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AVALIAÇÃO EPIDEMIOLÓGICA SOB DIFERENTES CRITÉRIOS DE DIAGNÓSTICO DA CÁRIE DENTÁRIA

Tese apresentada à Faculdade de Odontologia de Piracicaba, da Universidade Estadual de Campinas para a obtenção do título de Doutor em Odontologia, Área de concentração Saúde Coletiva.

Orientador: Prof. Dr. Marcelo de Castro Meneghim

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“Primeiro faça o necessário;

depois faça o possível; e de repente,

você vai perceber que pode fazer o

impossível”.

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RESUMO

As condições e critérios de avaliação empregados em estudos epidemiológicos são muito importantes para a confiabilidade e a veracidade dos resultados encontrados. Esta tese, composta de dois artigos científicos, teve como objetivos: a) comparar exames epidemiológico e clínico sob diferentes critérios de diagnóstico na detecção da cárie dentária; e b) verificar a influência de lesões iniciais não–cavitadas de cárie (LI) no incremento de cárie em crianças, considerando grupos etários distintos, e a presença/ausência de experiência de cárie no *baseline*. Um estudo longitudinal-prospectivo foi conduzido no período de 2003 a 2005. No *baseline* (2003), 983 crianças de 7 a 10 anos de idade, matriculadas em escolas públicas, foram examinadas por três examinadores, previamente calibrados, em condições epidemiológicas e posteriormente em consultório odontológico. As avaliações foram precedidas por escovação e secagem dental, utilizando espelho plano, sonda ponta romba e luz natural nas avaliações epidemiológicas e luz artificial nas avaliações no consultório odontológico. Os resultados obtidos, considerando o critério de detecção de cárie dentária da Organização Mundial de Saúde (OMS), foram comparados com o critério OMS+LI (lesões cavitadadas e não cavitadas) na avaliação epidemiológica. O critério OMS+LI também foi utilizado para comparar os dados obtidos na avaliação epidemiológica versus avaliação clínica. As variáveis incluíram ceos, CPOS, cs, Cs, selantes e número de indivíduos "livres" de cárie. O teste-t pareado e o teste de McNemar foram utilizados para avaliar as diferenças entre as médias e proporções para cada grupo de idade. Na avaliação epidemiológica, todas as variáveis respostas apresentaram diferenças significativas quando se compararam os critérios OMS versus OMS+LI ($p<0,05$). Diferenças estatísticas ($p<0,05$) também foram detectadas quando se compararam as diferentes condições de exame utilizando o critério OMS+LI. Concluiu-se que o critério diagnóstico escolhido (OMS ou OMS + LI) e as condições de exame (epidemiológico ou clínico) foram relevantes na detecção de cárie. Em estudo posterior, a amostra constou de 765 crianças que foram reavaliadas por um dos examinadores, em condições epidemiológicas, seguindo o mesmo protocolo do exame inicial (*baseline*) e utilizando o critério diagnóstico OMS+LI. Para a análise dos dados, as crianças foram divididas em dois grupos, de acordo com a idade no *baseline*: 423 crianças com idades de 7

a 8 anos e 342 crianças de 9 a 10 anos. Realizou-se uma análise univariada (qui-quadrado e Odds Ratio), tendo como variável dependente o incremento de CPOD≥1. A associação entre o incremento no CPOD e a presença de LI foi significativa ($p<0,05$) para a faixa etária de 9 a 10 anos. A experiência de cárie na dentição permanente foi significativa estatisticamente no incremento no CPOD nas duas faixas etárias estudadas (7 a 8 e 9 a 10 aos). Concluiu-se que os preditores de incremento de cárie em 2 anos de avaliação foram a experiência de cárie na dentição permanente, para os dois grupos estudados, e a presença de lesões iniciais no baseline afetam o desenvolvimento futuro de cárie, na faixa etária de 9 a 10.

Palavras- chave: cárie dentária, diagnóstico, epidemiologia, fatores de risco

ABSTRACT

The conditions and criteria of evaluation carried out in epidemiologic studies are very important for the veracity and reliability of the results found. This thesis is composed of two scientific papers and has as objectives: a) to compare epidemiologic and clinical evaluation under different criteria of diagnostic in the detection of the dental decay; and b) to verify the influence of non-cavitated initial lesions of decay (IL) in the decay increment in children, considering different age groups, and the presence/absence of decay experience in the baseline. A longitudinal-prospective study was carried out in the period from 2003 to 2005. In the baseline (2003), 983 children from 7 to 10 years of age enrolled at public schools, were examined by three examiners, previously calibrated in epidemiologic conditions and later in dental clinic. Dental brushing and drying preceded the evaluations, using plan mirror, ball point probes and under natural light in the epidemiologic evaluations and artificial light in the evaluations in the dental clinic. The results according to the criterion of dental decay detection by The World Organization of Health (WHO) were compared with the criterion WHO+IL (cavitated and non-cavitated lesions) in the epidemiologic evaluation. The WHO+IL criterion was also used in order to compare the data obtained in the epidemiologic evaluation versus clinical evaluation. The variable answers included dmfs, DMFs, ds, Ds, sealants and number of individuals "decay free". The paired t-test and the McNemar's test were carried out to evaluate the differences between the averages and proportions for each group of age. In the epidemiologic evaluation, all the variable answers presented significant differences when the WHO criteria were compared with WHO+IL ($p < 0.05$). Statistical differences ($p < 0.05$) were also detected when compared with different exam conditions using the criterion WHO+IL. It was concluded that the chosen diagnostic criterion (WHO or WHO+LI) and the exam conditions (epidemiologic or clinical) were relevant in the decay detection. In a subsequent study, the sample consisted of 765 re- children evaluated by one of the examiners, in epidemiologic conditions, following the same protocol of the initial exam (baseline) and using the diagnostic criterion WHO+IL. In the data analysis the children were divided in two groups, according to the age in the baseline: 423 children with ages from seven to eight years and 342 children from nine to ten years. The unvaried (qui-square) analysis and the

multiple logistics analysis of regression were used in the statistical analysis, with dependent variable the increment of DMFT ≥ 1. The association between the increment in DMFT and the presence of IL was significant ($p < 0.05$) for the group age from 9 to 10. The analysis of logistic regression showed that caries experiences in permanent teeth was a predictor of increment in DMFT for the age groups studied, with the largest risk in the ages from seven to eight years. The conclusion is that one of the predictors of caries increment was the experience of caries in the permanent dentition for the age group studied, and that the presence of initial lesions favors the development of caries for the group from 9 to 10 years of age.

Key words: dental caries; diagnosis; epidemiology, risk factor

LISTA DE ABREVIATURAS E SIGLAS

ceod- Índice de dente cariado, extraído e obturado na dentição decídua

ceos- Índice de superfície dental cariada, extraída e obturada na dentição decídua

CPOD- Índice de dente permanente cariado, perdido e obturado

CPOS- Índice de superfície dental permanente cariada, perdida e obturada

CS- Componente cariado por superfície na dentição permante

cs- Componente cariado por superfície na dentição decídua

DS- Decay component pemanent surface

ds- Decay component deciduous surface

dmfs- Decayed, missing and filled deciduous surfaces – index

dmft- Decayed, missing and filled deciduous teeth – index

DMFS- Decayed, missing and filled permanent surfaces – index

DMFT- Decayed, missing and filled permanent teeth – index

IC- Interval confiance

IL – Initial Lesion

LI – Lesão Inicial

OMS – Organização Mundial de Saúde

OR- Odds Ratios

WHO – World Health Organization

SUMÁRIO

INTRODUÇÃO

Publicações nacionais (Brasil, 1988, 1996 e 2004) e internacionais (Marthaler, 2004) tem verificado através de dados epidemiológicos, uma diminuição na prevalência da cárie dentária nas últimas décadas.

A descoberta da atividade do flúor revolucionou mundialmente o controle da cárie dentária. Sua atuação como agente preventivo ligado à saúde bucal, disponibilizou na literatura, abundante suporte científico para referendar seu uso nas mais variadas formas, enfatizando seu potencial como agente cariostático, eficaz e seguro (Marinho *et al*., 2004).

A incorporação do flúor na água de abastecimento, sem dúvida, é considerada a medida mais eficaz e abrangente, pois tem grandes alcances populacionais, promovendo efetiva redução na cárie dentária nos diferentes níveis socio-econômicos, independentemente da cooperação e do interesse dos indivíduos (Burt, 2005; Manfredini, 2003).

Os vários estudos sobre a epidemiologia relataram mudanças epidemiológicas na história natural da cárie dentária nas últimas décadas. Observa-se a prevalência na localização, especificamente a predominância na superfície oclusal (Burt, 1998; Batchelor & Sheiham, 2004) e também a diminuição na velocidade de progressão e conseqüentemente, maior prevalência de lesões iniciais não-cavitadas em relação ás lesões cavitadas (Pine *et al*., 2003). A Filosofia de Promoção de Saúde atual exige dos pesquisadores, respostas a respeito da melhor forma para ações e medidas preventivas eficazes para o controle da cárie dentária e, no que se diz respeito à epidemiologia, o comportamento e a prevalência dessas lesões são primordiais para estabelecer clara relação entre a estimativa epidemiológica e a necessidade de tratamento, quer seja invasivo ou não-invasivo, em indivíduos ou grupos de indivíduos (Manfredini, 2003).

Tradicionalmente, em pesquisas epidemiológicas, utilizam-se critérios preconizados pela Organização Mundial de Saúde (OMS), e condições de exame diferentes dos empregados em ambiente de consultório odontológico. Com a inclusão de lesões

iniciais aos exames epidemiológicos, propicia-se a oportunidade de impedir a progressão dessas lesões para o estágio de cavitação (Assaf, 2005).

A inserção de adjuntos diagnósticos, como a luz artificial, ar comprimido e radiografias, visam melhorar a capacidade de detecção da cárie dentária. Contudo, o uso destas está freqüentemente restrito a profissionais em consultórios odontológicos, enquanto que epidemiologistas, comumente, realizam suas avaliações clínicas em condições muito diferentes, com menos recursos diagnósticos comparados àqueles encontrados em ambiente de consultório odontológico padrão (Assaf, 2002 e Assaf & Pereira, 2003).

Dessa forma, o presente trabalho foi composto por dois artigos científicos visando elucidar e testar hipóteses dentro dessa linha de pesquisa. Os principais objetivos foram comparar exames epidemiológico e clínico sob diferentes critérios de diagnóstico na detecção da cárie dental e verificar a influência de lesões iniciais não–cavitadas de cárie (LI) no incremento de cárie em crianças, considerando grupos etários distintos e a presença/ausência de experiência de cárie no *baseline*, em um estudo prospectivo longitudinal de dois anos.

CAPÍTULO 1

Comparison of epidemiological evaluations under different caries diagnostic thresholds*

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ABSTRACT

Objective: To investigate the influence of different settings, epidemiological and clinical, and different diagnostic thresholds on caries detection in a group of children aged 7-10-year-old in Brazil. Methods: Nine hundred and eighty-three 7 to 10-year-old children enrolled in 4 public schools were randomly selected. Three examiners performed firstly the epidemiological examinations followed by an examination of the same children using a clinical setting. The examinations of cleaned and dried teeth in both settings were carried out using dental mirror and ball-ended probe, under natural light in the epidemiological setting examinations and under artificial light during the clinical setting examinations. For the analysis of results, comparisons were focused on: WHO (World Health Organization) versus WHO+IL, both under epidemiological conditions, in order to demonstrate the influence of the inclusion of IL in the study; and WHO+IL under epidemiological setting versus WHO+IL under clinical setting, aiming to demonstrate the importance of examination setting. Outcome measures: dmfs, DMFS, ds, Ds, sealants and number of children 'free' of caries. Paired t-test and McNemar's test were used to test the difference between means and proportions for each age group. Results: Epidemiological examinations, under the WHO diagnostic threshold, presented significant differences when compared with the WHO +IL threshold for all outcome measures. Statistical differences were also detected when comparing the WHO+IL threshold under different settings. Conclusion: The choice of a diagnostic threshold (WHO or WHO+IL) and the conditions of examination (epidemiological or clinical) were relevant on detecting caries.

Key words: dental caries; diagnosis; epidemiology.

INTRODUCTION

Surveys are used to monitor trends in oral health and disease, to develop policy, to evaluate dental health programs, and to assess dental needs (Burt, 1997). However, when the epidemiological data are compared with those obtained in standard clinical setting, epidemiological surveys underestimate the prevalence of the disease, particularly in the case of untreated dental caries (Lindwood et al., 1979). Furthermore, the epidemiological evaluation of dental caries is a poor indicator in determining the number of surfaces, which will subsequently be treated (Nuttall, 1983, Nuttall & Davies, 1988), and has no discriminatory power in the prediction of an individual's future restorative treatment (Nuttall & Deery, 2002).

Differences in the examination conditions of both settings, epidemiological and standard clinical setting, may be relevant factors in the underestimation of disease in surveys. For instance, artificial light, compressed air, radiographs, and other diagnostic aids as well as access to patient history are frequently used by the dentists in clinical settings, while the epidemiologists usually use only clinical examinations under conditions very different from those found in a clinical setting (WHO, 1997; Lundman et al., 1998; Meneghim et al., 2003).

In addition to these factors, the criteria employed in most cross sectional surveys of prevalence consider dental caries only at the point of cavitation, excluding the initial lesions (IL), thus resulting in underestimation of disease (WHO, 1997). Some reasons for these criteria are based on the inherent difficulties in the epidemiological examination to diagnose earlier stages of the disease. Furthermore, the invasive treatment is only suitable once there is a lesion in the dentine (WHO, 1997; Pitts & Fyfee, 1988).

Scientific evidence has shown the need for changes in the criteria used in surveys, including the use of epidemiological diagnosis of initial lesions (Nyvad et al., 1999; Fyffe et al., 2000; Pitts, 2004). Recent epidemiological research has shown that the prevalence of IL is higher than the prevalence of cavitated lesions (Ismail, 1997; Amarante et al., 1998; Biscaro et al., 2000). The inclusion of IL within

epidemiological surveys is likely to establish a clearer relation between the epidemiological estimates of dental caries prevalence and the treatment needs, invasive as well as non invasive, in individuals and/or groups (Pitts, 2004).

Despite the clear need for consideration to include IL in epidemiological surveys, previous studies have measured the differences of established caries between surveys and clinical setting using different combinations of diagnostic adjuncts with the same or with different diagnosis criteria from that used by the WHO (Lindwood et al., 1979; Lundman et al., 1998; Meneghim et al., 2003; Assaf et al., 2004). Lundman et al. (1998) and Assaf et al. (2004) showed that there were no differences between examinations carried out in a school outdoor setting and in a clinical setting, under the WHO diagnostic criteria. However, the exclusion of IL in epidemiological examinations resulted in underestimation of caries (Assaf et al., 2004).

Differences between the levels of dental caries under epidemiological surveys and the normative treatment need of the group/population have therefore been observed (Nuttall & Deery, 2002; Biscaro et al., 2000; Assaf et al., 2004). Surveys may therefore be limited as an instrument for the appropriated planning of preventive/curative strategies in the dental health services.

The present study aims to investigate the influence of different settings, epidemiological and clinical, and different diagnostic thresholds on caries detection in the primary and permanent teeth of a group of children aged 7-10-year-old in Brazil.

MATERIAL AND METHOD

The project was first approved by the Ethical Committee in Research at Piracicaba Dentistry School/UNICAMP (State University of Campinas) in agreement with Resolution 196/96 of the National Committee of Health Department (BZ). The schools granted permission for the study and informed positive consent was obtained from the parents.

Study design

-Sample and examiners

The sample was calculated by age group, based on caries experience of previous surveys carried out in Piracicaba SP-Brazil with a design error of 2% and a sampling loss of 20%. The highest sampling error was in a confidence level of 95%. The final sample was nine hundred and eighty three 7 to 10-year-old children who were randomly selected from public schools.

Children having local or general problems, such as the use of a fix orthodontic device, severe fluorosis, and hypoplasia or a serious systemic disease were excluded from the sample (n=54). Three examiners with clinical experience and epidemiological experience in surveys using WHO criteria (WHO, 1997) participated in the study.

-Diagnostic thresholds used for the evaluation

Two diagnostic thresholds were used in the study: WHO diagnostic thresholds (WHO, 1997), where caries was defined as cavitated lesions only; and WHO+IL diagnostic threshold, where active, initial lesions were also defined as caries. The unit of evaluation used in examination was the DMFS and dmfs (decayed, missing, and filled surfaces for permanent and primary dentition respectively).

-Diagnostic criteria and codes

The criteria and codes were those based on the WHO recommendations (WHO, 1997). Active caries with intact surfaces were recorded as an initial lesion (IL): an adaptation of the criteria according to Nyvad et al. 1999 and Fyffe et al. 2000. Thus, an IL is defined as active caries which, through visual assessment by a calibrated examiner, indicates an intact surface, no clinically detectable loss of dental tissue, with a whitish/yellowish colored area of increased opacity, rough, with loss of luster and presumed to be carious; when the probe is used, its tip should move gently across the surface. For the smooth surface, caries lesion is typically located close to gingival margin. For the occlusal surface, the lesion extends along the walls of the fissure. In this study, localized surface defects (active microcavities) restricted to enamel only were also included in the IL group. Active white spot lesions and microcavities contiguous to sealants, restorations and cavitations were also recorded (Table 1).

-Calibration of examiners

The three examiners were calibrated prior to the study. A benchmark "Gold Standard" dental examiner, who routinely uses the WHO criteria, conducted training and calibration of examiners. The benchmark examiner had been previously trained and calibrated in the diagnosis of IL using similar criteria in other studies (Biscaro et al., 2000; Assaf et al., 2004).

The training and calibration exercise, carried out in both settings, began with theoretical discussions using clinical photographic slides in order to provide visual examples of each criterion held to instruct the examiners on the use of different sets of criteria and examination method. Clinical training sessions were then held in outdoor setting, under natural light, in four periods of 4 hours, followed by a calibration exercise to ensure all examiners were performing at the same standard. During a separate period (4 hours), clinical training and calibration were carried out in a traditional clinical setting under artificial light. Mean inter-examiner agreement, measured using a Kappa calculation (Landis & Koch, 1977) were Kappa= 0.88 for the WHO+IL and Kappa= 0.95 for the WHO diagnostic threshold

under epidemiological conditions and Kappa=0.90 for the WHO+IL diagnostic threshold under traditional clinical setting.

Examination Procedures for the epidemiological and clinical settings

All subjects were examined using dental mirror and ball-ended probes with a diameter of 0.5mm for removing debris and assessing presence of fissure sealants in case of doubt and to check the surface texture of IL, associated with previous dental drying and brushing, in both the epidemiological and clinical setting by the three examiners. During the examinations, all the examiners were given note taking assistance.

Teeth were cleaned by the subject under supervision prior to examination using the modified Bass technique with fluoridated dentifrice for a standardized time of 2 minutes. Prior to examining, dental drying was carried out for about 5 seconds per tooth with the use of compressed air through a dental compressor (Proquest Delivery System, model 4010, Compressor Technologies LTD, Englewood, USA).

All clinical examinations followed the epidemiological examinations due to practical reasons. A minimum interval of 15 days between the epidemiological and clinical examinations was established to avoid examiners' familiarity to the clinical conditions of the volunteers.

- Epidemiological examinations

The examinations of cleaned and dried teeth were carried out in an outdoor setting under standardized conditions using natural light. Examinations were only performed on days with an appropriate natural luminosity.

- Examinations in clinical settings

The examinations were carried out using the same method of exam and diagnostic adjuncts as the epidemiological examinations, except for the additional use of artificial light. Children were positioned in the dental chair as closely as

possible to that used in the epidemiological setting, so that the dental chairs were not fully reclined.

Reexaminations were performed in 10% of the sample for each epidemiological and clinical examination. Kappa statistics (Landis & Koch, 1977) were employed to determine intra-examiner error. Mean Kappa values of intra-examiner agreement were Kappa=0.96 (WHO) / Kappa=0.89 (WHO+IL) for the epidemiological examinations and Kappa=0.87 (WHO+IL) for the examinations performed in a traditional clinical setting, respectively. Children who needed treatment were then treated in a preventive-restorative program at the Dental School of Piracicaba-UNICAMP, SP, Brazil.

- Statistical analysis

For the analysis of results, comparisons were: a- WHO versus WHO+IL, in order to demonstrate the influence of inclusion of IL under epidemiological conditions; b- WHO+IL under epidemiological setting versus WHO+IL under clinical setting, aiming to demonstrate the importance of examination setting. Main outcome measures were the dmfs, DMFS, ds, Ds, sealants in primary and permanent teeth and number of children 'free' of caries, by age group (7 to 10-year-old children) (Tables 2-5). Paired t-tests were used to the comparison of dmfs, DMFS, ds, Ds and sealants means according to different thresholds (item a) and settings (item b); McNemar's test was used to compare the proportion of children "free" of caries experience, according to different thresholds (item a) and settings (item b).

RESULTS

Epidemiological examinations under the WHO diagnostic threshold presented significant differences when compared with epidemiological examinations under WHO+IL diagnostic threshold, for all age groups. The percentages of observed epidemiological examination outcomes under the WHO diagnostic threshold with WHO+IL threshold as a reference varied from 23.59% for the Ds to 95.64% for the dmfs (7-year-old) (Table 2).

Epidemiological examinations under the WHO+IL diagnostic threshold were significantly different from those examinations under the same threshold performed in clinical setting, for all age groups. The percentages of observed epidemiological examination outcomes with clinical setting examination as a reference varied from 76.15% for the Ds (7-year-old) to 99.09% for the dmfs (8-year-old) (Table 3).

Regarding the sealants, significant differences were not found between the epidemiological and clinical setting examinations, except for the permanent teeth of 9 to 10-year-old individuals. Epidemiological settings resulted in the estimation of 60 to 100% of sealants observed under clinical setting conditions (Table 4).

There were statistical differences between the epidemiological examinations and the clinical setting examinations, both under WHO+IL diagnostic threshold, in the number of children ‘free’ of caries, except for the 10-year-old group. Statistical differences were also found between different thresholds under epidemiological conditions for all age groups. These differences in observed ‘caries free’ numbers between settings and thresholds were lower than 10% for all age groups (Table 5).

DISCUSSION

This study aimed to examine the influence of both distinct conditions of examinations: epidemiological and clinical settings, as well as to assess the use

of different diagnostic thresholds on the detection of caries. Comparisons were made in such a way as to minimize methodological bias by using the same visual-tactile method of examination, the same diagnostic adjuncts (previous dental brushing and drying), as well as standardization of the positioning of children in chairs in both settings clinical and epidemiological. The only source of variation was the light, which was natural in the epidemiological examinations and artificial in the clinical setting examinations. Moreover, intervals of a minimum of 15 days between epidemiological and clinical examinations were performed to avoid any possibility of memorization by the examiners of the children's dental conditions, although this was unlikely due to the large number of examined individuals.

Diagnosis of sealants in primary and permanent teeth was considered satisfactory during the epidemiological examinations. Although statistical differences between conditions of examinations were found for the permanent teeth in the 9 to 10-year-old-groups, the analysis of percentages showed underestimated values of 16.36 and 15.01%, respectively (Table 4).

In general, the present study showed that both, settings (clinical *versus* epidemiological) and diagnostic thresholds (WHO *versus* WHO+IL), could influence on the detection of lesions for the 7-10 year-old children. The inclusion of IL in the examinations could be a relevant factor in the degree of underestimation in dental surveys. Furthermore, the use of artificial light, which was only used in the clinical setting examinations, could be considered an essential factor to improve the IL diagnosis during the epidemiological examinations (Mitropoulos & Worthington, 1984; Meneghim et al., 2003; Assaf et al., 2004). Therefore, it might be suggested that the differences in IL detection under different conditions of examinations, epidemiological and clinical settings, could be due to the absence of this diagnostic adjunct.

In accordance with previous studies (Pitts & Fyfee, 1988; Amarante et al., 1998; Biscaro et al., 2000), the present study showed increases in the prevalence of dental caries to both dentitions and in all age groups when using

a criterion, which includes the IL under epidemiological conditions. This increase was more evident for the decayed component in deciduous and permanent teeth. However, contradictory to the findings of Pitts & Fyfee (1988) and Biscaro et al. (2000)'s studies, differences in relation to the number and percentage of children considered 'free' of caries were small between the diagnostic thresholds, indicating, therefore, that most of the IL were present in children with past history of caries (Tables 2, 3 and 5). Divergence in results could be explained by the differences found in the methodologies of each study, particularly the variation of caries criteria used, even when including the initial stages of caries.

Some discussion could be raised because clinical setting examinations were used for the comparisons with the epidemiological examinations under the WHO+IL diagnostic threshold without the association of any additional method of detection of lesions, such as the X-Rays, or even by opening suspected cavities. The literature has shown that the clinical caries detection, performed generally in clinical practice, results in both under and over-estimation of diagnosis (Bader et al., 2002; Nyvad, 2004). Although being considered a relevant diagnostic method, X-Rays was not used in the present study to confirm the presence of suspected lesions, such as the clinical diagnosis of microcavities, due to practical and financial reasons. Furthermore, one of the relevant points in the present study was to show the ability to verify the differences in detecting cavitated and non-cavitated lesions by using or not the artificial light.

Studies which have evaluated conventional clinical examination by using a method of validation have shown that, in general, validation methods, such as the determination of the depth of lesion penetration determined after minimal operative intervention, is currently used in clinical research, although it may not represent the most appropriate 'gold standard' for detecting caries. In the present

study, its use was not possible due to practical and ethical issues, such as ethical problems to open lesions.

It is important to point out that these results cannot be extrapolated to all populations and regions or countries. Different results may be found when comparing different regions. In tropical countries natural light is usually recommended because variations of luminosity are slight during the year, while in temperate countries the examinations are only possible under artificial light, in closed spaces (Biscaro et al., 2000, Pitts NB, Evans, 1997).

Studies have been conducted in the epidemiology of dental caries in order to develop new strategies, such as the use of criteria, which include the IL in epidemiological examinations, as well as the use of other methods of diagnosis. Studies have shown better performances in the detection of carious lesions when the epidemiological examinations have employed FOTI (fiber-optic transillumination) and bitewing radiography (Deery et al., 2000; Poorterman et al., 2000). Such improvements may contribute to a reduction in the levels of underestimation of disease, and, consequently, to a better classification of the dental caries levels in groups or populations (Ismail, 1997; Nyvad et al., 1999; Fyffe et al.,2000; Pitts, 2004). This would, consequently, lead to more accurate reflection of epidemiological disease data, depicting trends for a future redirection in epidemiology, not only with regard to correct epidemiological diagnosis but also to the implementation of preventive-therapeutic measures for the population.

CONCLUSION

The choice of a diagnostic threshold (WHO or WHO+IL) and the conditions of examination (epidemiological or clinical) are relevant on detecting caries.

The inclusion of IL in the epidemiological examinations contributed to the reduction of caries underestimation among children aged from 7 to 10 year-old.

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Table 1: Summary of the criteria and codes, according to WHO and WHO+IL diagnostic threshold for caries, restorations, sealants and other dental conditions.

WHO			WHO+IL		
Codes		Criteria	Codes		Criteria
Prim	Perm		Prim	Perm	
A	0	Sound	A	0	Sound, excluding the W (white spot)
			W	WP	W (active white spot/ surface discontinuity in enamel only)
B	1	Decayed	B	1	Decayed without W (chronic lesion)
			BW	1W	Decayed with W (active lesion)
C	2	Filled, with decay	C	2	Filled, with decay (chronic lesion)
			CW	2W	Filled, with W + decay (active lesion)
D	3	Filled, no decay	D	3	Filled, no decay
			DW	3W	Filled with W
E	4	Missing, as a result of caries	4	4	Missing, as a result of caries
-	5	Missing, any other reason	5	5	Missing, any other reason
F	6	Fissure sealant	F	6	Fissure sealant
			FW	6W	Fissure sealant with W
G	7	Bridge abutment, special crown or venner/implant	7	7	Bridge abutment, special crown or venner/implant
-	8	Unerupted tooth		8	Unerupted tooth
T	T	Trauma (fracture)	T	T	Trauma (fracture)
-	9	Not recorded	-	9	Not recorded

Note: code W- presence of white spot or surface discontinuity in enamel in dental surfaces (W, WP), as well as in sealants (FW, 6W), filled (DW, 3W) and other conditions.

Table 2: Mean ds, dmfs, Ds and DMFS of the epidemiological examinations under WHO diagnostic threshold compared to each respective mean of ds, dmfs, Ds and DMFS of the epidemiological examinations under WHO+IL diagnostic threshold, according to 7 to 10-year old groups.

p<0.001*

Age	Threshold	ds	dmfs	Ds	DMFs
7	WHO	2.541 (5.123) *	4.979 (7.061) *	0.113 (0.417) *	0.309 (0.985) *
n=194		[89.47]	[95.64]	[23.59]	[45.77]
	WHO+IL	2.840 (5.560)	5.206 (7.435)	0.479 (0.961)	0.675 (1.264)
		[100.00]	[100.00]	[100.00]	[100.00]
8	WHO	1.615 (4.042)*	4.874 (6.899)*	0.111 (0.599) *	0.433 (1.256)*
n=270		[82.10]	[93.66]	[33.64]	[66.41]
	WHO+IL	1.967 (4.573)	5.204 (7.233)	0.330 (0.874)	0.652 (1.421)
		[100.00]	[100.00]	[100.00]	[100.00]
9	WHO	1.194 (2.518)*	3.971 (5.289)*	0.264 (1.004)*	0.771 (1.534)*
n=284		[77.79]	[92.52]	[41.19]	[67.40]
	WHO+IL	1.535 (2.965)	4.292 (5.591)	0.641 (1.787)	1.144 (2.175)
		[100.00]	[100.00]	[100.00]	[100.00]
10	WHO	1.247 (3.434)*	3.272 (5.256)*	0.230 (0.973)*	0.902 (1.698)*
n=235		[78.38]	[90.46]	[40.93]	[72.57]
	WHO+IL	1.591 (3.965)	3.617 (5.649)	0.562 (1.377)	1.243 (1.971)
		[100.00]	[100.00]	[100.00]	[100.00]

( ) standard deviations in parentheses

[ ] % of observed WHO epidemiological examination results with WHO+IL epidemiological examinations as a reference.

Table 3: Mean ds, dmfs, Ds and DMFS of the epidemiological examinations compared to examinations performed in clinical setting, both under WHO+IL diagnostic threshold, according to 7 to 10-year old groups.

p<0.05*, p<0.01**, p<0.001***

Age	Setting	ds	dmfs	Ds	DMFs
7	Epidemiol	2.840 (5.560)**	5.206 (7.435)*	0.479(0.961)*	0.675(1.264)*
n=194		[91.67]	[92.75]	[76.15]	[79.88]
	Clinical	3.098 (5.884)	5.613 (7.749)	0.629 (1.026)	0.845 (1.334)
		[100.00]	[100.00]	[100.00]	[100.00]
8	Epidemiol	1.967 (4.573)***	5.204 (7.233)*	0.330 (0.874)**	0.652 (1.421)**
n=270		[88.68]	[99.09]	[77.46]	[87.16]
	Clinical	2.218 (4.838)	5.252 (7.392)	0.426 (0.983)	0.748 (1.489)
		[100.00]	[100.00]	[100.00]	[100.00]
9	Epidemiol	1.535 (2.965) *	4.292 (5.591)**	0.641(1.787)**	1.144(2.175)**
n=284		[88.78]	[96.58]	[79.53]	[84.37]
	Clinical	1.729 (3.126)	4.444 (5.549)	0.806 (1.957)	1.356 (2.323)
		[100.00]	[100.00]	[100.00]	[100.00]
10	Epidemiol	1.591 (3.965)*	3.617(5.649)**	0.562 (1.377)**	1.243(1.971)***
n=235		[91.65]	[95.51]	[80.52]	[85.90]
	Clinical	1.736 (4.048)	3.787 (5.661)	0.698 (1.645)	1.447 (2.272)
		[100.00]	[100.00]	[100.00]	[100.00]

( ) standard deviations in parentheses

[ ] % of observed WHO+IL epidemiological examination results with WHO+IL examination results performed in clinical setting as a reference.

Table 4: Mean number of sealants in deciduous and permanent molars under the epidemiological and clinical setting examinations, according to each age group.

Age	Deciduous		Permanent	
	Epidemiological	Clinical	Epidemiological	Clinical
7	0.010 (0.101)	0.010 (0.101)	0.660 (1.194)	0.690 (1.220)
	[100.00]	[100.00]	[95.65]	[100.00]
8	0.018 (0.182)	0.030 (0.226)	1.430 (1.611)	1.511 (1.644)
	[60.00]	[100.00]	[91.90]	[100.00]
9	0.042 (0.344)	0.070 (0.444)	1.299 (1.513)	1.553 (1.580)***
	[60.00]	[100.00]	[83.64]	[100.00]
10	0.299 (0.194)	0.299 (0.170)	1.464 (1.824)	1.723 (1.958)**
	[100.00]	[100.00]	[84.99]	[100.00]

p<0.01**, p<0.001***

( ) standard deviations in parentheses

[ ] % of observed epidemiological examination results with clinical setting as a reference

Table 5: Comparison of the number and (%) “free” of caries experience, in both dentitions, between epidemiological examinations under WHO and WHO+IL diagnostic thresholds and comparison of the number and (%) “free” of caries experience of the examinations performed in epidemiological and clinical settings under WHO+IL diagnostic threshold, according to each age group.

Age	Epidemiological examinations		Examinations in clinical setting
	WHO	WHO+IL	WHO+IL
7	71 (36.60) A	61 (31.44) B a	57 (29.38) b
8	100 (37.04) A	92 (34.07) B a	82 (30.37) b
9	99 (34.86) A	88 (30.99) B a	77 (27.11) b
10	82 (34.89) A	68 (28.94) B a	66 (28.08) a

Values followed by distinct letters - capital letters for the comparison between different thresholds (WHO and WHO+IL) and lower case for the comparison between different settings (epidemiological and clinical)- are statistically different ($p<0.05$).

( ) % “free” of caries experience in relation to the total number of individual for each age group.

CAPÍTULO 2

CARIES EXPERIENCE AS RISK PREDICTOR OF CARIES INCREMENT IN 7-10 YEAR OLD SCHOOLCHILDREN: EPIDEMIOLOGICAL ASSESSMENT IN A 2-YEAR LONGITUDINAL STUDY

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SUMMARY

Objective: To investigate how caries experience, at initial lesions (early or non-cavitated lesions) and cavitated stages, predicts caries increment in permanent teeth a 2-year cohort study (2003 to 2005).

Methods: The random sample of 765 children, attending public schools in Piracicaba, Brazil, was divided into two groups: 423 children aged 7-8 years and 342 children aged 9-10 years. All subjects were examined by a calibrated examiner, using dental mirror and ball-ended probes, after tooth brushing and dental air-drying in an outdoor setting, based on the World Health Organization criteria. Active caries with intact surfaces were also recorded as initial lesion (IL). Univariate analysis was used for statistical analysis (Odds Ratios and Chi-square). **Results**: The association between the DMFT (decayed, missing and filled teeth) increment and the presence of IL was significant only for 9-10-year-old children. The children with DMFT>0 at baseline were more prone to have DMFT increment, with the highest risk for caries increment occurring in children aged 7-8 years.

Conclusion: The predictors of caries increment were the presence (in baseline) of caries experience in permanent teeth for both age groups (7-8; 9-10-year-olds) and the presence of the initial lesion (in baseline) for 9-10-year-olds.

Key words: Dental caries; epidemiology; risks prediction

INTRODUCTION

Several epidemiological studies have discussed the changes in dental caries diagnosis criteria.[1-3]

Evidences from literature have shown that the early detection of initial caries lesions and the preventive approach are both the main aims for maintaining good oral health status.[1,2,4,5] In fact, detecting initial caries lesions in epidemiological studies is important to estimate the real disease prevalence and to know the treatment needs, targeting either invasive or non invasive procedures, to subjects and/or groups of populations at risk.

Since recent scientific researches have reported that initial caries lesions are significantly more prevalent than cavitated caries lesions[2], it is also important to determine the impact of initial caries lesions in caries risk assessment, verifying its influence as a predictor of caries increment, as assessed by some studies.[6-8]

Therefore, the aim of this cohort study was to investigate how caries experience, at initial caries lesions (early lesions) and cavitated stages, predicts caries increment in permanent teeth over a two-year period.

METHODS

Ethical aspects

The study was approved by the Research Ethics Committee of the Faculty of Dentistry of Piracicaba, State University of Campinas (UNICAMP), protocol number 151/2003. The School Principals granted permission for the study and an informed consent was obtained from each child's parents. All children diagnosed with treatment needs in the epidemiological examinations were treated in a preventive-restorative program at the Faculty of Dentistry of Piracicaba-UNICAMP, SP, Brazil.

Study design

This is a two-year prospective cohort study conducted between 2003 and 2005 in schoolchildren attending four different schools in Piracicaba, State of São Paulo, Brazil. At baseline (2003) 983 7-10-year-old schoolchildren of both genders were examined and in 2005 (final examination) 765 children (77.8%response rate) were reexamined for dental caries.

Study location

Piracicaba is a city located in the State of São Paulo. Its population is about 365.000 inhabitants[9], and its Human Development Index is 0.81.[10] Fluoride has been added to the water supply system since 1971. Over the last 3 decades epidemiological surveys have shown that the disease has decreased significantly, mainly due to the fluoridated water and dentifrices used by the population.[11,12]

Sample

In order to calculate the sample size, the random sampling method was used considering the caries experience by age group, based on previous surveys carried out in Piracicaba[12] with a design error of 2, sample error 2%, a sampling loss of 20% and a confidence level of 95%, that added up to 1037 children. Considering the exclusion criteria: having no parents' consent, presence of systemic diseases or communication and/or neuromuscular problems, use of a fixed orthodontic appliance, presence of severe fluorosis or hypoplasia (n=54), the initial sample was composed of 983, 7 to 10-year-old children. In 2005, 765 children aged 9 to 12 years were reexamined for dental caries.

All the schools selected in this study, are run by the municipality and are situated in the outskirts low income suburbs. The schoolchildren were similar concerning socioeconomic characteristics.

Examination methodology

The dental examinations carried out in 2003 (baseline) and in 2005 (final examination) followed the same protocol. All subjects were examined by a calibrated examiner, helped by a note taking assistant, using dental mirror and ball-ended probes with a diameter of 0.5mm for removing debris and assessing presence of fissure sealants in case of doubt and also to check the surface texture of initial lesion (IL). Before the examination each child brushed their teeth with fluoridated dentifrice for about 2 minutes, using the modified Bass technique, under supervision of a dental hygienist. Moreover, dental drying was carried out for about 5 seconds per tooth using air from a dental compressor (Proquest Delivery System, model 4010, Compressor Technologies LTD, Englewood, USA). Examinations were performed only on days with an appropriate natural luminosity with the

child seated in a school chair in front of the examiner. No radiographs were taken in both, baseline and final examinations.

Diagnostic thresholds, criteria and codes

The criteria and codes used in this study were those based on the WHO recommendations[13] that consider a tooth as decayed only when cavitations are present. Active caries with intact surfaces were also recorded as initial lesions (IL) following an adaptation of the criteria of Nyvad *et al*.[14] and Fyffe *et al*.[15] Thus, an IL is defined as active caries which, through visual assessment by a calibrated examiner, indicates an intact surface, no clinically detectable loss of dental tissue, with a whitish/yellowish colored area of increased opacity, rough, with loss of luster and presumed to be carious; when the probe is used, its tip should move gently across the surface. For the smooth surface, caries lesion is typically located close to gingival margin. For the occlusal surface, the lesion extends along the walls of the fissure. In this study, localized surface defects (active microcavities) restricted to enamel only were also included in the IL group. IL and microcavities contiguous to sealants, restorations and cavitations were also recorded.

Two diagnostic thresholds were used in the study: WHO diagnostic thresholds (DMFT - decayed, missing and filled permanent teeth - index) and WHO+IL diagnostic threshold (DMFT index + initial caries active lesions).

Calibration of the examiner

One examiner who has already had epidemiological experience in surveys using the World Health Organization criteria[13] was calibrated before baseline and final examinations by a benchmark "Gold Standard" dental examiner, who routinely uses the WHO criteria for training and calibration for oral health surveys. The benchmark examiner had also been previously trained and calibrated in diagnosing initial lesions using similar criteria of other studies.[5,16] The calibration process consisted of theoretical discussions in classrooms and clinical training sessions held in outdoor setting, under natural light, in four periods of 4 hours. Mean inter-examiner agreement (benchmark examiner versus examiner), measured by the Kappa statistics,[17] was K= 0.88 for the WHO+IL. Reexaminations were performed in 10% of the sample to determine intra-examiner error. Mean weighted Kappa value of intra-examiner agreement was K=0.89 (WHO+IL).

Data Analysis

In data analysis the dependent variable was DMFT increment>0 over the 2-year period (DMFT at final examination subtracted from DMFT at baseline, according to the WHO). First the influence of initial lesions on caries increment was tested according to age groups (7-8-year-olds and 9-10-year-olds) by the Chi-square test. Then each age group was divided according to caries experience as follows: DMFT and dmft=0 (Control group); DMFT=0 and dmft>0 (caries experience in primary teeth); DMFT>0 and dmft≥0 (caries experience in permanent and caries experience or no in primary teeth) to test the influence of caries experience at cavitated stage on the caries increment. Odds Ratios (OR), their 95% confidence intervals (CI) and significance levels were estimated. All statistical tests were performed using the software SAS[18] at 5% significance level.

RESULTS

The response rate in this 2-year cohort study was 77.8%, as among 983 children that were examined at baseline, 765 completed the study. The reasons for some children did not complete the study were: moving out of the schools and refusal to participate in the final examination.

Table 1 shows the results of the univariate analyses where the association between DMFT increment (dependent variable) and age groups considering the presence or absence of initial lesions was assessed. The presence of initial lesion at baseline affected the caries increment in permanent dentition after 2 years only for 9-10-year-old children. Among those with initial lesions, 37.1% presented DMFT increment after 2 years.

Table 2 shows that for both age groups children with DMFT>0 (not included initial lesions) were more prone to have DMFT increment, with the highest risk for caries increment occurring in children aged 7-8 years.

DISCUSSION

In this prospective cohort study, in which the aim was to investigate how caries experience predicts caries increment in permanent teeth, the presence of initial lesion at baseline was associated with caries increment in permanent dentition after 2 years for 9-

10-year-old children (Table 1). This indicates that this variable is an important clinical finding and that these children should be assisted regularly.

Another important result is that all the children with DMFT>0 and dfmt≥0 were significantly more prone to develop caries in permanent dentition in comparison to those caries-free in both dentitions (Table 2). The children aged 7-8 years were probably in a dentition transition phase, with eruption of several permanent teeth, specially the first molars and incisive, when data were collected. As pointed out by Carvalho *et al*.[19] teeth in eruption process are more prone to develop dental caries, because plaque finds favorable conditions for accumulation, as teeth are not in functional usage yet. Moreover, children may present poor dental cleanness, becoming a more susceptible group for dental caries in permanent dentition.

An unexpected result was that a child with caries experience in permanent dentition at baseline presented statistically higher probability of developing DMFT increment (Table 2), since many studies about caries prediction have showed that caries in primary dentition is a good predictor of the disease in permanent dentition.[20-24] In general, children aged 7-8 years are in a period of dentition transition, with many primary teeth exfoliating and permanent teeth in eruption. Especially the last condition may increase the caries risk due to some characteristics such as: a) a higher amount of carbonate in dental enamel, which causes changes in the hydroxyapatite crystal lattice, resulting in an more acid-susceptible enamel surface[25]; and b) teeth in eruption have no functional occlusal contact, which may increase dental plaque accumulation and difficult tooth brushing.[26]

Regarding the lack of association between the DMFT increment and the presence of initial lesions for younger children (Table 2), in a study of Neilson & Pitts[27], 74% of initial lesions detected at baseline halted or receded during the 2-year period of the research. It is also important to note that in a recent study also conducted in Piracicaba with 6-8 year-old children, there was no association between initial lesions and caries increment after 7 years of evaluation.[24] However, the inclusion of initial lesions within epidemiological surveys is likely to establish a clearer relation between the epidemiological estimates of dental caries prevalence and the treatment needs.[28] Moreover, in a longitudinal

study, changes in behavioral characteristics, such as, improvement in dental cleanness, reduction in sugar consumption, etc., may modify the oral environment so that risk of caries diminish over time. Therefore data collection in relation to initial lesions in oral health surveys should be encouraged in order to know the real prevalence of caries and to help oral health administrators in planning prevention actions.

It is important to mention the limitations of this study. The results cannot be extrapolated to all populations and regions or countries due to some existent differences in other regions, such as availability of fluoridated dentifrice since about 1990's and water fluoridation since 1971.

In conclusion, the predictors of caries increment were the presence (in baseline) of caries experience in permanent teeth for both age groups (7-8; 9-10-year-olds) and the presence of the initial lesion (in baseline) for 9-10-year-olds.

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Table 1. DMFT increment in function of the presence/absence of initial lesions.

Age group	Initial Lesion	DMFT Increment>0		OR	95% CI	p-value
		Number of children	%			
7-8-year-olds	No	93	27.0	1.00		
	Yes	24	30.8	1.20	0.70-2.06	0.497
9-10-year-olds	No	69	24.6	1.00		
	Yes	23	37.1	1.80	1.00-3.23	0.045

Table 2. DMFT increment in function of caries experience at baseline

Groups	DMFT Increment>0		OR	95% CI	p-value
	Number of children	%			
7-8-year-olds with DMFT and dmft=0	30	19.0	1.00		
7-8-year-olds with DMFT=0 and dmft>0	55	29.1	1.25	0.82-1.91	0.302
7-8-year-olds with DMFT>0 and dmft≥0	32	42.1	9.87	4.26-22.78	<0.001
9-10-year-olds with DMFT and dmft=0	30	22.1	1.00		
9-10-year-olds with DMFT=0 and dmft>0	21	23.6	1.08	0.60-1.94	0.789
9-10-year-olds with DMFT>0 and dmft≥0	41	35.0	2.96	1.51-5.78	0.002

CONCLUSÃO

As conclusões do primeiro capítulo foram que o critério de diagnóstico (OMS ou OMS + LI) e as condições de exame (epidemiológico ou clínico) são relevantes na detecção da cárie dentária, e que a inclusão de lesões iniciais de cárie dentária em exames epidemiológicos contribuem na redução da subestimação da cárie dentária em crianças de 7 a 10 anos de idade.

As conclusões do segundo capítulo foram de que o preditor de incremento de cárie na faixa etária de 7 a 8 anos foi a presença de experiência de cárie na dentição permanente e os preditores de incremento de cárie na faixa etária de 9 a 10 anos foram a presença no baseline de lesão inicial de cárie dentária e de experiência de cárie na dentição permanente.

CONSIDERAÇÕES GERAIS

Com os dados dos estudos apresentados, concluiu-se que o critério de diagnóstico e as condições de exame influenciam de forma estatisticamente significativa na detecção da cárie dentária; a experiência de cárie na dentição permanente é um forte preditor do incremento de cárie na faixa etária de 7 a 10 anos e finalmente a lesão inicial é um forte preditor de incremento de cárie na faixa etária de 9 a 10 anos de idade. Esses resultados fornecem uma ferramenta importante para gestores de saúde, elucidando a real prevalência da cárie dentária e auxiliando no planejamento de medidas de intervenções restauradoras e/ou preventivas mais apropriadas.

Além disso, a literatura é clara ao mostrar as mudanças atuais no perfil epidemiológico da cárie dentária, tal como as alterações na morfologia da lesão, em virtude de menor velocidade de progressão das lesões, bem como maior ocorrência de novas lesões em superfícies oclusais, que acarretam a necessidade de medidas preventivas eficazes, priorizando indivíduos com experiência prévia de cárie, além de avaliar o custo/efetividade desses métodos na redução da cárie dental.

Dessa forma, a inclusão da detecção de lesões iniciais em levantamentos epidemiológicos é um aspecto relevante, pois sua prevalência tem aumentado nos últimos anos (Pine *et al*., 2003). Em um dos estudos desenvolvidos, a presença de lesões iniciais demonstrou ser um fator diretamente relacionado ao incremento de cárie na faixa etária de 9 a 10 anos, ressaltando que sua detecção precoce possibilita implementar medidas de controle da lesão. Dessa forma, estudos epidemiológicos utilizando métodos de diagnóstico de cárie dentária devem ser conduzidos, a fim de se estabelecer os métodos mais efetivos de detecção às cáries, principalmente em seu estágio inicial.

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