ORIGINAL PAPER

ATTENTION DEFICIT HYPERACTIVITY DISORDER AND DENTAL CARIES – EVALUATION OF CHILD PATIENTS

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ABSTRACT

Introduction: Research provides evidence of increased incidence of caries among children with attention deficit hyperactivity disorder (ADHD). Although not all studies confirm such a regularity, numerous hypotheses indicate that such a relationship may exist. The occurrence of hyperkinetic disorders may adversely affect the possibilities and willingness to implement and adhere to good hygiene and nutrition standards.

Objectives: The aims of the study were as follows: 1) to perform an analysis of oral health of children and adolescents with ADHD, 2) to assess the impact of ADHD on the development of caries, 3) to compare decay-missing-filled (DMF) index and its components in children and adolescents with ADHD with a group of healthy people.

Material and methods: The study included a group of 120 children and adolescents diagnosed with ADHD based on DSM-IV/V classification or hyperkinetic syndrome based on ICD-10 classification. In each case, the diagnosis was made by a psychiatrist. The control group comprised 120 people who were not diagnosed with ADHD. The age of the subjects ranged between 7 and 17 years. The decayed, missing, and filled teeth (DMFT) index, and frequency and intensity of caries in both groups were calculated.

Results: It was found that caries were slightly more common in the group with ADHD (75.83%) than in the control group (65.00%). Studies have shown that the number of D, M, and DMF were higher in the group with ADHD compared to the control group, while the number F was slightly higher in the control group.

Conclusions: The obtained high values of caries indexes indicate unsatisfactory dental health of the examined group of children and adolescents. The caries treatment index had a much lower value in children and adolescents with ADHD than in the control group. Children and adolescents with ADHD should be included in the group of patients with increased risk of oral disease.

Key words: ADHD, oral health, caries, hyperkinetic syndrome.

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INTRODUCTION

The impact of attention deficit hyperactivity disorder (ADHD) on oral health is unequivocal. There are many factors that can affect the health of teeth and their surrounding tissues. Among factors that can influence the propensity to develop caries, gum disease and the occurrence of injuries include the following: physiological, psychological, pharmacological, social, and behavioural, i.e. consistency in compliance with hygiene or dietary choices, as well as having an anxious attitude towards dental treatment.

Research provides evidence on increased incidence of caries among children with attention deficit hyperactivity disorder. Although not all studies confirm such a regularity, numerous hypotheses indicate that such

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a relationship may exist. It is believed that the occurrence of hyperkinetic disorders may adversely affect the possibilities and willingness to implement and adhere to good hygiene and nutrition standards [1, 2].

There is no doubt that proper oral hygiene is an important factor in ensuring healthy dental and soft tissue. It is believed that regular brushing and use of other hygienic procedures may be less frequently practiced in the group of people suffering from attention deficit hyperactivity disorder. People with ADHD have problems with concentration; therefore, it can be difficult for them to properly perform the rather monotonous activity of brushing their teeth. In addition, parent-child conflict often occurring in families in which children suffer from ADHD may also affect oral hygiene behaviours; namely, persistent and deliberate lack of brushing teeth may be a manifestation of rebellion towards adults [3-6].

Numerous studies indicate that children with attention deficit hyperactivity disorder have increased appetite, which leads to overweight and obesity. One hypothesis proves that dopamine may play an important role in both disorders. Benjamin Charles Campbell and Dan Eisenberg showed an increase in the level of that neurotransmitter caused merely by the awareness of the presence of food even if it is not consumed. ADHD is a disorder in which the level of dopamine is reduced, especially in the prefrontal cortex, so the increase in dopamine caused by food intake has a positive effect on the patient's well-being causing happiness. It should also be noted that among people with ADHD, the self-control mechanisms may be disturbed, and they may not stop eating even when they are no longer hungry. It can be assumed that consumed food includes products with a karyogenic effect, which may have a significant impact on the development of caries. Parents of children with hyperactivity disorder struggle with numerous upbringing problems, so they are willing to reward children with sweet snacks to achieve the expected behaviour [7-10].

On the other hand, there are studies proving that diet can have a significant impact on the course of ADHD; therefore, it is recommended that food containing artificial additives, dyes and preservatives be eliminated. As a result, this leads to a reduction in the consumption of cariogenic products in some patients and a potential decrease in the occurrence of caries. Some drugs used in the pharmacotherapy of ADHD may have a similar effect, causing a decrease in appetite and, as a result, weight reduction [1, 6].

Although pharmacological agents used to treat attention deficit hyperactivity disorder may reduce the desire to consume cariogenic products, such agents can also have a very negative effect on oral health. Drugs used for the pharmacological treatment of ADHD such as methylphenidate (Ritalin) or dexamphetamine may reduce salivation and thus increase the risk of caries. People struggling with dry mouth also tend to increase the consumption of refreshing drinks to reduce the unpleasant feeling [1, 2, 6].

OBJECTIVES

Aims of the study were: 1) to analyse the oral health of children and adolescents with ADHD, 2) to assess the impact of ADHD on the development of caries, and 3) to compare the decay-missing-filled (DMF) index and its components in children and adolescents with ADHD with a group of healthy people.

MATERIAL AND METHODS

The study included a group of 120 children and adolescents diagnosed with attention deficit hyperactivity disorder based on DSM-IV/V classification or hyperkinetic syndrome based on ICD-10 classification. In each case, the diagnosis was made by a psychiatrist. The study was conducted on the premises of health care facilities in which outpatient psychiatric treatment is carried out as well as in a psychiatric hospitals and dental care facilities. The control group comprised 120 people who were not diagnosed with ADHD. The age of the subjects ranged between 7 and 17 years and amounted to an average of 11.53 ± 2.54 years in the examined group and 11.90 ± 2.62 years in the control group. In the study group there were 57.50% (n = 69) boys and 42.50% (n = 51) girls, while in the control group there were 55.83% (n = 67) boys and 44.17% (n = 53) girls. There were no statistically significant differences between the control and study groups in terms of age or gender. Parents of all children agreed to the examination. A survey, a clinical examination, and a microbiological test were conducted.

RESULTS

As a result of the study, it was found that caries were slightly more common in the group with ADHD (75.83%) than in the control group (65.00%). The differences found were not statistically significant (p = 0.07) (Table 1).

The study showed that the intensity of caries in the examined groups was similar. Statistical analysis showed no significant differences in the Ip assessment between the groups (p = 0.94) (Table 2).

Studies have shown that the number of D, M, and DMF were higher in the group with ADHD compared to the control group, while the number F was slightly higher in the control group. Statistical analysis showed significant differences between the groups only in the assessment of the number P (p = 0.004), while in the assessment of numerous DMF, M, and F no statistically significant differences were found (p > 0.05). The obtained results are presented in Table 3.

TABLE 1. Evaluation of caries frequency (Fp) in the group with attention deficit hyperactivity disorder (ADHD) and the control group

Group	No caries		The presence of caries
	n	%	*n*
ADHD	29	24.17	91
Control group	42	35.00	78

Statistical analysis; $\chi^2 = 3.38$; $p = 0.07$

TABLE 2. Evaluation of caries intensity (Ip) in the group with attention deficit hyperactivity disorder (ADHD) and control

Group	Total teeth with caries	Caries intensity, average	Standard deviation
ADHD	328	3.60	1.99
Control group	280	3.59	2.02

Statistical analysis: $Z = 0.07$; $p = 0.94$

TABLE 3. Number of decayed (D), missing (M), filled (F) teeth, and DMFT in the group with attention deficit hyperactivity disorder (ADHD) and in the control group

Number	ADHD			Control group			Statistical analysis
	Average	Median	Std.	Average	Median	Std.	FROM
DMFT	2.73	2.00	2.32	2.33	2.00	2.37	1.49
D	1.37	1.00	1.57	0.75	0.00	1.20	2.85
M	0.13	0.00	0.44	0.05	0.00	0.25	0.67
F	1.24	0.00	1.79	1.52	1.00	1.84	–1.19

TABLE 4. Number of decayed (D), missing (M), filled (F) teeth, and DMFT in the group with attention deficit hyperactivity disorder (ADHD) and the control group, taking into account age

Number		7-10 years old			11-13 years old			14-17 years old		
H	*p*	Average	Median	Std.	Average	Median	Std.	Average	Median	Std.
ADHD										
DMFT	1.64	1.50	1.62	2.78	3.00	1.96	4.44	4.00	2.86	–
D	1.11	0.00	1.47	1.57	1.00	1.53	1.41	0.00	1.80	–
M	0.00	0.00	0.00	0.06	0.00	0.24	0.44	0.00	0.80	–
F	0.52	0.00	0.98	1.14	0.00	1.50	2.59	2.00	2.48	–
Control group										
DMFT	1.63	1.00	1.81	1.93	2.00	1.86	3.66	4.00	2.96	–
D	0.60	0.00	1.01	0.53	0.00	0.94	1.20	1.00	1.57	–
M	0.05	0.00	0.32	0.00	0.00	0.00	0.11	0.00	0.32	–
F	0.93	0.00	1.51	1.40	1.00	1.63	2.34	2.00	2.15	–

The study showed that in the group with ADHD the number of DMF, M, and F was significantly higher in the 14-17-year-olds compared to the 7-10 and 11-13-year-olds ($p = 0.0003$), but no significant differences in the assessment of the number D were observed ($p = 0.30$). In the control group, statistically significant differences in the observed numbers of DMF, D, M, and F were found between the age groups ($p = 0.04$). Higher values were observed in the 14-17-year-olds (Table 4).

DISCUSSION

Tooth decay is one of the most widespread disease entities in the world, so it is not surprising that susceptibility to it is probably the best researched aspect of oral health in children with attention deficit hyperactivity disorder. Research provides reports showing an increased frequency of incidences of caries in children with attention deficit hyperactivity disorder. Although not all studies confirm such a regularity, numerous hypotheses indicate that such

a relationship may take place. The authors usually took into account the DMFT (decayed, missing, filled teeth) indicator, which is the equivalent of the Polish PUWz indicator, which shows the number of permanent teeth affected by caries, removed or filled due to caries.

Our own research showed that in the group of children with attention deficit hyperactivity disorder there is a higher average number of DMF. Among the persons suffering from ADHD, the average number of DMF was 2.73, while in the control group it was 2.33. Comparing the average number of DMF in individual age groups, it was observed that among children aged 7-10 years, the average number of DMF was 1.64 among children with ADHD and 1.63 among children without ADHD. Among children aged 11-13 years, this figure was 2.78 in the study group and 1.93 in the control group, while in the oldest age group (14-17-year-olds) it was 4.44 and 3.66, respectively. The research also showed a statistically significant difference in the value of the number of D. In the group of children with ADHD, the average number of D was 1.37 while in the control group it was on average 0.75. Although some discrepancies in the results between the groups are not statistically significant, it can be stated that among people with attention deficit hyperactivity disorder there is a slightly higher tendency to develop carious lesions. However, this study showed a higher F value in the control group (1.52 vs. 1.24 in the test group); therefore, children without a disorder have more teeth cured.

Grooms *et al*. came to similar conclusions. At the Duke University Medical Centre in the state of North Carolina in the United States they examined 38 children aged 6 to 10 years with diagnosed ADHD and compared them with a properly selected control group. A clinical trial was performed, and unstimulated saliva samples were collected. The authors found no significant differences in the DMFS index; however, these studies showed an increased incidence of caries in children with attention deficit hyperactivity disorder. This observation applies to both carious lesions limited to enamel as well as deeper defects in primary and primary dentition [11].

Bimstein *et al*., conducting retrospective studies in Florida in the United States, used dental documentation to compare a group of children with ADHD with a group without the disorder. That study did not consider the DMFS index, but only the number of surfaces covered by the carious process and filled. It was shown that in the group of children with ADHD the average number of carious surfaces was 8.1 while in the control group it was 6.5, and the number of filled surfaces was 1.3 and 1.6, respectively. Therefore, some discrepancies can be seen, but no statistical significance is observed. However, a statistically significant difference was shown in the past in the presence of oral pain. As the authors themselves noted, this study had some limitations, including the fact that it was retrospective and performed by various researchers [12].

Kohlboeck *et al*. obtained results that may suggest an increased tendency for caries in children with ADHD. The authors studied the relationship between the occurrence of symptoms of ADHD and the presence of carious lesions. A total of 1126 respondents at the age of 10 years took part in the study. Based on the Strengths and Difficulties Questionnaire (SDQ), the subjects were classified into three groups. People who scored 0 to 10 were classified into the group with no disorders (965 respondents), while people who scored higher were classified to the group with abnormal level (101 people) and borderline level (60 people). Many aspects were considered in this study. The average DMFS number in the group with no disorders was 0.3, while in the borderline and abnormal group the recorded number was 0.27. The DMFS index for individual groups was 0.39 and 0.37, respectively. 97.7% of children without disorders and 98.1% of children with disorders did not have a single tooth with a carious defect, one tooth with a carious lesion occurred in 2.2% and 1.2% of children, respectively, and two defects in 0.1 % and 0.6% of children, respectively. The number of surfaces affected by caries was as follows: 0 area – 97.7% and 98.1%, 1 area – 1.9% and 0.6%, 2 areas 0.3% and 0.6%, and 3 areas 0, 1% and 0.6% for the group without and with disorders, respectively. These differences were not statistically significant. Studies have shown, however, that more children with an abnormal and borderline ADHD index have at least one carious lesion without enamel loss compared to children with a normal index. Such a change was found in 47% of children without disorders and 57.1% of children with disorders. The difference was statistically significant. Both examined groups also differed significantly in the number of teeth with carious lesions without enamel loss and the number of such surfaces. An average of 1.05 teeth and 1.36 surfaces were observed in the group without ADHD, and an average of 1.4 teeth and 1.96 caries surfaces without a defect in the group showing disorders [13].

Chandra *et al*. studied 80 children with primary dentition, half of whom were diagnosed with ADHD. An oral visual examination was performed, and the level of oral hygiene was determined. Parents and guardians were also asked to complete a questionnaire regarding child's behaviour, hygiene habits, and eating habits. The study showed that children with ADHD have a statistically significantly higher surface def index [14].

Extensive research on the state of the oral cavity and dental treatment in children with attention deficit hyperactivity disorder was carried out in Sweden by Blomqvist *et al*. Individual analyses concerned children aged 11 and 13 years and adolescents aged 17 years [15-17].

Studies conducted on a group of 11-year-olds (25 children with ADHD and 58 in the control group) showed a statistically significantly higher DMFS and DS index in the group of children with ADHD relative to the control group. The DMFS was 2.0 ± 3.0 in the study group and

1.0 ± 1.5 in the control group, while the DS index was 1.7 ± 3.6 and 0.5 ± 0.9, respectively.

In the group of children of 13-year-old children consisting of 21 children with attention deficit hyperactivity disorder and 79 children without this disorder, there were no statistically significant differences between the groups in the frequency of caries at different stages. The average DMFS index was 2.8 ± 4.0 for the group of children diagnosed with ADHD and 2.2 ± 3.2 for the group without the disorder. The DS index was 1.0 ± 2.2 and 0.7 ± 1.5, respectively, for the above groups. 38% of children with ADHD and 48% in the control group were free from caries.

Blomqvist *et al.* also studied 17-year-old youths: 32 with attention deficit hyperactivity disorder and 55 without the disorder were analysed. The DMFT index was 4.6 ± 2.8 for adolescents with ADHD and 3.6 ± 3.6 for the control group, and the DMFS index was 6.1 ± 4.3 and 4.4 ± 4.9, respectively. The average number of teeth with initial caries without cavity was 2.6 ± 2.6 for the test group and 2.3 ± 2.7 for the control group, whereas the area covered by initial caries was 2.7 ± 2.6 and 2.5 ± 3, respectively. All these differences do not show statistical significance. The DS index giving information about the number of surfaces affected by caries was 2.0 ± 2.2 for the group with ADHD and 0.9 ± 1.4 for the test group; this difference is statistically significant. The difference in the percentage of people free from caries, which was 6% for the study group and 29% for the control group, is also statistically significant [15-17].

Broadbent *et al.* studied slightly different parameters when comparing a group of children with ADHD and their peers aged 11-13 years old from Otago, New Zealand. The study and control groups were matched in terms of age, gender, ethnicity, and socioeconomic status. All examined children had access to free dental treatment in school. The authors based the study on the medical records of the respondents and the conducted survey. In the group of children with the disorder there was a 12-fold higher chance of occurrence of a high DMFT index (i.e. a value of 5 or higher) [18].

The above results suggest a greater tendency to develop caries in children with attention deficit hyperactivity disorder compared to children without the disorder – manifested by a higher DMF value. However, such studies were also carried out, whose authors received quite different results. Research conducted by Hidas *et al.* in Israel did not show statistically significant differences between the three examined groups of children aged 5-18 years. The subjects were divided as follows: children with ADHD – pharmacologically untreated, children with ADHD – pharmacologically treated and control group. The average DMFT/dmft ratio in individual groups was: 2.55, 4.30, and 4.10 (standard deviation, respectively: 2.29, 3.8, and 3.59), and therefore was the lowest in the pharmacologically untreated ADHD group and the highest among the pharmacologically treated ADHD group. However, these differences were not statistically significant ($p = 0.065$) [19, 20].

Atmetlla *et al.* also obtained different results from their research on a group of 36 children with ADHD and a control group of 47 children aged 5-13 years, showing a significantly higher DMFT index for the control group relative to the study group [21].

CONCLUSIONS

The obtained high values of caries indexes (frequency and intensity of caries) indicate unsatisfactory dental health of the examined group of children and adolescents with attention deficit hyperactivity disorder.

The caries treatment index had a much lower value in children and adolescents with attention deficit hyperactivity disorder than in the control group.

Studies have shown a strong correlation between the presence of high titres of *Streptococcus mutans* and *Lactobacillus* spp. in saliva and the occurrence of caries.

Children and adolescents with attention deficit hyperactivity disorder should be included in the group of patients with increased risk of oral disease.

CONFLICT OF INTEREST

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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