DOI: 10.1111/j.1365-263X.2010.01109.x

INTERNATIONAL JOURNAL OF PAEDIATRIC DENTISTRY

Dental caries status and salivary properties of asthmatic children and adolescents

MÔNICA PAGANINI[1], CÁSSIA CILENE DEZAN[2], THIAGO RODRIGO BICHACO[1], FLAVIANA BOMBARDA DE ANDRADE[3], ALCINDO CERCI NETO[4] & KAREN BARROS PARRON FERNANDES[1]

[1]School of Dentistry, University of Northern Parana – UNOPAR, Londrina, Paraná, Brazil, [2]Department of Paediatric Dentistry, State University of Londrina, Londrina, Paraná, Brazil, [3]Bauru Dental School, University of São Paulo, Bauru, São Paulo, Brazil, and [4]Department of Pneumology, State University of Londrina, Londrina, Paraná, Brazil

International Journal of Paediatric Dentistry 2011; 21: 185–191

Aims. This study aimed to investigate the dental caries status and salivary properties in 3- to 15-year-old children/adolescents.

Methods. The sample was split in two groups: asthma group (AG), composed of 65 patients who attended Public Health Service; asthma-free group (AFG), composed of 65 nonasthmatic children/adolescents recruited in two public schools. Stimulated salivary samples were collected for 3 min. Buffering capacity and pH were ascertained in each salivary sample. A single trained and calibrated examiner (kappa = 0.98) performed the dental caries examination according to WHO criteria.

Results. The AFG showed salivary flow rate (1.10 ± 0.63 mL/min) higher ($P = 0.002$) than AG (0.80 ± 0.50 mL/min). An inverse relationship was observed between asthma severity and salivary flow rate (Phi coefficient, $r\phi$: 0.79, $P = 0.0001$). Children with moderate or severe asthma showed an increased risk for reduced salivary flow rate (OR: 17.15, $P < 0.001$). No association was observed between drug use frequency ($P > 0.05$) and drug type ($P > 0.05$) with salivary flow rate. Buffering capacity was similar in both groups. No significant differences were encountered in dental caries experience between AFG and AG groups.

Conclusions. Although asthma can cause reduction in flow rate, the illness did not seem to influence dental caries experience in children with access to proper dental care.

Introduction

Bronchial asthma is an inflammatory chronic disease with wheezing, dyspnoea, chest oppression and cough as main clinical aspects[1,2]. Several factors, such as genetic predisposal, respiratory infection, allergy, social status and environmental conditions, can modulate its clinical manifestation[3,4].

Millions of people around the world are affected by asthma with marked differences in its morbidity and mortality. Recent studies have shown that about 3.8% of the infantile population presents asthma and its prevalence is increasing in many countries[5], being more prevalent in 6- to 11-year-old children[6]. Inhaled corticosteroids as well as short-time action beta2-agonists are the main drugs used for asthma treatment, being usually chosen according to disease severity. On the other hand, long-action beta2-agonists, leukotriene inhibitors, sodium cromoglicate and aminophilins can also be used[1].

Asthma is an important public health problem affecting children and adolescents, although there are few reports about the oral health status of asthmatic children.

Guergolette *et al.*[7] have reported a high prevalence of developmental defects of enamel in relation to asthma severity, symptom onset and pharmacological treatment in paediatric asthma patients.

Asthmatic children may have an increased risk for dental caries[8], as changes in salivary flow and buffering capacity have been related to asthma or its treatment[4]. Studies concerning dental caries experience in asthmatic children have reported some contrasting results.

Therefore, the aim of this study was to evaluate the dental caries status and salivary

Correspondence to:
K. B. P. Fernandes, Rua Marselha, 183, Jd. Piza, CEP 86041-100, Brazil. E-mail: karen.fernandes@unopar.br

properties (salivary flow rate, salivary pH and buffering capacity) in 3- to 15-year-old asthmatic children/adolescents.

Methods

This research aimed to evaluate the oral conditions of asthmatic children and adolescents attended by the 'Breath Londrina Program'. This program begun in 2003 to improve the quality of health assistance to asthmatic patients, as well as to recommend better therapeutic choice for each clinical situation. Inhaled corticosteroids and bronchodilators are the main pharmacological approach used. In this program, the patients also have monthly conferences and meetings with health professionals when they receive suitable information about the disease and its treatment. Since its beginning, a marked reduction in acute crisis and in hospital visits was observed, which resulted in better patient quality of life as well as significant economy for the public health system[9].

Experimental design and study population

This cross-sectional study involved children and adolescents (aged 3–15 years) from two experimental groups: asthma (AG, $n = 65$) and asthma-free group (AFG, $n = 65$).

For the AG, children and adolescents from both genders were randomly selected from the list of patients who attended the 'Breath Londrina Program' (Municipal Health Service for Asthma Assistance in Londrina-PR, Brazil).

The patients selected as AG were using continuously either corticoids or bronchodilators for acute crisis.

Children and adolescents from Londrina public schools with similar age, gender and social background to AG were recruited as control patients and called the AFG. Indeed, these patients used no chronic medication and had no systemic diseases.

Any child/adolescent from public schools recruited as AFG presenting bronchial asthma was included at the AG afterwards.

This study was approved by the Institution's Ethical Committee (University of Northern Parana, Londrina-PR, Brazil) and by coordination of the 'Breath Londrina Program'. The patients' parents received a phone call explaining the research as well as an invitation to join it. If the parents agreed to join the research, a dental appointment at the University was scheduled.

At the dental appointment, the children's parents received information about the purpose of this research and a written informed consent was obtained prior to the clinical examination. All children received instructions about oral health maintenance and a toothbrush at the end of the clinical examination.

Children and adolescents living in Londrina take part in a basic dental preventive program starting at 1 year of age. Furthermore, individually intensified preventive programmes are designed for children with special needs, such as a high caries risk or mental or physical disabilities.

Pilot study and sample size determination

A pilot study was performed with 40 children (20 children from AG and 20 children from AFG) and salivary flow rate was the variable used in this pilot study for sample size determination.

BIOESTAT 4.0 program was used to estimate the sample size, using the mean and standard deviation of the salivary flow rate from both groups (AG: 0.55 ± 0.23 mL/min; AFG: 1.19 ± 0.77 mL/min) obtained in this pilot study. The test power was set at 0.99 (99%) with an alpha level of 0.01 ($P < 0.01$) for bicaudal distribution. Therefore, the minimum sample size established was 38 patients.

Methodological procedures

Three examiners performed data collection, one being responsible for the parents' interview, another for salivary property (salivary flow rate, salivary pH and buffer capacity) determination and the last one for dental caries diagnosis.

Dental caries diagnosis was performed by one examiner who had been previously trained and calibrated, according to World Health Organization criteria[10]. The kappa value estimated for repeat examination for the consistency of the fieldwork examiner was $k = 0.98$.

After the clinical examination, dmf and DMFT (number of decayed, missed or filled teeth) were calculated. Those responsible for each child or adolescent were instructed not to allow him or her to eat or drink for 2 h before saliva collection. Whole saliva was stimulated by chewing paraffin wax, with the samples collected between 9 and 11 A.M to reduce variations caused by changes in circadian rhythm. The collected saliva during the first 10 s was discarded and then collected for 3 min into ice-chilled test tubes. The pH of saliva was measured immediately after collection and flow rate was calculated and classified as: *normal* – salivary flow rate greater than 1 mL/min; *low* – salivary flow rate between 0.7 and 1 mL/min; *very low* – salivary flow rate smaller than 0.7 mL/min. A pH meter (Model 710A; Orion Research, Boston, MA, USA) was used to measure initial pH, and buffering capacity was determined by the Ericsson's method[11].

The parents were interviewed about the medical and dental history of their children, with special regard to bronchial asthma history (disease onset and its pharmacological treatment). Asthma severity was classified according to Shulman *et al.*[12] These data were used to classify asthma severity that was confirmed through patients' medical records.

Statistical analysis

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) software 15.0 (IBM Company, Chicago, IL, USA). A confidence interval of 95% and significance level of 5% ($P < 0.05$) were established for all statistical tests used.

All data were presented as mean ± standard deviation (SD). The chi-square test was used to access differences in categorical data between groups.

Phi's coefficient was used to evaluate possible association between asthma severity, drug use frequency, drug type and changes in salivary flow. To perform this analysis, the following variables were considered dichotomic: asthma severity (intermittent-mild or moderate-severe); drug use frequency (continuous or for acute crisis); drug type (bronchodilators or corticosteroids).

To evaluate if asthma characteristics could affect salivary flow, a multivariable logistic regression model (Forward Stepwise Likelihood Ratio) was used, controlled by gender and age. Therefore, the independent variables included in the model were those related to a reduction in salivary flow rate: asthma severity (intermittent, mild, moderate and severe), symptom onset (first year, second year, after third year), treatment beginning (first year, second year, after third. year), treatment duration (1 year, 2–4 years, >4 years) and chronic use of bronchodilators (yes/no). The data categories were established based on data distribution in the population study and the reference category was established as the low risk category.

Results

Demographic characteristics

In this study, 130 patients were enrolled, being 65 from AG and 65 from AFG.

The AG was composed of 43 (66.15%) female and 22 (33.85%) male children. Considering that asthma patients were randomly selected from a patients' list of Breath Londrina Program and only the patients who agreed to join the research had a dental appointment scheduled, gender distribution occurred by chance and it does not represent the asthma distribution according to gender.

Moreover, the AFG was composed of 34 (52.31%) female and 31 (47.69%) male children. No differences between the mean age from AG (8.92 ± 3.02) and AFG (9.42 ± 2.47) were observed, according to *t*-test ($t = -1.02$; $P = 0.31$).

Asthma severity and treatment

In the AG, moderate or severe asthma was observed in 41 (63.10%) patients and 24 (36.90%) patients had mild or intermittent asthma.

Regarding asthma treatment, 32 (49.23%) patients used corticosteroids whereas 24

(36.93%) patients used bronchodilators to prevent acute crisis. On the other hand, four (6.15%) patients used concomitantly corticosteroids and bronchodilators daily.

Additionally, most patients (43.08%) have used the medication for more than 4 years.

Although the asthma symptoms started in the first year of age in 52.31% of the patients, only 33.85% had promptly started the treatment at this age. On the other hand, several patients (30.77%) started the treatment after 3 years of age.

Salivary flow rate, salivary pH, buffering capacity and dental caries experience

Statistically significant differences were observed between the groups concerning salivary flow rate (mL/min) and initial pH, although no differences were observed regarding buffering capacity (Table 1). Salivary flow classification showed that 23.08% of asthmatic children had normal and 50.77% had very low salivary flow rate (Table 2).

Salivary flow rate has statistically reduced in relation to asthma severity (Table 3), according to one way ANOVA. Additionally, asthma severity was associated with the reduction in salivary flow rate, according to Phi coefficient ($r\phi$: 0.79, $P = 0.0001$). On the other hand, no association was observed between drug use frequency ($P > 0.05$) and drug type ($P > 0.05$).

Multinominal logistic regression showed that asthma severity is an important risk factor in decreasing salivary flow rate (OR = 17.153; 95% CI: 3.777–77.898) (Table 4).

To compare dental caries experience between the groups, the children were split into different age ranges. On the other hand, no differences in dmft and DMFT indexes were observed between the groups (Table 5). Additionally, both groups showed a similar dental caries experience. It was observed that 33.85% of the patients from the AG and 40.0% of the patients from AFG are caries free. Moreover, most patients showed one to four dental caries lesions in AG (56.92%) and AFG (49.23%).

In contrast to the data obtained with salivary flow rate, bronchial asthma does not seem to be a risk factor for buffering capacity and dental caries experience.

Discussion

In this study, a marked reduction in the salivary flow of asthmatic children and adolescents was observed. Considering that systemic disorders solely do not always evoke oral diseases, controversies about asthma influence on oral health status of children and adolescents still remain[3,4,12–14].

When studying the relationship between systemic and oral pathologies it is important to get reliable information about both. In this research, the access to medical records allowed to achieve credible information concerning asthma onset and pharmacotherapy, once the data obtained from the children's parents were checked and confirmed. Moreover, as the medical records present not only the drug type used but also the frequency of the drug type, a better comprehension about the drug's influence on salivary properties could be achieved.

Table 1. Comparison of salivary flow rate, initial and final pH between the asthma group (AG) and asthma-free group (AFG), according to *t*-test.

Variable	Group	*n*	Mean	SD	*t*	*P* (bicaudal)	95% CI	
							Upper	Lower
Salivary flow rate (mL/min)	AG	65	0.80	0.50	–3.04	0.002	–0.50	–0.11
	AFG	65	1.10	0.63				
Initial pH	AG	65	7.44	0.26	2.52	0.01	0.02	0.18
	AFG	65	7.33	0.20				
Final pH (buffering capacity)	AG	65	6.23	0.80	1.13	0.26	–0.12	0.43
	AFG	65	6.08	0.79				

Table 2. Frequency of salivary flow and buffering capacity in the asthma group (AG) and asthma-free group (AFG), according to the chi-squared test.

Classification	AG		AFG			
	n	%	*n*	%	χ^2	*P*
Salivary flow						
Normal (>1 mL/min)	15	23.08	28	43.08	6.63	0.04
Low (0.7–1 mL/min)	17	26.15	16	24.61		
Very low (<0.7 mL/min)	33	50.77	21	32.31		
Buffering capacity						
High (>6.50)	32	49.23	16	24.62	11.60	0.09
Normal (5.75–6.50)	22	33.85	39	60.00		
Low (4.0–5.74)	10	15.38	7	10.77		
Very low (<4.00)	1	1.54	3	4.62		

Table 3. Mean and standard deviation of salivary flow rate related to asthma severity.

Asthma severity	Salivary flow rate (mL/min)	
	Mean	SD
Intermittent	$1.43^{a,b}$	0.71
Mild	$1.07^{c,d}$	0.43
Moderate	$0.58^{a,c,e}$	0.19
Severe	$0.49^{b,d,e}$	0.21
Total	0.80	0.50

ANOVA: $P < 0.001$; means with the same letter are statistically different (Tukey: $P < 0.01$).

Table 4. *P*-value, odds ratio (OR) and confidence intervals (95% CI) of salivary flow rate according to asthma severity (intermittent, mild, moderate, severe), symptom onset (first year, second year, after third year), treatment beginning (first year, second year, after third year), treatment duration (1 year, 2–4 years, >4 years) and use of bronchodilators (yes/no).

Variable	*P*-value	OR	95% CI
Asthma severity	<0.001	17.15	3.77–77.89
Symptom onset	0.60	0.76	0.27–2.11
Treatment beginning	0.61	1.28	0.49–3.38
Treatment duration	0.56	0.82	0.42–1.61
Frequency of bronchodilator use	0.48	0.22	0.06–3.88

Saliva is basically composed of water (99%), organic and inorganic contents and plays many functions in oral health[15]. The clearance effect of saliva removes the endogenous and exogenous microorganisms and products from the bowel besides providing immunological and nonimmunological antimicrobial factors in the mouth[16]. Asthmatic children enrolled in this study had a lower salivary flow rate when compared with control children. Previous reports have also reported a reduced salivary flow in asthmatic children[4,17,18].

Logistic regression showed that asthma severity increases by about 17 times the risk of having a reduced salivary flow. Moreover, a negative relationship between asthma severity and salivary flow was also observed, as children with mild asthma showed a salivary flow about two times higher than those with severe asthma. On the other hand, as described by Ersin[4] and in contrast to the findings of Kargul *et al.*[19] the asthma pharmacotherapy (drug type or drug frequency) was not associated with a reduction in salivary flow rate. Some studies report a correlation between pH, buffer capacity and salivary flow rate and, therefore, factors that affect the salivary flow rate could modify the other properties[20]. Salivary pH was higher in asthmatic children when compared with the control group, in contrast to data presented by Ersin *et al.*[4]. On the other hand, as described by Larsen *et al.*[21], both groups exhibited a great variability in salivary pH, despite similar buffer capacity. Ersin *et al.*[4] have also found that buffer capacity in AG was similar to that in controls. Although the relationship between bronchial asthma and dental caries was evaluated in previous studies, many contrasting results have been presented. Some studies found no association between asthma and dental caries[3,12,22] as well as asthma and salivary properties[23].

There are also some reports that asthma severity or pharmacological treatment can

Table 5. Comparison between dmft and DMFT indexes in different groups (asthma group: AG; asthma-free group: AFG) related to age range.

Variable	Age range (years)	Group	*n*	Mean	SD	*t*	*P*	95% CI	
dmft	03–06	AFG	15	1.40	1.96	−0.32	0.76	−2.78	2.08
		AG	8	1.75	2.76				
	07–10	AFG	25	1.72	3.30	0.50	0.62	−1.13	1.86
		AG	31	1.35	1.82				
	11–15	AFG	5	0.80	0.84	0.11	0.92	−1.01	1.11
		AG	12	0.75	0.97				
DMFT	03–06	AFG	7	0.00	0.00	−1.55	0.17	−0.74	0.16
		AG	7	0.29	0.49				
	07–10	AFG	28	0.96	1.55	0.59	0.56	−0.50	0.92
		AG	37	0.76	1.21				
	11–15	AFG	22	1.55	1.79	1.42	0.16	−0.30	1.73
		AG	18	0.83	1.38				

evoke changes in dental caries prevalence[4,8,12,13,24–27].

In this study, an association between asthma severity and pharmacological treatment with caries experience was not observed, reinforcing the data obtained by Meldrum *et al.*[3], Halterman *et al.*[12] and Eloot *et al.*[22]. The oral health status of the study population, evaluated by caries experience, was satisfactory, as 33.85% of the asthmatic and 40.00% of nonasthmatic children were caries free. Moreover, only 9.23% of children from asthma and 10.77% from AFG showed more than four carious lesions in oral cavity. The DMFT index from 11- to 15-year-old-children enrolled in this study is in agreement with caries prevalence described for the local population at 12 years of age. This community has fluoridated water since 1972 and also has a public service, which provides free dental assistance to children from birth to 18 years of age to a great amount of children[28].

Considering that many authors such as Anjomshoaa[29] and Mehta[30] have reported an increase in dental caries in asthmatic children, it can be speculated that the oral health status observed seems to be more related to public policies for oral health than to asthma itself.

In conclusion, this study has demonstrated that despite asthmatic children showing a reduction on salivary flow rate, children with bronchial asthma have similar dental caries prevalence when compared with the control group, probably because dental caries is a multifactor disease and this population study had proper access to dental care. On the other hand, the importance of salivary flow rate on caries risk assessment should be considered.

Therefore, special oral health attention should be provided to asthmatic children to improve their quality of life. Moreover, it can be recommended that dentists should be included in the multiprofessional team involved in asthma assistance.

What this paper adds

- This study shows that asthma can cause reduction in flow rate, a very important risk indicative of dental caries. On the other hand, asthma did not seem to influence dental caries experience.

Why this paper is important to paediatric dentists

- It points that special oral health attention should be provided to asthmatic children and adolescents to improve their quality of life.
- It raises the idea that dentists should be included in the multiprofessional team involved in asthma assistance.

References

1 Busse WW, Lemanske RF Jr. Asthma. *N Engl J Med* 2001; **344**: 350–362.

2 Kumar RK. Understanding airway wall remodeling in asthma: a basis for improvements in therapy? *Pharmacol Ther* 2001; **91**: 93–104.

3 Meldrum AM, Thomson WM, Drummond BK, Sears MR. Is asthma a risk factor for dental caries? Finding from a cohort study. *Caries Res* 2001; **35**: 235–239.

4 Ersin NK, Gülen F, Eronat N *et al.* Oral and dental manifestations of young asthmatics related to medication, severity and duration of condition. *Pediatr Int* 2006; **48**: 549–554.

5 Lugogo NL, Kraft M. Epidemiology of asthma. *Clin Chest Med* 2006; **27**: 1–15.
6 Taylor WR, Newacheck PW. Impact of childhood asthma on health. *Pediatrics* 1992; **90**: 657–662.
7 Guergolette RP, Dezan CC, Frossard WTG, Ferreira FBA, Cerci Neto A, Fernandes KBP. Prevalence of developmental defects of enamel in children and adolescents with asthma. *J Bras Pneumol* 2009; **35**: 295–300.
8 Stensson M, Wendt LK, Koch G, Oldaeus G, Birkhed D. Oral health in preschool children with asthma. *Int J Paediatr Dent* 2008; **18**: 243–250.
9 Cerci Neto A, Ferreira Filho OF, Bueno T, Talhari MA. Reduction in the number of asthma-related hospital admissions after the implementation of a multidisciplinary asthma control program in the city of Londrina, Brazil. *J Bras Pneumol* 2008; **34**: 639–645.
10 WHO (World Health Organization). *Oral Health Surveys, Basic Methods*, 4th edn. Geneva: WHO, 1997.
11 Ericsson Y. Clinical investigations of the salivary buffering action. *Acta Odontol Scand* 1959; **17**: 131–165.
12 Halterman JS, Yoos HL, Sidora K, Kitzman H, McMullen A. Medication use and health care contacts among symptomatic children with asthma. *Ambul Pediatr* 2001; **1**: 275–279.
13 McDerra EJ, Pollard MA, Curzon ME. The dental status of asthmatic British school children. *Pediatr Dent* 1998; **20**: 281–287.
14 Wogelius P, Poulsen S, Sørensen HT. Use of asthma-drugs and risk of dental caries among 5 to 7 year old Danish children: a cohort study. *Community Dent Health* 2004; **21**: 207–211.
15 Edgar WM. Saliva: its secretion, composition and functions. *Br Dent J* 1992; **172**: 305–312.
16 Tenovuo J. Antimicrobial function of human saliva–how important is it for oral health? *Acta Odontol Scand* 1998; **56**: 250–256.
17 Ryberg M, Möller C, Ericson T. Effect of beta 2-adrenoceptor agonists on saliva proteins and dental caries in asthmatic children. *J Dent Res* 1987; **66**: 1404–1406.
18 Ryberg M, Möller C, Ericson T. Saliva composition and caries development in asthmatic patients treated with beta 2-adrenoceptor agonists: a 4-year follow-up study. *Scand J Dent Res* 1991; **99**: 212–218.
19 Kargul B, Tanboga I, Ergeneli S, Karakoc F, Dagli E. Inhaler medicament effects on saliva and plaque pH in asthmatic children. *J Clin Pediatr Dent* 1998; **22**: 137–140.
20 Rotteveel LJ, Jongerius PH, van Limbeek J, van den Hoogen FJ. Salivation in healthy school-children. *Int J Pediatr Otorhinolaryngol* 2004; **68**: 767–774.
21 Larsen MJ, Jensen AF, Madsen DM, Pearce EI. Individual variations of pH, buffer capacity, and concentrations of calcium and phosphate in unstimulated whole saliva. *Arch Oral Biol* 1999; **44**: 111–117.
22 Eloot AK, Vanobbergen JN, De Baets F, Martens LC. Oral health and habits in children with asthma related to severity and duration of condition. *Eur J Paediatr Dent* 2004; **5**: 210–215.
23 Al-Dlaighan YH, Shaw L, Smith AJ. Is there a relationship between asthma and dental erosion? A case control study. *Int J Paediatr Dent* 2002; **12**: 189–200.
24 Kankaala TM, Virtanen JI, Larmas MA. Timing of first fillings in the primary dentition and permanent first molars of asthmatic children. *Acta Odontol Scand* 1998; **56**: 20–24.
25 Reddy DK, Hegde AM, Munshi AK. Dental caries status of children with bronchial asthma. *J Clin Pediatr Dent* 2003; **27**: 293–295.
26 Milano M, Lee JY, Donovan K, Chen JW. A cross-sectional study of medication-related factors and caries experience in asthmatic children. *Pediatr Dent* 2006; **28**: 415–419.
27 Shashikiran ND, Reddy VV, Raju PK. Effect of antiasthmatic medication on dental disease: Dental caries and periodontal disease. *J Indian Soc Pedod Prev Dent* 2007; **25**: 65–68.
28 Iwakura ML, Morita MC. Fluoride mouth-rinsing to prevent dental caries in a Brazilian municipality with fluoridated drinking water. *Rev Panam Salud Publica* 2004; **15**: 256–261.
29 Anjomshoaa I, Cooper ME, Vieira AR. Caries is associated with asthma and epilepsy. *Eur J Dent* 2009; **3**: 297–303.
30 Mehta A, Sequeira PS, Sahoo RC. Bronchial asthma and dental caries risk: results from a case control study. *J Contemp Dent Pract* 2009; **10**: 59–66.