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ORIGINAL ARTICLE

Caries Prevalence in Preschool Children in a City of Southern Brazil According to Two Diagnostic Criteria: dmf-t and ICDAS II

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Abstract

Objective: This cross-sectional research evaluated caries prevalence and treatment need in preschool children using different indexes. **Material and Methods:** A sample of 931 children (3-5 years old) attending public schools were examined by two calibrated researchers, who recorded the caries prevalence using dmf-t and ICDAS II. The clinical records obtained directed the decision regarding the treatment needs, which were divided into non-invasive and invasive procedures according to the scores registered in the different caries indexes. Descriptive statistics were used to present the data related to each index; qui-square test was used to compare the need of invasive and non-invasive treatment in the different ages. **Results:** The mean dmf-t was 1.8 ± 2.9, with a 42.9% caries prevalence. Using cut-off points of ICDAS II (≥1, ≥3 and ≥4), the caries prevalence values found were 50.7%, 40.8% and 30.7%, respectively. Five-year-old children exhibited the highest caries prevalence, assessed with dmf-t or ≥3 and ≥4 cut-off points of ICDAS II (≥3: p=0.032; ≥4: p=0.015). The percentages of caries-free children were 49.1% and 57.1%, respectively for ICDAS II and dmf-t. Restorative treatment in at least one tooth was required by 30.7% and 40% of the children for ICDAS II and dmf-t. Only ICDAS II could establish the percentage of non-invasive treatments (20%). Both indices pointed out the expressive need of restorative treatment. **Conclusion:** The use of dmf-t in epidemiological surveys may underestimate caries prevalence whereas the ICDAS II allowed the identification of early carious lesions and the viability of the use of non-invasive procedures as caries control measures in a child population.

Keywords: Epidemiology; Dental Caries; Tooth, Deciduous; Dental Care for Children.

Introduction

Data from epidemiological research reflect the oral health status of a given population at a specific period. They are the foundation of the strategic planning in dental services, enabling the development of effective programs in prevention and dental treatment [1,2].

During the last two decades, governmental health policies enhanced the population access to public dental health services. In Brazil, there was an important change in the distribution and pattern of the caries disease over the years [3], which places Brazil in the group of countries with low prevalence of dental caries [4]. Concurrently, the use of non-invasive and more conservative procedures has increased, which has contributed to huge changes in the clinical protocols for caries treatment [5,6]. In order to support these transformations, a need for the development of new indices for caries epidemiological research, as well as for clinical and academic purposes has appeared.

Traditionally, the dmf-t (decayed, missed and filled deciduous teeth) is the most used caries index in epidemiological studies. It is recommended by the World Health Organization (WHO) and points out the prevalence of caries linked to the presence of cavitation. The teeth surface is diagnosed as carious when a clear cavity is found, with or without softened tissue on the base of the lesion or around cavity walls. However, this index does not support early diagnosis, such as demineralized enamel lesions. Since preventive and non-invasive procedures are the most desirable treatments to control caries disease nowadays, the focus should be not only on cavitated lesions, but also on the initial signs of the disease [7].

For this reason, the International Caries Detection and Assessment System (ICDAS) has been proposed by a group of researchers in 2002. The ICDAS II integrates various systems in a standard model for the detection and evaluation of carious lesions, from the early stages of mineral loss up to extensive cavitation. By diagnosing the two extremes of the clinical signs of caries disease, ICDAS II allows a more comprehensive diagnosis to support treatment planning. Another important feature of this index is the possibility of monitoring the evolution of a lesion over time, which helps the clinical evaluation of the effectiveness of the treatment. When a detailed diagnosis of the carious lesion is achieved, the treatment plan can include several options, including non-invasive and minimally invasive procedures to minimize the operational costs and clinical chair time [8]. This model of dental attention is feasible in the Public Health System. It has the potential to reduce oral infection in populations with high prevalence of caries [9] and it helps to expand the access to dental services, thus decreasing the unmet demand of dental treatment in public health services.

Therefore, this study aimed (1) to carry out epidemiological research using the described indices to assess the prevalence, distribution and severity of dental caries in pre-school children; (2) to find out the influence of the two different indices in caries detection and (3) to relate these findings with the possible treatment options of the examined children. The null hypothesis tested was that there is no difference in the prevalence of caries measured by the dmf-t or ICDAS II and both indices can be used to determine treatment needs.

Material and Methods

Study Design

This cross-sectional study was accomplished in the city of Ponta Grossa (Paraná, Brazil), which is considered a middle-sized city in the state of Paraná. Its economic foundation is based on industrial and agricultural activities, and there are about 340.000 inhabitants, with a mean per capita income of $ 262 per month.

Sample Size Calculation

The sample size was calculated based on the number of children aged 3 to 5-year-old that lived in Ponta Grossa in 2010, when the most recent population census was done (15.023 children), and in a caries prevalence of 50% for deciduous teeth. The statistical accuracy used was 5%, with a confidence interval of 95% and a design effect of 2.0 (considering the sample selection by clumps). The sample calculation resulted in a sample of 750 children, to which 25% was added to avoid possible loss. Therefore, the study sample consisted in 931 children of both genders, aged 36 to 60 months-old, that attended municipal day care centers in Ponta Grossa.

Selection of the Day Care Centers

A list of all day care centers was provided to the researchers by the Department of Education of Ponta Grossa. After a drawing, 18 nurseries were randomly included in the study to fulfill the sample.

The day care center directors and the parents/caregivers of all the children were informed about the objectives of the study and the informed consent forms were obtained. The selected patients and their parents also received a lecture and oral health instructions before the dental exams. All the children regularly enrolled in these Municipal Day Care Centers were examined.

Calibration of the Examiners

Two examiners carried out this epidemiological research: one used the dmf-t index and the other the ICDAS II. They were trained and calibrated before the beginning of the study. The training consisted on a theoretical discussion about the indices with an experienced epidemiologist, followed by a practical training with dental photographs and extracted/exfoliated deciduous teeth from the Human Teeth Bank of our university. After that, they performed two dental exams in 20 children of the same age. The exams were carried on within a 24h interval, under the same conditions that were used in the study (as further described). The data were collected and Kappa statistics were obtained.

Dental Examination Protocol

The dental examination was accomplished at the day care centers, in a room with good ventilation and light. Before dental examination, each child brushed his/her teeth with the help of the examiners. The patient was asked to lay down on a mattress over a table. The examiners used

head LED lights to assist in the visualization of the dental surfaces, as well as mouth mirrors and WHO explorers. Teeth were dried with gauze and isolated with cotton rolls before examination. The exams were done in a standardized way, always beginning at the right upper second molar (55) and ending at the right lower second molar (85) [8]. All the patients were examined twice and the data from dmf-t and ICDAS II indices were recorded in an individual file. A trained recorder assisted the examiners and they were not aware of the registered scores from each other.

The dmf-t index represents the sum of the decayed (d), missing (m) and filled (f) deciduous teeth in an individual; it ranges from 0 to 20. A tooth is considered carious when there is an evident sign of cavity or when there is softened tissue in a pit, fissure or smooth surface. If there are white lesions, rough enamel surfaces or stained pit and fissures without visual signs of cavity or softened tissue, the tooth is marked as sound. A missing tooth is absent as a result of the evolution of a carious lesion; it should not be confused with teeth lost due to physiological exfoliation [7].

The ICDAS II collaborative team has developed useful, easy to use, and clearly defined criteria for clinical visual caries detection. This index classifies the evolution stage of the carious lesions in an ordinal scale ranging from 0 to 6 [2].

All the children that exhibited carious lesions that could be treated with atraumatic restoration received the restorative treatment at the municipal day care centers, as part of another research project. If additional treatment was required, the children were referred to the dental clinics of the university for treatment.

Data Analysis

In order to compare the indexes and to evaluate the treatment needs (non invasive or invasive treatments), 3 cut-off points were defined for ICDAS II: scores > 1, scores > 3 and scores > 4. The scores 0, 1 and 2 from ICDAS II were grouped and constituted the first cut-off point (cut-off > 1), which correlates to the absence of cavity – at most a white spot lesion; score 3 (cut-off > 3) is the first score that may indicate the presence of a cavity – even if restricted to enamel; scores 4, 5 and 6 (cut-off > 4) indicate the presence of dentin lesions. Therefore, cut-off points were related to the presence or absence of cavitation and the presence of dentin carious lesions, which defines the need for non invasive or invasive treatments. The comparison with dmf-t index was only possible from the score 3 onwards, since that is the first ICDAS II score that considers cavitation.

Data were analyzed using IBM SPSS Statistics, version 15 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to calculate the absolute and relative frequencies, mean and standard deviation. Comparisons between indexes were done with Pearson's chi-square test, with a significance level of 5%.

Ethical Aspects

This epidemiological research was approved by the Ethical Committee of the State University of Ponta Grossa (#71695/2012). It also received authorization from the Educational and Health Departments from Ponta Grossa City Hall.

Results

Dental exams were performed in 931 children (50.8% boys and 49.2% girls). The age groups were distributed in 17.5% (n=163) of children aged 3 years old, 38.9% (n=362) aged 4 years old and 43.6% (n=406) aged 5 years old.

The caries prevalence measured by the dmf-t index was 42.9%, with a mean dmf-t of 1.8 + 2.9 (Table 1). The highest caries prevalence was observed in the 5-year-old children (45.8%). When the ICDAS II was used, the caries prevalence varied according to the different cut-off points. The lowest cut-off point (ICDAS II >1) led to an enhanced caries prevalence, since the white lesions were included. In this cut-off point, there was no statistical difference at different ages. An increased cut-off point (ICDAS II ≥3 and ≥4) determined a decline in caries prevalence (Table 2).

Table 1. Caries prevalence according to age (dmf-t index).

Age	dmf-t ≥ 1*		
	N	%	CI 95%
3 Years	56	34.3	27.1 – 41.3
4 Years	157	43.4	37.9 – 48.7
5 Years	186	45.8	41.1 – 50.7
Total	399	42.9	39.7 – 46.0

*Significant difference between ages (p<0.05).

There was a statistically significant difference between ages for ICDAS II ≥3 (p = 0.032) and ≥4 (p = 0.015). Therefore, the caries prevalence was 50.7% for the cut-off point ICDAS II >1; 40.8% for ICDAS II >3 and 30.7% for ICDAS II >4. With this index, 5-year-old children were also the most affect by the caries diseases, regardless of the cut-off point used (Table 2).

The number of caries-free patients and those that presented only white lesions (ICDAS II scores 1 and 2) are shown on Table 2; 11% of 3 and 4-year-olds and 8.4% of 5-year-olds had scores 1 or 2 as the maximum score in the ICDAS II. This group of patients is not reported in the dmf-t index. The total percentage of caries-free children by ICDAS II was 49.1%, compared to 57.1% for dmf-t. No differences in the prevalence of white spots were observed between age groups (Table 2).

Table 2. Presence of dental lesions in the different ICDAS II scores at different ages.

Age	Dental Lesions											
	Caries Free		ICDAS II ≥1		Caries Free		ICDAS II ≥3		Caries Free		ICDAS II ≥4	
	N	%	N	%	N	%	N	%	N	%	N	%
3 Years	91	55.8	72	44.2	109	66.9	54	33.1	127	77.9	35	21.5
4 Years	178	49.2	184	50.8	218	60.2	144	39.8	248	68.5	114	31.5
5 Years	190	46.8	216	53.2	224	55.2	182	44.8	269	66.3	137	33.7
p-value	0.150				0.032				0.015			
Total	459	49.3	472	50.7	551	59.2	380	40.8	644	69.2	286	30.7

Caries Analysis According to the Tooth Units, Type of Tooth and Dental Arch

Regarding the unit "tooth", it was observed that the ICDAS II index resulted in a total of 2,157 carious teeth (ICDAS II > 1), which represented a percentage of 11.7% of the teeth in need of

some kind of treatment (Table 3). For the dmf-t index, the total number of carious teeth was 1,386 (Table 4), which represented a percentage of 7.4% of the teeth that needed some kind of treatment. Data regarding the dmf-t index showed that the component "decayed teeth" is the main factor that contributes to increase the index total value, regardless of the children's age. Also, all the components were observed to tend to rise with the age of the patients (Table 4).

The distribution of the carious lesions in the different groups of teeth and dental arches is shown in Table 3 for ICDAS II. There were significant differences when the three cut-off points were considered (ICDAS II > 1, > 2 and > 3) ($p < 0.001$). Lower molars were more affected by caries than the upper ones. But when considering the arches, the highest caries prevalence was seen in the upper arches regardless of the cut-off points (Table 3). Considering the 18,579 teeth evaluated by the dmf-t index, 91% were judged as sound (16.898). The other components of the index composed the remaining 9% of the index (Table 4).

Table 3. Distribution of carious lesions according to groups of teeth and dental arches, considering three different cut-off points in ICDAS II index.

Variables	Cut-off Point - Carious Lesions								
	ICDAS II ≥1*			ICDAS II ≥3*			ICDAS II ≥4*		
	N	%	IC 95%	N	%	IC 95%	N	%	IC 95%
Groups of Teeth*									
Upper Molars[a] (N = 3669)	584	15.7	14.6–16.9	449	12.1	11.1–13.2	273	7.3	6.5–8.2
Lower Molars[a] (N = 3620)	770	20.7	19.3–22.1	635	17.1	15.8–18.2	432	11.6	10.6–12.6
Upper Incisors[b] (N = 3679)	609	16.4	15.1–17.5	377	10.1	9.2–11.0	264	7.1	6.3–7.9
Lower Incisors[b] (N = 3712)	50	1.3	1.0–1.7	33	0.9	0,6–1.2	12	0.3	0.2–0.5
Upper Canine[c] (N = 1861)	105	5.6	4.6–6.7	30	1.6	1.0–2.2	19	1.0	0.6–1.5
Lower Canine[c] (N = 1862)	39	2.1	1.5–2.8	14	0.8	0.4–1.2	7	0.4	0.1–0.7
Dental Arch*									
Maxillary (N = 9219)	1298	13.9	13.2–14.7	856	9.2	8.6–9.8	556	6.0	5.5–6.4
Mandibular (N = 9194)	859	9.2	8.6–9.8	682	7.3	6.8–7.8	451	4.8	4.4–5.3
Total (N = 18.413)	2157	11.6	11.1–12.1	1538	8.3	7.9–8.7	1007	5.4	5.1–5.7

*Significant differences ($p \leq 0.001$); [a, b, c] Significant differences between teeth of the same group for the three cut-off points ($p \leq 0.001$); Pearson's chi-square test.

Table 4. Distribution of the dmf-t components according to the total evaluated teeth.

Age	Decayed		Missing		Filled		Total	
	N	%	N	%	N	%	N	%
3 Years	174	83.3	13	6.2	22	10.5	209	100.0
4 Years	178	49.2	218	60.2	248	68.5	693	100.0
5 Years	190	46.8	224	55.2	269	66.3	779	100.0
Total	542		455		539		1681	

Need of Dental Treatment According to the Indexes

The need of dental treatment is shown on Tables 5 and 6 according to ICDAS II and dmf-t, respectively. The data considered the age groups (3, 4, and 5-year-olds) as well as the kind of treatment (no intervention, no invasive treatment, restorative treatment).

For ICDAS II, 30.7% of the children required restorative treatment in at least one tooth, 20% non-invasive treatments (fluoride therapy or sealants) and 49.3% needed only follow-up. An

increased need of dental treatment was observed as the children's age increased. There was a significant difference in the need of treatment considering non-invasive and restorative procedures for children aged 4 and 5 years old; this difference was not observed in the 3-year-old group of children (Table 6).

Table 5. Treatment need of children evaluated according to ICDAS II index by the different ages.

Age	Non Operative Intervention		Non-invasive Treatment		Restaurative Treatment	
	N	%	N	%	N	%
3 Years	91	55.8	37	22.7	35	21.5
4 Years	178	49.2	70	19.3	114	31.5
5 Years	190	46.8	79	19.4	137	33.8
p-value*	0.150		0.632		0.015	

*Qui-square test.

Table 6. Treatment need of children according to dmf-t index by the different ages.

Age	Non Operative Intervention		Restaurative Treatment	
	N	%	N	%
3 Years	110	67.5	53	32.5
4 Years	217	60.0	145	40.0
5 Years	231	56.9	175	43.1
p-value*	0.066		0.066	

*Qui-square test.

The need for treatment of children assessed according to the dmf-t index is shown in Table 5. According to that, the total number of children with at least one carious and untreated tooth ("d" component) determined the number of children in need of restorative treatment (cavitated lesion). Thus, the differentiation of invasive and non-invasive treatments could not be established. There was a statistically significant difference between treatments at the ages evaluated, showing an increase in the need for restorative treatment also for 5-year-old children.

Discussion

This research showed that the use of dmf-t index in epidemiological surveys may underestimate the caries prevalence since it does not contemplate the early signs of the caries disease (enamel white spots). Despite this characteristic of dmf-t, both indexes pointed out the expressive need of restorative treatment in pre-school children. However, the use of the ICDAS II system allows early intervention and the application of non-invasive procedures. The diagnostic of early stages of carious lesions may be pointed out as the key difference between dmf-t index and ICDAS II. Therefore, the null hypothesis was rejected.

There is some difficulty to compare ICDAS II and dmf-t indices, since their evaluation criteria show some important differences. In order to overcome this problem, the establishment of equivalences between the indexes was suggested, facilitating the analysis of the results [10,11]. Therefore, different cut-off points were established in the ICDAS II scores, and they were used for

the first time in a study carried out in 2009 [8]. After that pioneer study, other surveys found possible the comparison between ICDAS II and dmf-t at cut-off point ≥3 [1,2,12,13]. This cut-off point starts at score 3, which is the first one to considered the presence of cavitation and includes scores 3, 4, 5 and 6.

Therefore, in our epidemiological survey, the prevalence of caries obtained in dmf-t (40.1%) is similar to ICDAS II (40.8%) when the cut-off ≥3 was used. Recently, another study compared the prevalence of dental caries with ICDAS II and dmf-t indexes [14], also using the cut-off ≥3 as the comparator point between the two indices; the caries prevalence was lower than the one found in this study (ICDAS II – 31%; dmf-t – 34%), but the sample consisted of children aged 3 -4 years old.

The difference in the caries prevalence data between our study and that developed in Porto Alegre (Brazil) [14] probably lies on the fact that we included 5-year-old children in our sample and they showed higher caries prevalence according to both indices (dmf-t 45% and ICDAS II 53%). This data is in agreement with other studies [2,8,15,16].

Higher value of caries prevalence was found using the dmf-t index in children of the same age in the last national epidemiological survey (53.4%). However, the values varied between different regions of Brazil and they were perceived at all ages. The South region of Brazil is characterized by lower caries prevalence [4].

This was observed in our study even with the use of a sample that was composed by children attending public schools in the city. The type of school attended is a reliable indicator of the socioeconomic condition in urban environments, showing a significant association between caries experience and school type, with a higher prevalence of caries lesions in public schools [12]. Low socioeconomic status and low educational levels have less access to dental services [17] and in Brazil there is a lack of specialized care for infants at public health services [13]. Therefore, the data obtained is representative of this specific population.

Regardless of the epidemiological index used, higher caries prevalence was observed in older children. This can be explained by the longer time the teeth have been exposed to the cariogenic challenge in the oral environment, which makes the lesions visible and more easily detected. This situation is related to active carious lesions in the deciduous dentition and demonstrates lack of care and access, endangering the integrity of the permanent dentition [1,12,13], since past caries experience is considered the strongest and best predictor for the development of future dental caries in children [15].

One differential of our study is that we established the relation between caries prevalence and treatment needs, according to both indices employed. It is important to point out that ICDAS II is the only index that allows the implementation of non-invasive treatments and an early approach to the treatment of carious lesions. The ICDAS II scores 1 and 2 are related to initial lesions. Therefore, to reduce the bias, our survey grouped both scores, considering the presence of white-spot-lesions as the outcome.

In the current context, it is fundamental to adopt a therapeutic behavior directed to the control of the caries disease, since not every enamel cavitated lesion will require restorative intervention [18] and not all active lesions in enamel will progress to more severe situations. Such lesions can be treated conservatively by preventive programs.

A substantial reduction in caries is achieved in populations with different levels of caries risk if exposed to fluoride sources, along with health education and the adoption of adequate diet and hygiene habits. These measures are very cost effective and easily accomplished by private and public dental services [11]. On the other hand, if not treated, active lesions in enamel may progress to the dentine and require restorative treatment [18,19].

Our study showed that perhaps the ideal approach is to treat 3-year-old children because there is a chance for the lesions to evolve if inadequate behavior perpetuates over time. This affirmative is corroborated by the data provided in Table 6, which shows that the need of invasive treatment enhances with age and there is a significant difference between age groups when this feature is considered.

By providing specific data about the need of invasive or non-invasive treatment, we pointed out the fact that early diagnosis and non-invasive treatment can only be accomplished when ICDAS II is used. Also, we were able to identify that the need of invasive treatment increases with age, which corroborates the need for early intervention.

Regarding the application of the two indices outside the clinical setting, some considerations must be presented. In this survey, cotton rolls were used to help the dental exam. This situation could be a limitation in epidemiological surveys, since the use of compressed air is considered essential for the visualization of ICDAS II scores 1 and 3 [1]. However, with cotton rolls, there was no dehydration in the enamel, thus reducing the risk of bias during evaluation and the overestimation of white spots.

Another situation is the need for calibration to avoid bias with multiple examiners. However, in our study only one examiner evaluated each index using the same methodology proposed by a similar study [20]. Kappa values ranged from 0.86 for the ceo-d index to 0.88 for the ICDAS II, indicating high agreement of the indices, values similar to those obtained in other studies [19,21-23].

When analyzing the treatment needs amongst the different age groups, 30.7% of the study subjects required restorative intervention. Data regarding treatment has to provide a basis for the type of treatment required for a population considering the existing infrastructure and manpower facilities [24]. The access to appropriate dental care, which should be focused on prevention, control of initial lesions and conservative management of moderate and extensive lesions, is necessary for better oral health [25].

Conclusion

Both indexes were seen to point out the expressive need for restorative treatment in pre-school children that increased over time, but the use of the dmf-t index in epidemiological surveys

may underestimate caries prevalence in a child population. The use of ICDAS II allowed the identification of early carious lesions and the viability of the use of non-invasive procedures as caries control measures.

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