Caries Experience Associated with Attention – Deficit / Hyperactivity Disorder

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The purpose of this cross-sectional study was to examine whether children with attention-deficit / hyperactivity disorder (ADHD) had a total caries experience that was equivalent to children without the disorder.

Methods*: The test sample included children ages 6 to 10 years old diagnosed with ADHD by physicians at Duke University Medical Center. The control group also included healthy children 6 to 10 years old without the diagnosis of ADHD. A visual dental exam for caries was performed and a sample of whole, unstimulated saliva was collected. The parent / guardian of each participant completed a health/medication history and a questionnaire concerning the child's oral health and habits, daily routine, and demographic information.*

Results*: Wilcoxon and chi-square tests showed that children with ADHD have significantly more enamel caries in the primary and permanent dentitions and a significantly higher prevalence of total caries experience when compared to controls. There was no significant difference in whole saliva production between the ADHD children and the controls.*

Conclusions: *Dentists should be aware that children with ADHD are at higher risk for caries.*
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INTRODUCTION

Attention-deficit / hyperactivity disorder (ADHD) is one of the more commonly diagnosed mental disorders of children. Studies have noted a prevalence of ADHD ranging from 1.7% to 17%.[1,2] It is usually diagnosed when children are between six and twelve years of age as they enter and progress through the educational system. These children are unable to concentrate on tasks and are often considered hyperactive. Symptoms include making careless mistakes, being disorganized, having difficulty listening to others and following instructions, having difficulty completing tasks in an appropriate amount of time, restlessness, speaking out of turn, or having trouble being patient and playing quietly.[3-5]

Some parents and health care providers choose to treat ADHD through behavior modification but the most common treatment is pharmacological therapy. Stimulant medications include Ritalin®, (methylphenidate HCl), Dextrostat®, (dextroamphetamine sulfate) and Adderall®, (amphetamine aspartate, amphetamine sulfate, and dextroamphetamine saccharate). Alpha-adrenergic medicines for the treatment of ADHD include Catapress®, (clonidine) and Tenex®, (guanfacine). Serotonin reuptake medicines include Wellbutrin®, (bupropion) and Effexor®, (venlafaxine). Tricyclic antidepressant medications for the treatment of ADHD include Tofranil®, (imipramine), Norpramine®, (desipramine) and Pamelor®, (nortriptyline).[6,7] Xerostomia, which could contribute to a greater caries experience for these children, has been reported with dextroamphetamine medications and non-stimulant medications such as serotonin reuptake medicines and tricyclic antidepressants.[6,7]

The dental community is concerned with the oral health of children with this disorder because of the associated inattentiveness and / or hyperactivity. Additionally, the diet and appetite of an ADHD child may be altered by medications that could contribute to an

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increased caries risk. The purpose of this study was to examine the caries experience of children diagnosed with ADHD. Information was collected on medication history, dietary habits, oral hygiene routines, saliva production, and socioeconomic status to provide insight into the caries susceptibility of these children.

METHODS AND MATERIALS

This investigation was an IRB approved cross-sectional study of a convenience sample of pediatric patients. Data collection occurred at Duke University Medical Center (DUMC) Pediatrics and Pediatric Dentistry clinics. Children included in the study met the following inclusion criteria: (1) they were between the ages of 6 years 10 months and 10 years 11 months of age, (2) they had a minimum of 16 teeth present in their mouth, (3) they were considered healthy and willing to participate by their parents. Both males and females were included in the study. Subjects were sampled to obtain approximately equal numbers of children in each of the two groups: ADHD cases and non-ADHD controls. DUMC physicians diagnosed the ADHD cases according to the Diagnostic and Statistical Manual, Fourth Edition (DSM-IV).[5] The non-ADHD control group was age, race, sex and socioeconomic status matched patients. Socioeconomic status was determined by distributing the participants into two groups: (1) those with Medicaid or SCHIP dental insurance, and (2) those with private dental insurance or no dental insurance.

The parent / guardian of all children in the study completed a questionnaire concerning their child's oral health including diet, oral hygiene, dental care, fluoride exposure, and daily activities. In addition, the parent / guardian of the ADHD subjects completed a medical history for their child. Information was gathered to when the diagnosis of ADHD was made and to assess which medications the child had taken for ADHD.

The clinical data was collected based on the protocol developed by the National Institute of Dental and Craniofacial Research for the National Health and Nutrition Examination Survey (NHANES III).[8] The decayed, missing, and filled surfaces index (DMFS) was obtained for the permanent teeth, and the (dmfs) was obtained for the primary teeth. The subject's teeth were charted for their presence, caries, restorations, and sealants. One examiner collected the data. Prior to data collection, the examiner was calibrated by an investigator who was experienced and previously calibrated in the use of the examination protocol, and assessed reliability.[8,9]

Following the dental examination, a timed, quantitative, unstimulated, whole saliva sample was collected for each study participant. The saliva sample was collected according to the procedure described by Bretz, et. al.[10] The weight of the saliva was measured to the nearest one-hundredth of a gram and recorded.

A power analysis was conducted with a beta of=0.80 and an alpha=0.05. Although there are no published dmfs / DMFS data for ADHD children, we proposed that a two-fold increase in dmfs / DMFS among ADHD children would represent a clinically-meaningful elevation in caries. In order to detect a statistically significant difference ($p \leq 0.05$) of this magnitude at the nominated power, we required 32 ADHD subjects and 32 non-ADHD subjects assuming a common standard deviation of 7.0 (as computed in our own unweighted analysis of NHANES III data for children 6 through 10 years old).[8]

TABLE 1: Age and dmfs / DMFS Score

	ADHD subjects			Non-ADHD controls / siblings			p value
	N	Mean	Std	N	Mean	Std	
Age (exact)	38	8.96	1.32	37	8.72	1.21	0.4
Primary Fiss Seal	38	0.08	0.35	37	0.27	0.73	0.2
Primary fs	38	3.97	7.19	37	3.59	7.69	0.3
Primary d(1)s	**38**	**1**	**2.26**	**37**	**0.32**	**1.2**	**0.04**
Primary d(1)fs	38	4.97	7.36	37	3.92	7.63	0.2
Primary d(1)mfs	38	5.76	8.81	37	5.81	10.76	0.2
Primary d(3)fs	38	4.97	7.36	37	3.92	7.63	0.2
Prmary d(3)ms	38	0.79	2.47	37	1.89	5.69	0.6
Primary d(3)mfs	38	4.76	8.63	37	5.49	10.37	0.4
Permanent Fiss Seal	38	2.21	3.14	38	3.16	3.53	0.2
Permanent FS	38	0.34	0.96	38	0.45	1.05	0.5
Permanent D(1)S	**38**	**0.55**	**1.88**	**38**	**0**	**0**	**0.01**
Permanent D(1)FS	38	0.89	2.03	38	0.45	1.05	0.3
Permanent D(1)MFS	38	0.89	2.03	38	0.58	1.48	0.4
Permanent D(3)FS	38	0.89	2.03	38	0.45	1.05	0.3
Permanent D(3)MS	38	0	0	38	0.13	0.81	0.3
Permanent D(3)MFS	38	0.34	0.96	38	0.58	1.48	0.5

(Note that d1mfs represents total caries experience in the primary dentition and that d3mfs represents caries experience starting at the threshold of dentinal decay.)

Table 2: Saliva Collection

	ADHD Subjects	Control Subjects
Average amount of saliva produced	0.94g	0.82g
Percentage of subjects producing less than 0.5g of saliva	45% (17/38)	37% (14/38)
Percentage of subjects producing more than 0.5g of saliva	55% (21/38)	63% (24/38)

RESULTS

Seventy-six children participated in this study; 38 ADHD subjects and 38 non-ADHD controls. Each group contained 31 males and 7 females. This gender mix was similar to that reported by Rowland.[11] The dmfs index represents surfaces with incipient decay confined to the enamel (d1), surfaces with dentinal decay (d3), surfaces that were filled (f), or surfaces of teeth that had been extracted because of caries (m). The mean total caries experience in the primary dentition did not differ between ADHD cases (mean $\pm$ sd=5.76 $\pm$ 8.81) and the non-ADHD controls (5.81$\pm$10.26). DMFS scores for the permanent dentition were also calculated (Table 1). The results from unstimulated, whole saliva collection are shown in Table 2 and the response to the oral hygiene questionnaire items are shown in Table 3. There was no difference in exposure to fluoridated drinking water or fluoride supplements between the ADHD subjects and controls.

Seventy-nine percent (30/38) of ADHD subjects

Table 3: Oral Hygiene / Eating Practices and Systemic Fluoride Exposure

	ADHD Subjects	Control Subjects
Reported by parent / guardian to brush 3 or more times per day	63% (24/38)	71% (27/38)
Percentage who brushed one or less times per day and had one or more enamel caries lesions	37.5% (6/16)	14.3% (2/14)
Percentage who brushed two or more times per day and had one or more enamel caries lesions	18% (4/22)	4.3% (1/23)
Percentage who consumed two or more sugary snacks per day	45% (17/38)	53% (20/38)
Exposure to fluoride on a regular basis	71% (27/38)	71% (27/38)
Floss one or more times per week	53% (20/38)	71% (27/38)

Table 4: At Least One Medication Exposure

Percentage with at least one exposure to a methylphenidate medication	81% (30/37)
Percentage with at least one exposure to a dextroamphetamine medication	19% (7/37)
Percentage with at least one exposure to a non-stimulant medication	32% (12/37)

Table 5: Methylphenidate Exposure and dmfs / DMFS Score

	Exposure to a methylphenidate medication	All other ADHD subjects	Control Subjects
Filled primary teeth	3.90 surfaces	4.71 surfaces	3.59 surfaces
Total caries experience in the primary dentition	6.00 surfaces	4.71 surfaces	5.81 surfaces
Fissures sealed in the permanent dentition	1.87 surfaces	4.00 surfaces	3.16 surfaces
Amount of saliva produced	0.93g	1.08g	0.82g

Table 6: Dextroamphetamine Exposure and dmfs / DMFS Score

	Exposure to a dextroamphetamine medication	All other ADHD subjects	Control Subjects
Filled primary teeth	5.00 surfaces	3.83 surfaces	3.59 surfaces
Total caries experience in the primary dentition	5.00 surfaces	5.93 surfaces	5.81 surfaces
Fissures sealed in the permanent dentition	3.29 surfaces	2.03 surfaces	3.16 surfaces
Amount of saliva produced	1.33g	0.87g	0.82g

Table 7: Non-Stimulant Medication Exposure and dmfs / DMFS Score

	Exposure to a non-stimulant medication	All other ADHD subjects	Control Subjects
Filled primary teeth	2.92 surfaces	4.60 surfaces	3.59 surfaces
Total caries experience in the primary dentition	5.08 surfaces	6.08 surfaces	5.81 surfaces
Fissures sealed in the permanent dentition	2.92 surfaces	1.96 surfaces	3.16 surfaces
Amount of saliva produced	1.23g	0.83g	0.82g

reported seeing a dentist for regular visits versus 89% (34/38) of the control subjects. Two ADHD subjects and six controls either had never seen a dentist or the parent / guardian could not remember the last time a dental visit occurred. Forty-nine percent of the ADHD children had been taking disorder-related medications for less than 24 months and 51% had been taking medications for more than 24 months. One parent could not remember what medications his or her child had taken and for how long the child had taken the medications. The exposure of ADHD children to a methylphenidate, dextroamphetamine, or medication other than a stimulant for the treatment of ADHD varied. (Table 4)

The children who reported exposure to a methylphenidate medication had less filled primary teeth, but more total caries experience in the primary dentition compared to other ADHD children. This finding was consistent with an anecdotal report.[12] These children also had less fissure sealed surfaces in permanent teeth and they produced less saliva than other ADHD children not exposed to this medication. (Table 5)

Children who reported an exposure to a dextroamphetamine drug had more primary filled surfaces but less total caries experience in the primary dentition compared to other ADHD children. These children also had more permanent teeth fissures sealed and they produced more saliva than other ADHD children not exposed to the drug. (Table 6)

ADHD subjects exposed to non-stimulant medications for treatment of the disorder had less filled surfaces on primary teeth and their total caries experience in the primary dentition was less than stimulant medicated ADHD children. These children also had more fissures sealed in the permanent dentition and produced more saliva than those children who reported taking only a stimulant for the treatment of ADHD. (Table 7)

ADHD subjects had significantly more enamel caries surfaces in the primary dentition than the control subjects (Wilcoxon Two-Sample Test, $Z = -2.0$, $p = 0.04$). ADHD subjects also had significantly more enamel caries surfaces in the permanent dentition versus the control subjects (Wilcoxon Two-Sample Test, $Z = 2.5$, $p = 0.01$). The same conclusions were found for the dmfs / DMFS analysis of the matched pairs as the primary dentition had more enamel caries than the controls (McNemar's Test, $p = 0.05$) and the permanent dentition also had more enamel caries than the controls (McNemar's Test, $p = 0.02$). ADHD subjects had a total caries prevalence of 66% versus 43% total caries prevalence for controls in the primary dentition (Chi-square test, $p = 0.05$). There was no statistically significant difference between the prevalence of caries at the dentin threshold in the primary dentition for ADHD subjects versus controls (50% versus 35%).

There was not a significant difference between the number of ADHD participants and controls that were able to produce more or less than 0.5g of saliva upon collection (Chi-square, $p = 0.5$) and there were no significant differences found for the amount of saliva produced when taking medications for the treatment of ADHD (Wilcoxon Two-Sample Test, $Z = 0.00$, $p = 1.0$). No significant differences were noted for the type of medication an ADHD child was taking and the dmfs / DMFS scores versus other medications or control children.

Statistical significance was not reached when comparing the frequency of the child's response to toothbrushing and dmfs / DMFS scores, but significance was close for enamel caries in the primary dentition (Wilcoxon Two-Sample Test, $Z = 1.69$, $p = 0.08$). Furthermore, there was not a statistically significant difference between the fissure sealant experience in the permanent dentition of those children with or without the ADHD diagnosis (Wilcoxon Two-Sample Test, $Z = -1.23$, $p = 0.21$).

DISCUSSION

Children diagnosed with ADHD had more carious lesions confined to the enamel than children not diagnosed with the disorder. This was noted in both the primary and permanent dentitions and was confirmed by statistical analyses reaching significance when both unmatched and matched pairs were investigated. This study also noted a statistical difference in the prevalence of children with at least one or more lesions at the enamel caries threshold. This means that a significantly higher percentage of children with ADHD will have at least one carious lesion starting at the enamel when compared to children without the disorder.

There were no detected differences between ADHD and non-ADHD subjects in key preventive practices including tooth brushing with a fluoridated dentifrice, systemic fluoride exposure and flossing. There were also no reported differences in diet between ADHD subjects and controls. Even though tooth brushing with a fluoridated toothpaste is an important oral hygiene measure when examining the dentition for enamel caries ($p = 0.08$), it did not explain the ADHD effect resulting in more enamel caries lesions.

A greater number of ADHD subjects produced less than 0.5g of saliva than the controls but the mean salivary flow rate for ADHD subjects was greater than the mean salivary flow rate for the controls. These findings do not support reduced saliva production as a primary factor for the enamel lesions. Children taking methylphenidate produced the least amount of saliva of all children taking ADHD medications. This was unexpected since dextroamphetamine and non-stimulant medications have been reported to create xerostomia. In contrast, methylphenidate has not been reported to have this side effect.

This cross-sectional study was not able to explain the

differences in enamel lesions observed through differences in prior patterns of dental care. Non-ADHD subjects had a trend towards fewer filled surfaces than ADHD children in the primary dentition ($p = 0.2$) and permanent dentition ($p = 0.5$). However, no meaningful difference was found between ADHD and non-ADHD subjects in the mean number of sealants ($p = 0.2$) for the permanent dentition.

ADHD children have more filled surfaces and enamel caries. It can be hypothesized that the total caries experience in ADHD children may begin earlier than in the controls. If this occurred, children with ADHD would benefit from early professional dental examinations and prevention regimens to help avoid or manage these lesions. This is consistent with the findings reported by Broadbent et al.[13]

Plaque was observed on the teeth and the gingival margins of some patients but because this study had a cross-sectional design an oral hygiene index would have been of limited value. Given this limitation, the study could not determine if oral hygiene practices contribute to the child's caries experience as was hypothesized by Friedlander.[14]

By using the cross-sectional design, this study examined participants at one point in time. Different results may have been found if this study had followed the ADHD subjects longitudinally starting from when they were diagnosed with the disorder. Control subjects would have also had to be followed for the same amount of time. Other risk factors for dental caries such as the cariogenic bacteria load in the oral cavity and saliva composition were not measured.

This study was not able to identify the exact contributing factors to the caries experience of the ADHD children but the conclusions can be helpful to practicing dentists. Children with ADHD have higher-than-expected rates of enamel caries. Implementation of a more aggressive preventive program may help to prevent these lesions from occurring or could promote remineralization of the lesions. Sealants may also aid in preventing caries in these children.

CONCLUSIONS:

In examining the caries experience associated with ADHD, this study found a higher incidence of enamel caries in the primary and permanent dentitions of ADHD subjects compared to controls. A higher prevalence of caries starting at the enamel threshold was also noted for ADHD children compared to control subjects.

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Related abstract and article

A Process For Developing Community Consensus Regarding the Diagnosis and Management of Attention-Deficit/Hyperactivity Disorder. Meschan F. and Earls M.F. *Pediatics, 115*:e 105-e 108 p. 167-68, 2005 or
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Reduced Injury Risk to Restrained Children Exposed to Deployed First and Second Generation Airbags in Frontal Crashes.

Arbogast, KB et al. Arch.Pediat.Adolesc. Med. 159: 342-46, April 2005

Even if passenger airbags reduced occupant fatalities in adults by 18% in frontal crashes and by 11% in all crashes, the risk of death for children younger than 10 years old increased by 34% and non fatal injuries by 87%. Taking this into account, new second generation airbags are being tested to reduce potential ill effects of its predecessor. This study has shown some encouraging results. However the current recommendation of children under 13 years to sit in age-appropriate restraints in the rear seat of vehicles should still be stressed.