

# Dental caries prediction and the indication of pit and fissure sealant in children first permanent molars: a prospective study

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## Research Article

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# Abstract

**Objectives:** To evaluate predictors for caries incidence on first permanent molars and to assess the accuracy and efficiency of these predictors for the indication of pit and fissure sealants.

**Methods:** This 7-y cohort study started in 2010 with a sample of 639 children (1–5 years) from Southern Brazil. Dental caries was assessed using the ICDAS. Maternal education, family income, parental perception on child oral health and severe dental caries experience were collected at baseline and used to test the prediction of dental caries. Predictive values, accuracy and efficiency were estimated for each possible predictor.

**Results:** About 449 children were re-assessed at follow-up (70.3% retention rate). Low family income and poor parental perception of child oral health were moderately accurate in correctly identifying sound children who would not need to receive pit and fissure sealant. However, all the adopted criteria have lower accuracy incorrectly identifying children who later developed dental caries in first permanent molars.

**Conclusions:** Distal and intermediate factors were relatively accurate in determining caries risk incidence on children's first permanent molars. The criteria adopted were more accurate in identifying sound children than those who need to receive pit and fissure sealant.

**Clinical relevance:** Our findings reinforce the idea that investing in strategies that take into account common risk factors still represents the best option for dental caries prevention. However, adopting only these parameters is not enough to indicate pit and fissure sealants.

## Introduction

Recognizing factors that may determine a higher risk for disease development has been a priority in epidemiological studies. The literature has demonstrated the association of proximal, intermediate, and distal determinants and oral health outcomes in children [1]. Previous studies have been shown the association of socioeconomic [2–4] and psychosocial factors [5, 6] and dental caries experience in children. Knowledge of these associations has been considered important to the identification of risk groups and reorientation of actions, both in clinical practice and those focused on public policies aimed at controlling or reducing disease rates.

In pediatric dentistry, the evidence level for preventive and therapeutic approaches has increased over the last few years [7]. Specifically related to dental caries, it has been demonstrated the benefits of the use of pit and fissure sealants in preventing dental caries in permanent molars [8]. Although it has been considered an effective approach, there are still gaps in the literature in relation to which criteria should be taken into account for the indication of pit and fissure sealants in children. Most studies have demonstrated that past caries experience is the best predictor for dental caries incidence [9]. From this perspective, it is expected that this characteristic will be considered a good criterion for the indication of

sealants. It has been argued that the effectiveness of a preventive strategy depends on the population's current caries risk, which involves a number of clinical, behavioral and sociodemographic factors [8]. Thus, as a population-level strategy, distal and intermediate determinants could be used for the pit and fissure sealant indication. The use of these factors could improve caries prevention strategies since higher risk groups could be identified without a clinical evaluation.

In this sense, efforts should be made to assess the accuracy of possible parameters to be used as indicators of pit and fissure sealants use. Therefore, we aimed to evaluate the possible predictors for caries incidence in occlusal surfaces of first permanent molars by means of relative risk, risk difference, and attributable fraction to exposure. Notwithstanding, we evaluate predictors for caries incidence in occlusal surfaces of first permanent molars and assesses the accuracy and efficiency of these predictors for the indication of pit and fissure sealants as a preventive strategy in children. Our hypothesis is that distal and intermediate factors, such as socioeconomic and psychosocial characteristics experienced in early childhood, may present a good accuracy for the indication of pit and fissure sealants.

## **Methods**

### **Ethical considerations**

This prospective study was approved by the local Committee for Ethics in Research (Protocol Number 54257216.1.0000.5346). Children's legal guardians signed an informed consent form agreeing to take part in the study.

### **Study design and participants**

This is a prospective accuracy study performed to assess the predictive capacity of early childhood characteristics on the indication of pit and fissure sealants in first permanent molars. Between 2010 and 2017 we performed a cohort study with the aim of assessing early childhood determinants for dental caries incidence in first permanent molars. The first stage of the study comprised an epidemiological survey performed during the national vaccination day, in Santa Maria, Brazil. The city has a fluoridated water supply and an estimated population of 263,403 inhabitants of whom 27,520 were preschool children [10]. At baseline, a multistage sampling considered all health centers with a dental office as primary survey units, and 15 out of 28 health centers were selected. A representative sample of 639 preschoolers (aged 12–59 months) was assessed by 15 trained and calibrated examiners distributed in 15 health centers from different neighborhoods of the city. Detailed information on the methods used in this survey was already published [11].

At the follow-up, efforts were made to re-evaluate as many children as possible. They were reassessed in order to identify caries incidence in first permanent molars. From January 2017 to March 2018, using the phone number and address registered at baseline, participants were sought to be invited to participate in the follow-up assessment. For this stage, four calibrated examiners performed visits to children's homes and in their respective schools in order to find and assess them. The calibration process was performed

in the same way as the one conducted prior to baseline assessments which comprised a theoretical class and clinical training about the indexes and criteria that were used [11].

## **Dental caries assessment**

At baseline and follow-up, dental caries was assessed by using the International Caries Detection and Assessment System (ICDAS) criteria [12]. At baseline, children were examined while seated on a dental chair under artificial illumination. Visual examinations for the ICDAS criteria were conducted aided by plane dental mirrors and ball-ended probes. Wet gauze pads, ball-ended probes, toothbrushes, and dental floss were used to remove dental plaque when identified on the surfaces. Teeth were first examined wet and then examined after being dried with compressed air using a dental chair's syringe for 5 s. Teeth with dental restorations were also recorded. For purposes of statistical analysis, the children were then categorized as having severe caries experiences (scores 5 and 6) and children without severe caries (scores 0,1, 2, 3 and 4) at baseline.

At the follow-up, children were assessed in order to identify dental caries on occlusal surfaces of first permanent molars. At this time, the children were evaluated at their own homes or at the schools where they were enrolled. The examination was performed with the child sitting in a common chair, under artificial light. Dental plaque removal was performed with the aid of wet gauze pads and toothbrushes. Occlusal surfaces recorded with the ICDAS scores 2, 3, 4, 5, and 6 were considered decayed. We do not consider score 1 because of our inability to dry the tooth properly, as recommended by the ICDAS. Besides to considering severe lesions (scores 5 and 6), we chose to consider initial lesions (scores 2), and moderate lesions, localized enamel breakdown (score 3 and 4), since the first permanent molars are the teeth at the highest risk of development and progression of dental caries in mixed and permanent dentition [13]. In our study, children with first permanent molars presenting dental caries on occlusal surfaces at follow-up were used as the gold standard to identify the group in which the pit and fissure sealant should have been indicated. Such criterion was used as the outcome to identify predictive values: relative risk (RR), difference risk (DR), and attributable fraction to exposure (AFE); to test the accuracy, by means of sensitivity (SE), specificity (SP), a predictive positive value (PPV), and a predictive negative value (PNV); and efficiency, by means of number-needed-to-treat (NNT) of different parameters on the indication of sealants in first permanent molars.

## **Data collection on criteria for dental sealants indication**

The prediction of caries incidence, and the accuracy and efficiency of baseline variables in determining the use of dental sealants were evaluated. For this, the variables considered were: (1) "baseline severe caries experience", (2) "maternal education", (3) "family income", and (4) "parent's perception on child oral health". The socioeconomic and psychosocial data were collected through a structured questionnaire answered by parents or guardians. Maternal education was collected in terms of years of study and then categorized into  $\geq 8$  years or  $< 8$  years (incomplete primary education). Family income was collected in Real (Brazilian currency - R\$5.00 was equivalent to US\$1.00 approximately) which represents the amount of income monthly earned by all family members. It was collected as a continuous variable and then

dichotomized by the quartiles in 25% poorest - Q1 ( $\leq$  R\$ 560.00) and 75% richest – Q2, Q3 e Q4 ( $>$  R\$560.00). Parents' perception of child oral health was used as psychosocial variable and was collected by the following question: "How do you consider the oral health of your child?" with "excellent", "very good", "good", "regular" and "poor" as possible answers. This variable was later categorized into "good" or "poor" [14].

## ***Statistical analysis***

Data analyses were performed using the software STATA 14 (StataCorp.2014 Stata Statistical Software: Release 14.1. College Station, TX: StataCorp LP). Descriptive analysis was performed and chi-square testes compared differences in the baseline characteristics among the total sample and those followed-up children. The reliability of dental caries assessment both, at baseline and follow-up, were evaluated by means of kappa values.

The RR, RD, and AFE with their 95% confidence interval (95% CI) were estimated for each variable to be tested, considering caries incidence in occlusal surfaces of first permanent molars as the outcome. The AFE is defined as the proportion of disease in the exposed group that can be attributable to the risk factor [15]. To assess the validity of the criteria for sealant indication, we considered the following assumptions: if the children had severe dental caries at baseline, then they should have received pit and fissures sealants in the first permanent molars. The same reasoning was used for the other variables: if the mothers had lower education; if the children belonged to families with lower income; and if the parents perceived the child's oral health as poor, then the children should have received pit and fissures sealants on their first permanent molars. Thus, for each criterion, the accuracy was evaluated through the values of SE, SP, PPV, NPV [16], and NNT [17, 18] with 95% CI.

The values were calculated using contingency tables that cross-classified children according to each risk factors assessed at baseline and the observed rate of caries incidence in first permanent molars. The NNT is a measure for the efficiency of a preventive strategy [19], expressing the number of patients to be treated (with pit and fissure sealant, e.g.) in order to prevent the incidence of dental caries on the occlusal surface of the first permanent molar in one child.

## **Results**

The baseline and follow-up inter-and intra-examiner reliability values (kappa statistics) for dental caries ranged from 0.72 to 0.95 and 0.70 to 0.92, respectively. From the 639 participants assessed at baseline, 449 children were re-evaluated at follow-up (70.3% of retention rate). The characteristics of the sample are presented in Table 1. The prevalence of severe dental caries experience in primary dentition at baseline was 28.8% and for followed-up children, its prevalence was 28.3%. The incidence of dental caries in occlusal surfaces of first permanent molars was 28.5%. There were no statistical differences between followed-up and dropout's children regarding demographic, socioeconomic, and clinic characteristics ( $P > 0.05$ ).

Table 1  
Baseline characteristics of the total sample and of the children followed-up and not followed-up.  
Santa Maria, RS, Brazil.

<b>Variables</b>	<b>Baseline (n = 639) n (%)</b>	<b>Followed-up (n = 449) n (%)</b>	<b>Dropouts (n = 190) n (%)</b>	<b>p-value*</b>
<b>Sex</b>				0.280
Boys	322 (50.4)	220 (49.0)	102 (53.7)	
Girls	317 (49.6)	229 (51.0)	88 (46.3)	
<b>Family Income (in Reais)</b>				0.235
25% Poorest	158 (26.3)	109 (25.6)	49 (27.8)	
75% Richest	444 (73.7)	317 (74.4)	127 (72.2)	
<b>Maternal education</b>				0.059
≥ 8 years	357 (56.5)	246 (55.3)	111 (59.4)	
< 8 years	275 (43.5)	199 (44.7)	76 (40.6)	
<b>Parental perception on child oral health</b>				0.214
Good	488 (76.6)	347 (77.3)	141 (75.0)	
Poor	149 (23.4)	102 (22.7)	47 (25.0)	
<b>Dental caries experience</b>				0.662
Without	455 (71.2)	322 (71.7)	133 (70.0)	
With	184 (28.8)	127 (28.3)	57 (30.0)	
R\$, Real (R\$5.00 it was equivalent to US\$1.00 approximately); *Chi-square Test				

Children with severe dental caries experience in primary dentition showed 27% (RR 1.27 95% CI 1.12–1.45) more risk of present dental caries on occlusal surfaces of first permanent molars than counterparts. The AFE shows that 22% (AFE 0.22 95% CI 0.11–0.31) of dental caries in occlusal surfaces of first permanent molars can be attributed to dental caries experience in the primary dentition. Low maternal education increases in 26% (RR 1.26 95% CI) the risk of children presenting dental caries in occlusal surfaces of first permanent molars; and 20% of dental caries can be attributed to low maternal education (AFE 0.20 95% CI 0.11–0.29). Belong to the lowest income quartile at the baseline increases in 47% (RR 1.47 95% CI 1.23–1.74) the risk of having dental caries in occlusal surface of first permanent molars; and 32% (AFE 0.32 95% CI 0.19–0.42) of caries can be attributed to lower family income exposure at baseline. Children whose parents perceive their oral health as poor at baseline showed 59% (RR 1.59 95% CI 1.33–1.89) more risk of having dental caries in occlusal surfaces of first permanent molars and 37%

(AFE 0.37 95% CI 0.25–0.47) of dental caries were attributed to a poor parental perception on child oral health at baseline (Table 2).

Table 2

Predictive values among the criteria used to predict dental caries incidence in children first permanent molars.

<b>Criteria</b>	<b>RR (95%CI)</b>	<b>RD (95%CI)</b>	<b>AFE (95%CI)</b>
<b>Dental caries experience</b>	1.28 (1.12–1.45)	0.10 (0.04–0.15)	0.22 (0.11–0.31)
<b>Low maternal education</b>	1.25 (1.12–1.40)	0.10 (0.05–0.16)	0.20 (0.11–0.29)
<b>Low family income</b>	1.47 (1.23–1.74)	0.10 (0.05–0.15)	0.32 (0.19–0.42)
<b>Poor Parental perception on child oral health</b>	1.59 (1.33–1.89)	0.12 (0.07–0.16)	0.37 (0.25–0.47)
RR, Relative risk and 95% confidence interval; RD, Risk difference and 95% confidence interval; AFE, Attributable fraction to exposed and 95% confidence interval.			

Table 3 describes the values of SE, SP, PPV, NPV, and NNT, for the criteria considered in our study. The SE and SP of dental caries experience in primary dentition was 43.8% and 65.7%, respectively. Its positive and negative predictive values were 33.7% and 74.5%. Considering this criterion, the NNT was 11. When maternal education was considered, the SE and SP were 51.7% and 58.9%. The PPV and NPV for this criterion were 33.2% and 75.2%, respectively. The NNT considering mother education was 10. For family income criterion, SE and SP values were 32.2% and 78.0%; PPV and NPV were 37.0% and 74.2%, respectively. When family income was considered, the NNT was 10. Lastly, for parental perception on child oral health, the SE and SP values were 31.4% and 80.2%, respectively; the PPV and NPV were 38.8% and 74.5%. If the parental perception of child oral health was adopted as a criterion, the NNT would be 9.

Table 3  
Accuracy and efficiency values for indication of dental sealants in first permanent molars.

Criteria	SE (95%CI)	SP (95%CI)	PPV (95%CI)	NPV (95%CI)	NNT (95%CI)
Dental caries experience	43.8 (41.4–46.2)	65.7 (63.4–67.9)	33.7 (31.5–36.0)	74.5 (72.5–76.1)	11 (6.8–23.0)
Maternal education	51.7 (49.3–54.1)	58.9 (56.5–61.2)	33.2 (31.2–35.8)	75.2 (73.1–77.3)	10 (6.3–19.0)
Family income	32.2 (29.9–34.5)	78.0 (76.0–80.1)	37.0 (34.6–39.4)	74.2 (72.0–76.3)	10 (6.6–18.4)
Parental perception on child oral health	31.4 (29.2–33.6)	80.2 (78.3–82.1)	38.8 (36.5–41.1)	74.5 (72.5–76.6)	9 (6.1–14.3)
SE, Sensitivity; SP, specificity; NNT, number-needed-to-treat; PPV, positive predictive value; NPV, negative predictive value; CI, Confidence interval.					

## Discussion

This study aimed to evaluate the predictive characteristics of early childhood factors in relation to caries incidence in occlusal surface of first permanent molars, as well as the accuracy and efficiency for an indication of pit and fissure sealants in children. Generally, the results demonstrated that baseline characteristics as low family income and poor parental perception on child oral health were moderately accurate in correctly identifying sound children who would not need to receive pit and fissure sealant. However, all the adopted criteria have low accuracy, incorrectly identifying children who later developed dental caries in first permanent molars and should receive dental sealants.

Besides past severe caries experience, which is considered the best predictor for caries incidence [9], intermediate and distal factors collected from baseline presented similar risk values for the incidence of dental caries in first permanent molars. Children from lower-income families and whose parents perceived their oral health as poor at baseline had a higher risk of developing caries in first molars when compared to children from higher-income families and whose parents perceived oral health as good. Similar results have been demonstrated by other authors [4, 5].

In our study, we have demonstrated the AFE that is related to the proportion of incidence in the exposed group attributable to the risk factor considered [15]. It was possible to estimate how much we would reduce the proportion of children with dental caries in the first permanent molars when eliminating the



risk factors such as low family income, low maternal education, and poor parents' oral health perception. These findings reinforce the idea that investing in the improvement of strategies that take into account common risk factors still represents the best option for disease prevention [20]. The implementation of approaches aimed at controlling risk factors such as family income and parental education, common to other health conditions, may also bring benefits in reducing dental caries incidence in children first permanent molars.

In terms of accuracy, for all criteria evaluated the SE and PPV were considered low. It means that using our criteria, we fail to not indicate sealants on a considerable number of children who will develop dental caries in first permanent molars. The PPV showed a low percentage of correctness when using our criteria for the indication of sealants. On the other hand, the SP and the NPV were considered high, especially to family income and parental perception on child oral health variables. This indicates that these may be good confirmatory parameters; that is, using our criteria, children in whom the use of dental sealant is not indicated, in fact, will not develop dental caries in first permanent molars. A useful risk assessment variable is one with high SE and SP. However, due to the incompatibility of these two parameters, it might be difficult to achieve high SE and SP simultaneously [21].

The NNT has been used as a measure of efficiency. It is considered a well-known absolute effect-size measure, as a way for appraisal clinical relevance of an intervention [22]. In our study, NNT expresses the number of children that need to receive sealant in order to prevent dental caries development in the occlusal surface of the first permanent molar in one child. This measure is important to promote a better understanding related to the impact of preventive strategies tailored to subgroups of individuals [23]. Although NNTs close to 1 are preferable, higher values, such as those close to 10, maybe acceptable in less urgent clinical situations [22]. Considering caries as a chronic and cumulative condition, and that the first molars are not benefited in the same way as the other teeth by existing strategies such as the widespread use of fluoride [24], efforts should be made to avoid the early development of caries in these teeth.

Some points need to be discussed. Firstly, we have used only some variables to predict caries risk and to be used as criteria to pit and fissure sealant indication. However, these variables have been extensively recognized as risk factors for poor child oral health [5]. Furthermore, it is not our intention to exhaust the possibilities of the use of parameters for the indication of sealants. Although there is no clearly superior method to predict the occurrence of caries, the past caries experience has been suggested as the best single criterion for caries prediction [9] and when it is possible, its evaluation in a clinical setting must be a priority. Nevertheless, in a public health scenario, recognizing some factors that do not require a clinical evaluation and that could be used to define groups of children who need or not the implementation of the dental sealing strategy is of great importance.

Another point to be discussed is our low accuracy in define children who have to receive pit and fissure sealants. The literature has argued about the difficulty in assesses individual future caries risk [25]. It has been shown greater specificity rather than sensitivity results, that is the parameters commonly used to

assess the prediction of caries better identify individuals who will not develop the disease than those who will actually develop. It would be important to correctly identify the groups at greatest risk so that adequate preventive care could be directed to them [26]. In this sense, it has been shown that children at high risk who received sealants develop fewer caries in a given period [21]. Furthermore, the literature strongly supports the indication of sealants on permanent molars as efficacious in the prevention of caries [27, 28].

Despite the limitations, our study may contribute to the understanding of possible factors that may be used for the indication of pit and fissure sealants in children. The possibility of indicating pit and fissure sealants by means of distal and intermediate characteristics that avoid the need for a clinical evaluation could be considered important, especially when taking into account public health strategies that are low cost and capable of generating good results. Studies have shown the impact of socioeconomic and psychosocial factors on dental caries [4, 5]; however, to our knowledge, no study has estimated the magnitude of disease reduction when such factors are attenuated. We understand that eliminating low education and income from the population is not something simple or even feasible [29]; however, together with broader strategies, indicating sealants for children at increased caries risk may be an alternative to control the incidence of the disease in this population.

In conclusion, our study provided evidence that some early childhood factors were relatively accurate in determining caries risk incidence on occlusal surfaces of children's first permanent molars. The criteria tested in this study showed to be more accurate in identifying children who not need pit and fissure sealant than those who need it. Furthermore, the NNT can be considered acceptable, since caries is considered a multifactorial and chronic disease. Taking into account the disparities in the incidence of caries in childhood and the high disease prevalence observed in other life stages, the implementation of preventive and therapeutic strategies based on the risk of different groups should be considered in order to prevent caries incidence from early childhood to the school-age years and another life stages.

## **Declarations**

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### **Author Contributions**

All authors contributed to the final study's conception. Dr Emmanuelli conceptualized and designed the study, designed the data collection instruments, collected data, carried out the initial analyses, drafted the initial manuscript, and reviewed and revised the manuscript. Ms Knorst and Dr Menegazzo designed the study, designed the data collection instruments, collected data, and reviewed and revised the manuscript. Dr Mendes designed the study, coordinated and supervised data collection, and critically reviewed the

manuscript. Dr Ardenghi conceptualized and designed the study, coordinated and supervised data collection, carried out the analyses, and critically reviewed the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

### **Compliance with Ethical Standards**

**Conflicts of interest:** The authors declare that they have no conflict of interest.

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**Ethical approval:** This cohort study was approved by the Committee for Ethics in Research from the Federal University of Santa Maria (Protocol Number 54257216.1.0000.5346). The participants' parents or guardians signed an informed consent form.

**Informed consent:** Informed consent was obtained from all mothers participating in the study.

### **AUTHOR CONTRIBUTION STATEMENT**

#### ***Dental caries prediction and the indication of pit and fissure sealant in children first permanent molars: a prospective study***

All authors contributed to the final study's conception. Dr Emmanuelli conceptualized and designed the study, designed the data collection instruments, collected data, carried out the initial analyses, drafted the initial manuscript, and reviewed and revised the manuscript. Ms Knorst and Dr Menegazzo designed the study, designed the data collection instruments, collected data, and reviewed and revised the manuscript. Dr Mendes designed the study, coordinated and supervised data collection, and critically reviewed the manuscript. Dr Ardenghi conceptualized and designed the study, coordinated and supervised data collection, carried out the analyses, and critically reviewed the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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