Original Article

Oral Health Status and Its Relation with Medication and Dental Fear in Children with Attention-Deficit Hyperactivity Disorder

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ABSTRACT

Objective: The objective of this study was to determine the ora-dental health and its relation with medication and dental fear in a group of Turkish children with attention-deficit hyperactivity disorder (ADHD). **Subjects and Methods:** The levels of dental fear of children were determined with The Dental Subscale of Children's Fear Survey Schedule (CFSS-DS). The oral and dental health evaluation was performed. This study included a total of 117 children aged between 6 and 15 years and they were examined under two groups as "ADHD" (n = 59) and "Control" (n = 58). Ora-dental health variables were compared between the groups and were also analyzed in accordance with dental fear and medication. **Results:** ADHD children and the control group exhibited similar CFSS-DS scores (15–32). No significant differences existed in df(t)/df(s), DMF(T)/DMF(S), d/D values, and presence of the white spot lesions. ADHD children's Mutans streptococci and Lactobacillus quantities were found significantly higher than the control group. The incidence of parafunctional habits of the ADHD children was also found high. **Conclusions:** ADHD children that were medicated exhibited similar dental caries prevalence and periodontal health status. Although ADHD group had similar dental-periodontal health status and dental fear level with the control group and using ADHD medicines did not make a significant effect on the ora-dental health parameters, the patients should be carefully followed up because they were categorized in high caries risk groups.

Keywords: *Attention-deficit hyperactivity disorder, clinical study, dental fear, medication, ora-dental health*

Introduction

Attention-deficit hyperactivity disorder (ADHD) is one of the most common childhood-onset behavioral disorders that become apparent in the preschool and early school years and can continue through adolescence with 50%–80% and adulthood with 30%–50% probability.[1-3] ADHD is a heterogeneous disorder manifested by difficulties of attention and/or impulsivity/hyperactivity.[4] ADHD is affecting approximately 5%–10% of children and adolescents.[5] The prevalence of ADHD in Turkey is presented as 12.91%.[6] Males are diagnosed with the disorder eight times more than the females amongst children.[7] However, females may be more likely to be underdiagnosed; this may at least partly be a result of less prominent hyperactivity and less observable difficulties with girls.[8,9] Genetic and environmental etiologies that implicate the neurotransmitter dopamine has been proposed for the reason of ADHD.[10]

Some of the hyperactivity problems, which are commonly seen in children with ADHD such as difficulties in concentration, focusing, impulse control, and communication, make a successful dental treatment harder to achieve. In one study, children with ADHD were reported to experience more behavior management problems compared to the control group. Those children

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were stated to have communication problems with their dentists.[11] It was reported that 15% of children who had preferred to go to the private dental care centers because of high anxiety levels had attention-deficit problems.[12] While some authors were reporting that the children with ADHD showed similar behavior or have similar levels of dental anxiety compared to those without ADHD, others stated that dental anxiety was higher in children with ADHD.[13]

There are only a few studies about the oral hygiene of children with ADHD and these studies present conflicting results.[11,14-19] In a study from New Zealand, children with ADHD were reported to have tooth decay values as DMFT >5.[20] In another study performed in the USA, children with ADHD aged 6–10 years were reported to more commonly have enamel decays.[19] According to the literature, tendency to the formation of dental caries increases in ADHD.[21] This disorder was stated to be an important factor for the high risk of decays in children aged 11–13 years.[20,22] On the other hand; Blomqvist *et al*.[21] reported that children with ADHD didn't show a statistically significant difference compared to the control group in terms of the prevalence of tooth decay.

In addition, the medication, which is used in the treatment of ADHD, is reported to cause xerostomia; thus, it is increasing the risk for dental caries.[23]

Furthermore, the increased incidence of bruxism, dyskinesia, and dental trauma is also reported in these children.[24]

The objective of this study was to determine the ora-dental health level of a group of Turkish children diagnosed with ADHD, relationship between ADHD and dental fear, ADHD medication. The first hypothesis of this study was that children with ADHD might have higher dental fear and higher caries risk, and associated oral and dental health variables might show differences when compared with the healthy children. The second hypothesis was the medicated children with ADHD might have higher dental fear and exhibit worse ora-dental health than the control group. The null hypothesis of the study was the children with ADHD (medicated or not) did not have dental fear and show similar ora-dental health-like healthy children.

Subjects and Methods

This cross-sectional, comparative research was approved by the Istanbul University Clinical Research Ethics Committee (no: 1281). Participants were recruited from a clinical sample of children aged 6–15 years who were consecutively referred to an outpatient child and adolescents' psychiatry clinic in Istanbul, Turkey, between May 4th, 2015, and March 30th, 2016 and diagnosed with ADHD. ADHD diagnose was made according to DSM-V (American Psychiatric Association, 2013)[25] criteria and healthy children (who did not have any systemic disorder and mental or any other psychological disorders) constituted as non-ADHD (control group). Before initiation of the study, volunteer consent forms were received from children and/or their parents who accepted to participate in the study. A similar age and gender distribution were taken into account in the control group. The exclusion criteria were the presence of confounding medical history, a severe mental health, or any other psychological disorders. Six patients were excluded because of mental health; ten patients were excluded because of confounding medical history that could affect the ora-dental health (i.e., asthma and diabetes mellitus). Eighteen patients declined to participate in the study. Seven patients accepted to participate in the study at the initial examination in psychiatry clinic but did not attend to the pediatric dentistry clinic.

A total of 117 children participated in the study, consisting of 58 children aged between 6 and 15 years, diagnosed with ADHD and 59 healthy children who have neither any psychiatric diagnosis nor systemic disorders.

After psychological assessment, the children were referred to the pediatric dental clinic for oral and dental examinations.

First of all, the levels of dental fear of children were determined with "The Dental Subscale of Children's Fear Survey Schedule (CFSS-DS)" in the pediatric dental clinic. The CFSS-DS consists of 15 items, related to the different aspects of dental treatment. The possible item responses vary on a scale of 1–5, 1 representing "not afraid at all" and 5 for "very afraid," giving a range of possible scores of 15–75. Points 15–32 indicate low and 32–38 refer to moderate level of fear. Higher points than 39 are defined as dentally anxious.[26]

In addition, several other factors that could be related to the caries risk were questioned through a survey including socioeconomic status, frequency of dental follow-up, frequency of sugary snacks intake, fluoride program, frequency of toothbrushing, medication, and the persistence of parafunctional habits (bruxism, thumb sucking, pacifier sucking, nail biting, etc.). The questionnaire was replied by the parents/children with a face-to-face interview.

After the surveys had been completed, stimulated saliva samples were collected and laboratory study and culture procedures were performed in the Department of Microbiology. Salivary flow rate, buffering capacity (BC), Mutans streptococci (MS), Lactobacillus (LB), and yeasts quantities were calculated. The saliva sample was collected before the dental examination, and participants were asked to refrain from eating, drinking, toothbrushing, and rinsing their mouths for at least 1 h before saliva collection.

Oral and dental health evaluation was performed by an experienced pediatric dentist, using a dental mirror, dental explorer, and a World Health Organization periodontal probe. df(t)/df(s); DMF(T)/DMF(S) index score, presence of the white spot lesions, periodontal status (Silness Löe plaque index, sulcus bleeding index, and probing pocket depth) were recorded.

Plaque index was scored as 0 = PI <0.4, 1 = PI = 0.4–1, 2 = PI = 1.1–2.0, and 3 = PI >2; saliva flow rate (SFR) as 0 = SFR >1.1 ml, 1 = SFR = 0.9–1.1 ml, 2 = SFR = 0.5–0.9 ml, and 3 = SFR < 0.5 ml; BC as 0 = BC = pH <6, 1 = BC = 4.5–5.5, and 2 = BC = pH <4; MS as 0 = MS = Low $<10^5$ cfu/ml, 1 = MS = Medium 10^5–10^6 cfu/ml, and 2 = MS = high $>10^6$ cfu/ml, LB as 0 = LB = Low $<10^4$ cfu/ml, 1 = LB = Medium 10^4–10^5 cfu/ml, and 2 = LB = High $>10^5$ cfu/ml), and candida (C) as (0 = C = Low $<10^3$ cfu/ml, 1 = C = Medium 10^3–10^4 cfu/ml, and 2 = C = High $>10^4$ cfu/ml.

The collected data were entered into a computer-based program, the Cariogram, and caries-risk profiles of all children were determined as previously described.[27,28] The following five cariogram categories were used: "very low risk" = 81%–100% chance to avoid caries; "low risk" = 61%–80% chance to avoid caries; "moderate risk" = 41%–60% chance to avoid caries; "high risk" = 21%–40% chance to avoid caries; and "very high risk" = 0%–20% chance to avoid caries.

Ora-dental health variables were compared between children with ADHD and without ADHD. The groups were also analyzed in accordance with dental fear levels and medication.

Statistical analysis

Results obtained in this study were statistically analyzed through IBM SPSS Statistics 22 (IBM SPSS, Turkey) software. Normality of quantitative data was evaluated by the Shapiro–Wilks test and the parameters were found to be nonnormally distributed. In comparisons of descriptive statistical parameters (mean, standard deviation, and frequency) as well as quantitative data, Kruskal–Wallis test was used in comparison of the parameters among more than two groups and Man–Whitney U-test was utilized in comparison of the parameters between two groups. Chi-square test, Fisher's Exact Chi-square test, and Yates's continuity correction were used in comparison of qualitative data. $p < 0.05$ value was considered statistically significant.

Results

This study included a total of 117 children aged between 6 and 15 years with 106 (90.6%) males and 11 (9.4%) females. The mean age was found as 9.78 ± 2.53 years in ADHD and 9.93 ± 2.55 years in the control group. The patients were examined under two groups as "ADHD" (n = 59) and "Controls" (n = 58). No statistically significant difference was found between the groups in terms of age, gender, and socioeconomical status.

Within the scope of oral and dental health evaluation, df(t) ADHD/control/df(s) ADHD/control (2.75 ± 3.26; 3.74 ± 4.44/4.47 ± 5.38; 8.59 ± 10.16); DMF(T) ADHD/control/DMF(S) ADHD/Control (1.37 ± 2.3; 2.16 ± 2.59/1.85 ± 3.38; 3.47 ± 5.63), d(decayed primary teeth) ADHD/Control/ D(decayed permanent teeth) ADHD/Control 1.47 ± 2.01) values and presence of the white spot lesions (18.6% ADHD//17.2 Control) were examined. No statistically significant difference was observed between the groups in these values.

Periodontal health status of ADHD children and control group was given in Table 1. The SFR and salivary BC results were presented in Table 2.

Plaque index values were found to be statistically significantly lower in children with ADHD compared to the healthy children (p = 0.001). No statistically significant differences were observed between the groups in sulcus bleeding index and probing pocket depth, SFR, and BC values.

The saliva samples collected from children were also analyzed for quantities of MS, lactobacilli (LB), and yeast, and the results obtained were shown in Table 3.

There was a statistically significant difference between the groups in MS and LB values (p = 0.001, p = 0.024). The children with ADHD presented high MS and LB levels than in the control group. No statistically significant difference was observed between the candida levels.

The caries risk profile was determined with cariogram. Nearly 59.3% of ADHD and 50.0% of the control group were categorized as high caries risk group.

The incidence of parafunctional habits (bruxism, thumb sucking, nail bite, etc.) was found to be significantly higher in children with ADHD (44.1%) than in the control group (17.2%) (p = 0.003).

According to the results of the questionnaire [Table 4], frequency of sugary snacking intake of the control group

Table 1: Plaque index, sulcus bleeding index, probing pocket depth of the children with/without attention-deficit hyperactivity disorder

	ADHD	ADHD (−) (control)	*p*
Plaque index, *n* (%)			
<0.4	22 (37.3)	11 (19)	0.001*,[a]
0.4-1.0	21 (35.6)	13 (22.4)	
1.1-2.0	16 (27.1)	24 (41.4)	
>2.0	0	10 (17.2)	
Sulcus bleeding index, mean±SD (median)	3.24±4.75 (1.3)	2.16±3.95 (0.6)	0.227[b]
Probing pocket depth, mean±SD (median)	1.18±0.25 (1.1)	1.21±0.39 (1.03)	0.255[b]

[a]Chi-square test, [b]Mann–Whitney U-test, *$p<0.05$. ADHD=Attention-deficit hyperactivity disorder; SD=Standard deviation

Table 2: Stimulated saliva flow rate and buffering capacity of the children with/without attention-deficit hyperactivity disorder

	ADHD, *n* (%)	ADHD (−) (control), *n* (%)	*p*
Stimulated saliva flow rate (ml/min)			
>1.1	32 (54.2)	20 (34.5)	0.053[a]
0.9-1.1	14 (23.7)	25 (43.1)	
0.5-0.9	13 (22.0)	13 (22.4)	
Salivary buffering capacity (pH)			
>6.0	20 (33.9)	11 (19.0)	0.182[a]
5.5-4.5	37 (62.7)	44 (75.9)	
<4.0	2 (3.4)	3 (5.2)	

[a]Chi-square test, *$p < 0.05$. ADHD=Attention-deficit hyperactivity disorder

Table 3: Mutans streptococci, Lactobacillus, and Candida levels of the children with/without attention-deficit hyperactivity disorder

	cfu/ml	ADHD, *n* (%)	ADHD (−) (control), *n* (%)	*p*
MS	$<10^5$	6 (10.2)	19 (32.7)	0.001*
	10^5-10^6	21 (35.6)	27 (46.6)	
	$>10^6$	32 (54.2)	12 (20.7)	
LB	$<10^4$	10 (16.9)	4 (6.9)	0.024*
	10^4-10^5	16 (27.1)	29 (50)	
	$>10^5$	33 (55.9)	25 (43.1)	
Candida	$<10^3$	40 (67.8)	30 (51.7)	0.190
	10^3-10^4	14 (23.7)	19 (32.8)	
	$>10^4$	5 (8.5)	9 (15.5)	

Chi-square test, *$p<0.05$. ADHD=Attention-defcit hyperactivity disorder; MS=Mutans streptococci; LB=Lactobacillus

exhibited statistically significant difference with the ADHD group ($p = 0.003$). Exposure to fluoride program of the children with ADHD exhibited significantly high difference with the control group ($p = 0.024$).

No statistically significant difference was observed in the CFSS-DS scores between the ADHD and control group. CFSS-DS scores were between 15 and 31 points in 78% of children in ADHD group, and in 81% of children in the control group, indicating a low level of fear. The oral and periodontal health variables (df(t), df(s), d, DMF(T), DMF(S) and D values, plaque index, sulcus bleeding index and probable pocket depth, SFR, and BC) were compared in relation with dental fear level in both groups and no significant differences were found.

When the ADHD group was examined whether they were taking any medication or not, 45 children were found to take medication. When the medicaments were analyzed for active ingredients; 21 children were found to use methylphenidate-containing and 4 children atomoxetine-containing drugs.

When the study groups were analyzed as the ADHD with medication/without medication and the control group, no statistically significant difference was found among the groups with the values as df(t), df(s), d, DMF(T), DMF(S), D values, presence of the white spot lesions, salivary BC, sulcus bleeding index, and probable pocket index.

Plaque index values were found to be statistically significantly higher in the control group than in the ADHD group with and without medication ($p = 0.005$).

There was a statistically significant difference between the ADHD group with and without medication and the control group in SFRs ($p = 0.014$). The SFRs (SFR >1.1) were found to be significantly higher in children without medication (8.6%) compared to the children with medication (46.7%) and the control group (34.5%). No statistically significant difference was found between the children using medicine and the control group.

High MS level (MS $>10^6$ cfu/ml) was found to be significantly ($p = 0.001$) higher in children with medication (57.1%) and without medication (53.3%) than the control group (20.7%). Finally, no statistically significant difference was found between the ADHD group with and without medication in MS, LB, and yeast levels.

A statistically significant difference was observed between the same groups in the incidence of parafunctional habits ($p = 0.006$). The incidence of

Table 4: Questionnaire on, frequency of dental follow-up, dental hygiene, and dietary habits in children with/without attention-deficit hyperactivity disorder

	ADHD, *n* (%)	ADHD (−) (control), *n* (%)	*p*
Frequency of dental follow-up			
Regular	2 (3.4)	8 (13.8)	0.113
Not regular	7 (11.9)	8 (13.8)	
When a problem occurs	50 (84.7)	42 (72.4)	
Frequency of sugary snacks intake			
None	20 (33.9)	8 (13.8)	0.003*
Sugary snacks <3	22 (37.3)	16 (27.6)	
3≤ sugary snacks	17 (28.8)	34 (58.6)	
Fluoride program			
Using fluoride supplements	4 (6.8)	0	0.024*
Using toothpaste with fluoride	49 (83.1)	44 (75.9)	
None	6 (10.2)	14 (24.1)	
Frequency of toothbrushing			
Toothbrushing ≥2 times/day	7 (11.9)	5 (8.6)	0.701
Once a day	12 (20.3)	15 (25.9)	
Toothbrushing <1	40 (67.8)	38 (65.5)	

*$p<0.05$. ADHD=Attention-deficit hyperactivity disorder

parafunctional habits was found to be higher in the medicated (44.4%) and nonmedicated children (42.9%) than in the control group (17.2%).

Furthermore, CFSS-DS scores were compared between the ADHD group with medication/without medication and the control group and no statistically significant difference was observed between the groups.

Discussion

This study is first that comprehensively examining the oral and dental health status of a group of Turkish children with ADHD and ADHD's relationship with dental fear and pharmacological intervention. The main findings of this study presented that MS and LB quantities of ADHD children were found significantly higher and plaque index scores were significantly lower compared with the control group. Plaque index values of the control group were examined higher. Contrary to expectations, the periodontal health (sulcus bleeding index, probable pocket depth values) of the control group exhibited similar findings with the ADHD group, suggesting that children in the control group did not pay attention to daily oral hygiene at the day of clinical examination. Despite higher plaque index values, no significant differences existed in df(t)/df(s), DMF(T)/DMF(S), and d/D values, presence of the white spot lesions. These findings of the present study were contrary to previous studies in which higher values for the prevalence of caries and white spot lesions were presented[19,20,21] and similar with the other researchers.[15-17,29]

Possible reasons of higher prevalence of dental caries in ADHD children had been reported as poor oral hygiene and a higher consumption of sugared food and drinks.[22] Bimstein *et al.*[30] reported that there was no correlation between the prevalence of dental caries, oral hygiene, and ADHD. Blomqvist *et al.*[21] stated that, despite the high prevalence of dental caries in children with ADHD, oral hygiene was not poor. The reason of inconsistency among the results of these studies was stated as less number of examined patients and the differences between patient groups.[16] In the evidence-based dentistry journal, degree of evidence was given as 4 and explained that correlation between ADHD and high dmf(t) values depends on multiple factors including poor oral hygiene behavior or ADHD-related physiological changes during treatment of the disease.[31]

In this study, despite the fact that high consumption of sugary food was found significantly higher in the control group, higher MS and LB quantities of ADHD children existed. In spite of reported similar toothbrushing frequency in the ADHD and the control group, the plaque index of the control group was found significantly higher. This inconsistency might be due to unreliable survey responds. Kohlboeck *et al.*[16] and Bimstein *et al.*[30] found no significant differences between ADHD and the control group in plaque index values. Whereas Chandra *et al.*[22] reported a higher plaque index in the ADHD group. Hidas *et al.*,[15] reported that there was no significant difference between ADHD and the control group in MS and lactobacilli counts.

The first hypothesis of the study was, children with ADHD might have higher dental fear and higher caries risk, and associated oral and dental health variables might show differences when compared with healthy children.

Reliability and validity of CFSS-DS had been reported to be high.[18] In the present study, dental fear levels of children were determined using the CFSS-DS which had been translated to Turkish by Yalçın[32] and was used in the doctoral thesis. ADHD children exhibited similar CFSS-DS scores with the control group, and most of the children were grouped as having low levels of dental fear which was similar with the study of Blomqvist *et al.*[18] It was found that dental fear scores did not affect the oral health variables between the groups. The researchers that investigated the relationship between dental anxiety and having ADHD exhibited contrary results.[20,21,33] Some of them emphasized more common behavior management problems and higher dental caries prevalence.[21]

The second hypothesis of this study was medicated children would exhibit worse ora-dental health with lower salivary flow rates, buffer capacities and higher bacterial quantity than the control group. Children with ADHD are often treated with methylphenidate and dexamphetamine. According to the results of researches, using these medicines might be associated with severe atypical caries lesions. Xerostomia had been noted as a side effect of these drugs and had been associated with high consumption of sugary drinks and low oral hygiene.[20] In the present study, 21 children were medicated with methylphenidate-containing and 4 with atomoxetine-containing medicines. Very low SFR (0.5–0.9 ml) existed in the medicated group (28.9%) and the control group (22.4%), and significant differences were examined in the nonmedicated children (0%). The similarity in salivary flow rate between the medicated and the control group refutes the claim that medicines used in the treatment of ADHD may cause xerostomia. Furthermore, increasing the number of nonmedicated children can lead to different outcomes. In another study by Hidas *et al.,*[15] unstimulated salivary flow rate was found to be lower in the ADHD group compared with the controls, although DMF(T)/dmf(t) values were not high. In the same study, no significant difference was reported between the groups using and not using drugs in terms of salivary flow rate. Grooms *et al.*[19] reported no significant difference between the ADHD and control groups in terms of the salivary flow rate without regarding the medication which is similar with the present study.

The high MS counts (MS >10^6 cfu/ml) were found significantly higher in the medicated ADHD children. Despite to these results in the medicated ADHD children, this finding did not cause in higher df(t), df(s), d, DMF(T), DMF(S), D values, presence of the white spot lesions, salivary BC, sulcus bleeding index, and probably pocket index values. However, contrary to expectations, medicated ADHD children exhibited similar dental caries prevalence and periodontal health. In both of the researches published by Hidas *et al.*,[15,17] a higher plaque index was reported and no significant differences were found in salivary BC, MS, and LB quantities.

Parents and participants were asked to answer a questionnaire regarding to their children's parafunctional habits in this study. The incidence of parafunctional habits of the ADHD children was found higher than the control group, which shows similar results with the studies of Lalloo[34] and Sabuncuoglu *et al.*[35] According to those results, medication treatment does not make any difference in terms of the incidence of parafunctional habits when compared with the nonmedicated group. However, Malki *et al.*[36] reported possible relation with the medication of ADHD and parafunctional habits.

Although no significant difference was obtained in ora-dental health variables between the ADHD and control groups and not any remarkable relationship was found between the disorder, dental fear, ADHD medications, and ora-dental health, they should be carefully followed up because they were categorized in high caries risk groups. Malocclusion disorders' risk caused by parafunctional habits should also be closely monitored. Further studies with larger sample sizes and longitudinal studies are recommended to investigate the ora-dental health of children with ADHD.

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Conflicts of interest

There are no conflicts of interest.

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