Psychiatry Department, Odemis State Hospital Child and Adolescent Psychiatry Clinic, Istanbul University Child and Adolescent Psychiatry Department, Erzurum University Child and Adolescent Psychiatry Department, Erenkoy Training and Research Hospital Child and Adolescent Psychiatry Department). The measurements used in the study were prepared in the google survey and delivered to the participants via Whatsapp application. Ethics committee approval was granted for the study from Dokuz Eylül University Clinical Trials Ethics Committee (IRB Date: 27.04.2020 No: 2020/08-23). All study procedures were conducted following the Declaration of Helsinki and local laws and regulations.

TABLE 1. Sociodemographic features of Turkish children with ADHD and controls attending on-line classes

	ADHD (n=510)	Control (n=893)	p	X ² /t
Age* (mean±SD)	11.75±3.17	11.03±3.43	<0.001	-3.596
Gender,** n (%)				
Female	136 (26.7)	453 (50.7)	<0.001	77.157
Male	374 (73.3)	440 (49.3)		
Maternal age* (mean±SD)	40.70±7.20	40.52±7.61	0.801	-0.252
Number of people living in the house	4.22±1.74	4.18±1.05	0.648	-0.456
Maternal education, n (%)**				
<8 years	140 (27.5)	160 (17.9)	<0.001	17.552
> 8years	370 (72.5)	733 (82.1)		
Family member with chronic illness at home, n (%)				
Yes	116 (22.7)	164 (18.4)	0.048	3.898
No	394 (77.3)	729 (81.6)		
Psychiatric disorder in the family				
Yes	73 (14.3)	55 (6.2)	<0.001	26.036
No	437 (84.7)	838 (93.8)		

ADHD: Attention deficit and hyperactivity disorder; SD: Standard deviation.

Inclusion criteria for the ADHD group, were being diagnosed with ADHD (any type) according to DSM-5 based clinical interviews conducted at the study centers prior to COVID-19 pandemic, receiving treatments for ADHD (methylphenidate or atomoxetine) for at least two months and being 6–18 years old and taking at least one-month on-line education. Patients with chronic medical/ neurological disorders requiring treatment, those who were not receiving treatments for ADHD and those younger than 6 years of were excluded.

The healthy control group was formed after the participants in the ADHD group had been chosen. The families of children between the ages of 6 and 18 who applied to the pediatric clinics in the centers participating in the study with acute medical conditions (i.e. infections) or for well-child visits were asked whether they would participate in the study by contacting them by phone. Previous diagnosis of psychopathology/ neurodevelopmental disorders, history of treatment with psychotropic medications, presence of chronic medical/ neurological disorders requiring treatment, were criteria for exclusion from the control group. 899 healthy children and adolescents were recruited, of which six had missing data (0.7%) leading to 893 healthy controls being analyzed.

Measures

1. Sociodemographic Data Form: This form was prepared to collect information about the children's and parents' sociodemographic characteristics. Questions involved the child's age, sex, socioeconomic level, parent's age, educational status, marital status, and occupation.
2. Pediatric Quality of Life Inventory (PedsQL): This scale was developed to evaluate health-related quality of life in various dimensions (i.e. physical functioning, emotional functioning, social functioning and school functioning) for the past month for children and adolescents aged 2 to 18 years according to self and parent reports [17]. PedsQL does not assess attention, hyperactivity symptoms in ADHD patients, but assesses the impact of ADHD-related symptoms on quality of life. Cakın-Memik studied the reliability and validity of the Turkish version of PedsQL [18]. In our study, only the physical function scale form filled by the parents was used. In this study, cronbach's alpha of PedsQL was 0.702.
3. Family Assessment Device (FAD): The scale was developed to evaluate family functioning in various dimensions (i.e. problem solving, family communication, roles in family, responding effectively to emotions, active participation of family members,

TABLE 2. Comparison of parent-rated attention levels of Turkish children with ADHD and healthy controls before the COVID-19 outbreak and during on-line class attendance

	Attention levels before COVID-19 outbreak	Attention levels during the on-line education	p	t
ADHD (n=510)	6.18±1.93	5.03±2.24	<0.001	11.534
Control (n=893)	7.43±1.91	5.98±2.25	<0.001	19.188

ADHD: Attention deficit and hyperactivity disorder.

TABLE 3. Comparison of parent rated bedtime resistance, physical functioning related quality of life, working memory capacity and general family functioning among Turkish children with ADHD and controls during the COVID-19 outbreak

	ADHD (n=510)	Control (n=893)	p	t
CSHQ bedtime resistance	9.78±3.25	9.25±2.88	0.003	-3.128
PedsQL physical functioning	64.63±16.43	65.54±17.78	0.334	0.946
FAD general functioning	1.98±0.44	1.85±0.46	<0.001	-5.215

CSHQ: Children's Sleep Habits Questionnaire; PedsQL: Pediatric Quality of Life Inventory; FAD: Family assessment device.

behavior control and general family functioning) by Epstein and colleagues (1983) [19]. Higher scores indicate worse levels of family functioning. Bulut et al. translated the Turkish version of this questionnaire and conducted the validity and reliability study [20]. In this study, we used the general functioning subscale only. The cronbach's alpha of this subscale in the study is 0.788.

- Children's Sleep Habits Questionnaire (CSHQ): CSHQ was developed by Owens and colleagues to investigate children's sleep habits and sleep-related problems according to parental reports and consists of 33 Likert-type items [21]. Fis et al. established its validity and reliability in Turkish (Perdahlı Fiş et al., 2010). In the original and Turkish versions of CSHQ [22]. In the original and Turkish versions of CSHQ, a score of 41 is considered a "clinically significant sleep problem". In this questionnaire with 8 subscales, we only used the bedtime resistance subscale. The cronbach's alpha of the subscale in our study is 0.738.

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS 22.0, IBM Inc., Armonk, NY) program was used for the statistical analysis of data obtained in the study. Sociodemographic and clinical categorical variables of the

case and control groups were summarized by counts and frequencies. Quantitative variables were summarized by means and standard deviations. The Chi-square test was used for the comparison of categorical variables. Normality was evaluated with the Kolmogorov-Smirnov method. Bivariate comparisons of quantitative variables were conducted with t tests (for independent groups and for paired samples). Pearson's correlation analysis was used to determine the correlation between continuous variables. We performed a linear regression analysis to evaluate predictors of parent rated attention levels during on-line classes. P value was accepted as <0.05 (two-tailed).

RESULTS

Within the study period, 510 children and adolescents with ADHD and 893 control youth were eligible to be enrolled. Sociodemographic features of ADHD and healthy controls were provided in Table 1.

More than half of children with ADHD (n=288, 56.6%) had a comorbid diagnosis. The mean number of diagnoses accompanying ADHD is 2.02 (S.D.:1.21, min=1, max=6). The majority of parents of children with ADHD reported continuing their children's medications during the COVID-19 pandemic (62.9%, n=320). The most common reason for discontinuing treatment was

TABLE 4. Variables related to parent-rated attention levels in on-line classes among Turkish children with ADHD during the COVID-19 outbreak in linear regression analysis

Variables	B	SEB	β	p	95% CI
Age	-0.025	0.032	-0.035	0.442	-0.088 – 0.039
The number of diagnosis	-0.237	0.084	-0.129	0.005	-0.402 – -0.072
CSHQ bedtime resistance	-0.083	0.032	.0.121	0.010	-.0146 – -0.020
FAD general functioning	-0.421	0.227	-0.083	0.064	-0.867 – 0.025
Taking medication during on-line education	-0.291	0.174	-0.091	0.094	-0.632 – -0.050
Regular medication use in the morning	-0.170	0.243	-0.038	0.485	-0.645 – 0.307

1. $R^2=0.067$; $F(1.510)=5.955$; $p<0.001$; CSHQ: Children's Sleep Habits Questionnaire; FAD: Family assessment device.

parents' refusal to use the medication. The participants' attention levels before the COVID-19 outbreak and in the first month of on-line education was evaluated by parental reports. In the evaluation, parents were asked to score their children's attention levels between 1–10 (1=very poor attention level; 10=very good attention level). The attention levels of children with ADHD and healthy controls are shown in Table 2. Bedtime resistance, physical functioning related quality of life, and general family functioning are shown in Table 3.

Parents of both children with ADHD and of control children reported a significant reduction in attention during on-line classes. Bedtime resistance and problems in general family functioning were significantly elevated among children with ADHD during the COVID-19 outbreak.

We found a statistically negative correlation between attention in on-line classes and the number of diagnosis ($r=-0.165$; $p<0.001$), CSHQ bedtime resistance subscale ($r=-0.157$; $p<0.001$), FAD general functioning subscale ($r=-0.137$; $p=0.001$), taking medication during on-line training ($r=-0.121$; $p=0.003$) and regular medication use in the morning ($r=-0.106$; $p=0.009$).

Lastly, we performed a linear regression analysis to take into account the correlations among predictors. According to this analysis, our dependent variable was the attention levels in on-line education. When age, the number of diagnosis, CSHQ bedtime resistance, FAD general functioning, taking medication during on-line education and regular medication use in the morning were entered as predictors, the bedtime resistance and the number of diagnosis emerged as the significant predictor of attention levels in on-line education. The regression results are shown in Table 4.

DISCUSSION

In this cross-sectional, multi-center, internet-based, case-control study, we found a significant reduction in attention levels of both groups during on-line education. We also found that parents of children with ADHD reported more bedtime resistance, family functioning problems and working memory difficulties than control children during the COVID-19 outbreak. Furthermore, we found that the working memory difficulties significantly predicted attention levels' during on-line education.

In our study, the attention level of children with ADHD evaluated by their parents during on-line education at the end of the 1st month of the COVID-19 outbreak was found to be lower than baseline. Few studies have evaluated the effects of the COVID-19 pandemic on ADHD symptoms. In a recent study, Sasaki and colleagues reported that physical quarantine led to a worsening in symptoms of inattention among children with ADHD despite no change in treatment. The authors speculated that this worsening may be due to psychologically traumatic effects of social isolation [23]. Zhang and colleagues reported that ADHD symptoms of children significantly worsened during the COVID-19 pandemic in China, and that children's negative mood was associated with ADHD symptoms. They also found that ADHD symptoms decreased with longer study time [24]. On the other hand; Bobo and colleagues (2020) reported that ADHD symptoms worsened only in only one-third of French children during the COVID-19 outbreak. They speculated that presence of sufficient physical space at home and access to a garden for physical exercises may have compensated for the harmful effects of lockdown in some of the children. The majority of parents of children with ADHD in this study also reported problems in at-

tendance and engagement for on-line classes [25]. The results of our study are in accordance with the majority of those reported previously [23, 24] and suggest that ADHD symptoms may worsen during the pandemic despite continuing treatment. The difference between our results and those of Bobo and colleagues may be due to our sample having limited access to outdoors and the enforcement of strict lockdown procedures [26]. During the first two months of the outbreak, the government enforced strict lockdown for youth (<18 years) and elderly (65 > years) and those were allowed outdoors only after the second month on designated days and within specified time periods (i.e. 10:00–18:00). The lockdown on youth was eased on June 2020 and our results may not reflect the current symptom status of those children. When the existing problems of children with ADHD in traditional, face-to-face education are borne in mind, the problems reported during on-line education may not be surprising [27]. Because of the continuing pandemic and the necessity of prolonged periods of on-line education, the correlates and predictors of worsening ADHD symptoms and limited attendance in on-line classes should be studied.

Children with ADHD in our sample displayed elevated levels of bedtime resistance and their parents reported elevated problems in family functioning, than controls during on-line education. Sleep is very important for child and adolescent health and well-being [28], and the potential for sleep problems to occur or worsen during the COVID-19 outbreak is high [29]. Youth with pre-existing neurodevelopmental disorders may be particularly vulnerable to sleep problems during this period of change and uncertainty [30]. Previous studies reported elevated levels of stress and sleep problems among families of children with ADHD during confinement related to the COVID-19 pandemic [25, 31]. ADHD in children was known to be associated with greater levels of parenting stress, family conflict and sleep problems and measures taken due to the COVID-19 pandemic may have exacerbated those problems [32, 33].

In our study, bedtime resistance and comorbidity predicted parent rated attention problems during on-line education. Bedtime resistance may cause day-time sleepiness. Daytime sleepiness may also cause school restlessness, hyperactivity, emotional lability, irritability, aggression, and behavioral problems similar to symptoms of ADHD [34]. Vélez-Galarraga et al (2016) found an association between ADHD symptom severity and bedtime resistance [35]. ADHD is accompanied by many

comorbidities, mainly oppositional defiant disorder and conduct disorder [8]. Vurring et al. (2017) showed that when ADHD was accompanied by comorbid diagnoses, sleep problems significantly increased [36]. ADHD treatment including methylphenidate and atomoxetine may improve both on sleep problems and on comorbid conditions [37, 38]. Our findings and those reported previously may emphasize the importance of continuing psychotropic therapies and family/individual based interventions for ADHD during the COVID-19 outbreak.

Our results should be evaluated within their limitations. Firstly, we did not quantify the severity of ADHD symptoms with psychometric measures (e.g. SNAP-IV etc.). Secondly, all of our measures were completed by parents thereby being potentially influenced by shared method variance. Parent reports may also be affected by reporting and recall bias. Thirdly, parents rated attention only during on-line education classes. Fourthly, evaluations were made in the first month of on-line education. Evaluating attention levels in on-line education for longer periods of time may be a good option for future studies. Fifth, attention levels are based on parental assessment only. Evaluations using more objective methods or using more than one source of information (e.g. teachers) can produce more objective results. Sixth, the elevated rates of comorbidity may have affected our results. Sixth, variables such as age, gender, maternal education level and psychiatric illness can affect children's attention levels. Evaluating these variables may yield more objective results. Lastly, the results are valid only for the study centers within the specified time period and may have limited external generalizability.

Regardless of limitations, our study is among the first studies that evaluated attention levels of children with ADHD during the on-line education process introduced by the COVID-19 outbreak. A respectable sample-size and a multi-center design are among its strengths. Working memory was found to be the most predictive of attention levels in on-line education during the epidemic process. The findings of our study emphasize that the treatments that have been shown to be effective in the treatment of executive function difficulties in children with ADHD should continue during on-line education.

Ethics Committee Approval: The Dokuz Eylül University Non-Interventional Research Ethics Committee granted approval for this study (date: 27.04.2020, number: 2020/08-23).

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