Original Paper

Caries Research

Caries Res 2012;46:488–495
DOI: 10.1159/000339491

Received: December 21, 2011
Accepted after revision: April 27, 2012
Published online: July 14, 2012

Caries Is the Main Cause for Dental Pain in Childhood: Findings from a Birth Cohort

G.F. Boeira[a] M.B. Correa[a] K.G. Peres[c] M.A. Peres[c] I.S. Santos[b]
A. Matijasevich[b] A.J.D. Barros[b] F.F. Demarco[a, b]

Postgraduate Programs in [a]Dentistry and [b]Epidemiology, Federal University of Pelotas, Pelotas, and [c]Postgraduate Program in Public Health, Federal University of Santa Catarina, Florianopolis, Brazil

Key Words
Cohort study · Dental caries · Dental pain · Epidemiology · Oral health

Abstract
Aim: The aim of the study was to evaluate the prevalence of dental pain in preschool children and its association with socioeconomic, demographic, clinical, and behavior variables. ***Subjects and Methods:*** The study was nested in a population-based birth cohort from Pelotas, Brazil, started in 2004. A sample of 1,129 children aged 5 years was dentally examined, and their mothers were interviewed. Exploratory variables included demographics, socioeconomic status, mothers' oral health status and associated behaviors, and caries in primary teeth. Data were analyzed using multivariable Poisson regression. ***Results:*** The prevalence of dental pain was 16.5% (95% CI: 14.4–18.8). Multivariate analysis showed that dark-skinned children (prevalence ratio, PR = 1.6, 95% CI: 1.1–2.4) from low socioeconomic level (PR 1.9, 1.2–3.0) whose mothers had less than 4 years of education (PR 1.9, 1.0–3.6), from mothers with less than 10 teeth in at least one arch (PR 1.7, 1.2–2.5) and less than 10 in two arches (PR 1.6, 1.0–2.6), and those with high caries prevalence at the age of 5 years (PR 4.8, 3.3–7.1) were more likely to experience dental pain. ***Conclusions:*** Unrestored caries is the main factor associated with dental pain in childhood. Socioeconomic aspects and family context in which dental pain occurs should also be taken into account when dental pain preventive measures are implemented.

Dental pain in children has been described as a common experience, and studies performed in children report that not only the high prevalence but also the severity of pain have an impact on their quality of life, making the matter an important public health problem [Slade, 2001; Moura-Leite et al., 2008; Barretto et al., 2009]. Dental pain can affect sleep, impair nutrition, cause school absences, and compromise the time of parents and relatives, having a negative impact on several aspects of daily life [Shepherd et al., 1999; Naidoo et al., 2001; Lancet, 2009]. Dental caries has been considered the main biological cause of dental pain in children, followed by trauma and dental exfoliation [Slade, 2001; Peres et al., 2005; Bastos et al., 2007; Tickle et al., 2008].

The majority of studies have investigated the prevalence of dental pain in adults or the elderly. Only recently has attention been paid in epidemiologic surveys to the occurrence of pain in children and teenagers [Nomura et al., 2004; Pia and Poulsen, 2005; Vargas et al., 2005; Pau

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Flávio Fernando Demarco
Programa de Pós-graduação em Odontologia
Programa de Pós-Graduação em Epidemiologia, Universidade Federal de Pelotas
Rua Gonçalves Chaves, 457, 5º andar, Pelotas, RS 6015-560 (Brazil)
Tel. +55 53 3222 6690, E-Mail ffdemarco@gmail.com

et al., 2007; Bastos et al., 2008; Borges et al., 2008; Mashoto et al., 2009; Lewis and Stout, 2010; Peres et al., 2010]. A recent search (February 2011) in different databases (PubMed, Lilacs, BioMed Central and Web of Science) using the terms 'dental pain' and 'toothache' turned up few population-based studies investigating dental pain in deciduous teeth, with only five studies reporting this prevalence at the age of 5 [Slade, 2001; Barretto et al., 2004; Moura-Leite et al., 2008; Tickle et al., 2008; Oliveira and Colares, 2009].

Children from families of low economic and low educational levels presented higher prevalence of dental pain [Nomura et al., 2004; Thomson et al., 2004; Peres et al., 2007; Bastos et al., 2008; Barretto et al., 2009]. Family characteristics, such as parental perception of their own oral health or their children's oral health and knowledge and habits regarding oral hygiene and diet have been identified as indicators of oral health and, probably, dental pain as well [Bastos et al., 2008; Shearer and Thomson, 2010; Dye et al., 2011].

Since they provide the main daily oral care and show behaviors that can influence their kids, parents, and especially mothers, are responsible for promoting oral health in childhood [Mattila et al., 2000]. However, the aspects related to the family context have been poorly investigated relative to the identification and development of dental pain in deciduous teeth [Bastos et al., 2008; Weintraub et al., 2010].

This study assessed the prevalence of dental pain at the age of 5 and its association with demographic and socioeconomic variables, the mothers' behavior, and clinical aspects related to the mothers and children in a birth cohort.

Subjects and Methods

During the year 2004, 4,558 children were born in the urban area of Pelotas city and the Jardim America, a district from the city of Capão do Leão, a contiguous neighbor city of Pelotas, Brazil. Of the 4,231 live births, 99% were evaluated within the first 24 h after birth, 96% at 3 months of age, and 94% at 12 months of age. A previous study about the methodology of this cohort has already been published [Barros et al., 2006; Santos et al., 2010].

This investigation is part of a comprehensive oral health survey carried out in 2009, between August and December, nested on the 2004 Pelotas Birth Cohort. The mothers of all 5-year-old children born between August and December 2004 who were visited when they were aged 12 months (n = 1,303) were invited to participate. This sample is sufficient to estimate rates of 50% for oral outcomes (unknown rates), with a sampling error of three percentage points. In addition, the sample size is sufficient to test associations with a power of at least 80% to detect significant relative risks of 2 or more, considering a prevalence of 5% of outcomes in those not exposed to different conditions of research and using a significance level of 5%.

The oral health survey comprised a questionnaire applied to the mother and an oral examination of the child, both performed at their homes. The prevalence of dental pain was investigated with two questions directed to the mothers or responsible persons: 'Has your son/daughter had dental pain in the last 4 weeks?' and 'Has your son/daughter had dental pain in the last 6 months before this interview?' Dental pain outcome was dichotomized in no (absent) and yes (present), with prevalence in the last 6 months used in the analysis of associations.

Dental examinations also included the investigation of dental caries on the primary dentition through the dmf-s index [World Health Organization, 1997] that was later classified in tertiles.

The mothers' data, such as family income and educational level, were collected at the children's birth. Mother-reported skin color of the children was categorized as white, light-skinned black and dark-skinned black. Family income at birth was collected in Brazilian real (1 USD = 1.7 BRL) and then categorized into quartiles. Maternal schooling at children's birth was categorized into four groups: ≤4, ≥5–8, 9–11, and 12 completed years of study.

Eight dentists, students from the Masters or PhD courses in dentistry at the Federal University of Pelotas (PPGO-UFPel), were trained and calibrated. For the calibration process, which was performed at schools, 100 preschoolers of the same age who were not included in the sample to be surveyed were examined. Inter-rater diagnostic reproducibility was assessed by the kappa coefficient (categorical variables) and by the intraclass correlation coefficient (continuous and discrete variables). For dental caries (dmf-s), the intraclass coefficient varied between 0.93 and 1.0. The kappa for the evaluated questions varied between 0.6 and 1.0.

Previous knowledge regarding the prevention of oral disease was obtained with the question: 'Have you received professional orientation about how to prevent dental caries in your child(ren)?' The self-perception regarding their own oral health was assessed by asking: 'Compared to the individuals of your age, how do you consider the health of your teeth, gums or mouth: very good or good, regular, and bad or very bad?'

The number of teeth present in the mothers' mouths was obtained using the following questions: 'How many upper teeth do you have?' and 'How many lower teeth do you have?' This information was later categorized into 'no dental arch with less than 10 teeth (≥20 teeth)'; '<10 teeth in at least one arch', and 'less than 10 teeth in both arches'. The mothers' ability to control the oral hygiene of their children was assessed by agreement with the statement: 'I am not able to have my child brush their teeth at least twice a day.' Responses were categorized as 'disagree' (<2 times a day) and 'agree' (≥2 times a day).

For the fieldwork, the dentists, each assisted by a dental undergraduate student, conducted the interviews first and then the dental examinations to ensure that the questionnaire responses were not influenced by the outcomes of examinations. Children were examined sitting under artificial illumination (head lamp). The examiners were properly dressed, and all safety and biohazard measures were observed. Furthermore, to assess data quality, 15% of interviews were repeated with a shortened version of the questionnaire by fieldwork supervisors.

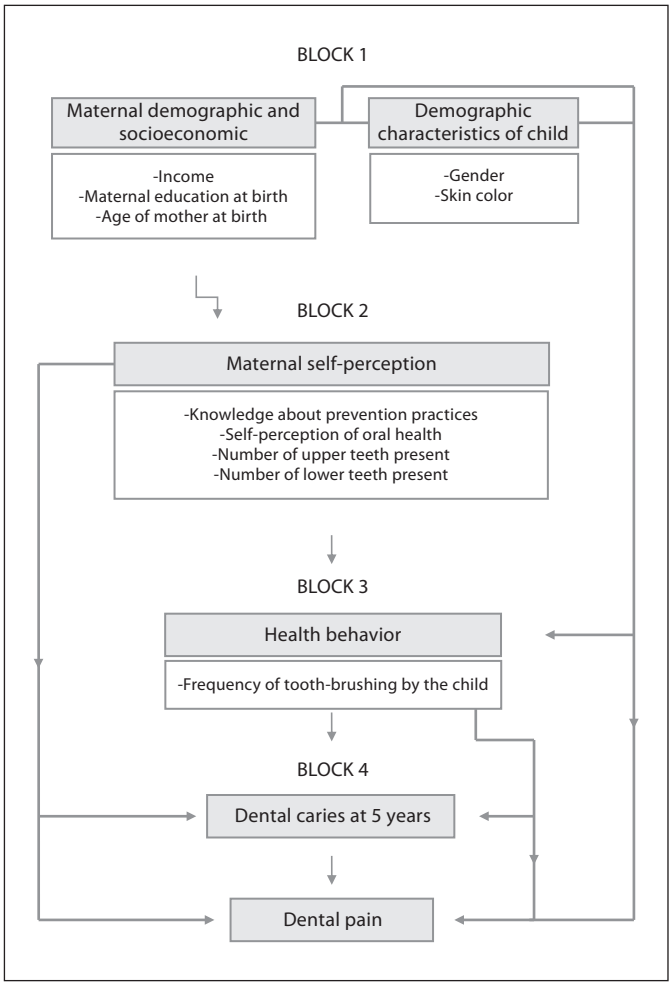

Fig. 1. Theoretical model of analysis for the outcome of dental pain in 5-year-old children and the independent variables to be studied.

The process of entering data occurred simultaneously with the fieldwork. Data were double-typed using Epi-Info 6.04, and the consistency of information was subsequently verified.

For data analysis, the software STATA version 10 was used. Descriptive analysis was performed to describe the absolute and relative frequencies and calculate the prevalence of interest variables of the study. The associations between dental pain and independent variables were assessed using bivariate analysis (χ^2 test for categorical variables and χ^2 for linear trend for ordinal variables) and multivariable analysis (Poisson regression with robust variance), estimating the prevalence rates and their 95% confidence levels.

For the multivariable analysis, a theoretical model was built (fig. 1) in which the independent variables were ordered in blocks that determined their entrance into the statistical analysis. This model had four blocks describing the hierarchical relationship between the potential risk factors and dental pain in children. Only those variables exhibiting $p < 0.25$ in the bivariate analysis were included in the model, except for gender and skin color, which were included in the analysis, independently of the p value. The socioeconomic and demographic variables from the mother were grouped in the first block, in a more distal position relative to the outcome. A lower level of schooling and a lower socioeconomic level at birth restrict the ability to buy goods and to procure oral health services, making these children more susceptible to the occurrence of caries and probably dental pain and tooth loss [Thomson et al., 2004; Peres et al., 2007].

Similarly, the way the mothers perceive their own oral health is also determined by family income and educational level, and these aspects can interfere with the children's oral health [Dye et al., 2011]. In the third block, the oral hygiene habits of the children (tooth-brushing frequency) are determined by the mothers' knowledge and attitudes [Honkala et al., 2001; Adeniyi et al., 2009]. Since dental pain is mostly determined by the presence of dental caries and its severity, the presence of dental caries at the age of 5 was considered the more proximal determinant [Moura-Leite et al., 2008].

The Ethics Committee of the Federal University of Pelotas, number 100/2009 on 29/06/2009, approved the project. All examinations and interviews were carried out after authorization by the parent of the participant through a consent letter. Children who had dental needs were referred to Pedodontics Dental Clinic, Dental School, Federal University of Pelotas.

Results

The response rate for this study was 86.6% (n = 1,129). The final sample included only those children whose mothers answered the questions related to experience of dental pain (n = 1,115). The prevalence of dental pain in the last 4 weeks was 7.3% (95% CI: 5.8, 8.9), and in the last 6 months before the interview was 16.5% (14.4, 18.8). Most of the participants were white (67.8%).

Table 1 presents the variables statistically associated with dental pain in the last 6 months. The findings from the bivariate analysis show a higher prevalence of pain for dark-skinned children ($p = 0.031$) compared to those with white skin color, in those with lower income at birth ($p < 0.001$), and in those with mothers with lower schooling ($p = 0.001$).

As regards the mothers' ages, it was observed that children with mothers of intermediate age (24–35 years) presented less prevalence of pain, compared to children of younger and older mothers ($p = 0.001$). The prevalence of dental pain was higher in children with mothers presenting a negative view of their personal oral health ($p = 0.009$), from mothers with 1 or 2 arches presenting less than 10 teeth ($p = 0.002$), and with mothers who stated that they were not able to brush the children's teeth at least twice a day ($p = 0.001$). In addition, a higher prevalence of dental pain was observed in children with higher severity of dental caries at the age of 5 ($p < 0.001$).

Table 1. Association between dental pain in children at the age of 5 years and socioeconomic, clinical and behavioral characteristics (2004 Pelotas Birth Cohort, Pelotas, RS)

Variable/category	Dental pain in the last 6 months, n (%)		p value
	total	dental pain	
Total	1,115 (100.0)	184 (16.5)	
Skin color			0.031[a]
White	756 (67.8)	111 (14.7)	
Light-skinned black	221 (19.8)	41 (18.5)	
Dark-skinned black	138 (12.4)	32 (23.2)	
Sex			0.185[a]
Male	583 (52.3)	88 (15.1)	
Female	532 (47.7)	96 (18.1)	
Family income at birth			<0.001[b]
1st quartile (richest)	233 (20.9)	26 (11.2)	
2nd quartile	318 (28.5)	45 (14.1)	
3rd quartile	284 (25.5)	50 (17.6)	
4th quartile (poorest)	280 (25.1)	63 (22.5)	
Maternal schooling, years			0.001[b]
≤4	141 (12.6)	31 (22.0)	
5–8	444 (39.8)	86 (19.4)	
9–11	386 (34.6)	52 (13.5)	
≥12	121 (10.8)	13 (10.7)	
Mothers' age, years			0.001[a]
≤24	515 (46.3)	104 (20.2)	
25–34	452 (40.5)	52 (11.5)	
≥35	147 (13.2)	28 (19.0)	
Mother received orientation on how to avoid dental caries			0.535[a]
Yes	504 (45.2)	87 (17.3)	
No	611 (54.8)	97 (15.9)	
Maternal self-reported oral health condition			0.009[b]
Very good or good	580 (52.0)	80 (13.8)	
Regular	370 (33.2)	69 (18.6)	
Bad or very bad	165 (14.8)	35 (20.2)	
Mothers' number of teeth			0.002[a]
≥20	919 (82.5)	135 (14.7)	
<10 in one arch	113 (10.1)	28 (24.8)	
<10 in both arches	83 (7.4)	21 (25.3)	
Mothers are able to convince children to brush teeth at least 2×/day			0.001[a]
Yes	844 (75.8)	121 (14.3)	
No	270 (24.2)	63 (23.3)	
dmf-s at 5 years (tertiles)			<0.001[b]
0	573 (51.7)	38 (6.7)	
1–3	183 (16.5)	23 (12.6)	
≥4	353 (31.8)	121 (34.3)	

[a] χ^2 test. [b] χ^2 test for linear trend.

Table 2 shows that after the adjustments by the different levels (blocks), dark-skinned children showed a prevalence of dental pain that was 60% higher (prevalence ratio, PR 1.60, 95% CI: 1.08, 2.37) than that of whites. Children from lower incomes and from mothers with lower educational levels presented 85% higher prevalence of dental pain than kids from higher income families (PR 1.85, 95% CI: 1.16, 2.95) and kids with mothers with higher educational levels (PR 1.85, 95% CI: 0.96, 3.56).

Children whose mothers presented at least 1 arch (PR 1.66, 95% CI: 1.09, 2.53) or 2 arches with less than 10 teeth (PR 1.63, 95% CI: 1.01, 2.61) had a higher prevalence of pain than those whose mothers presented 20 teeth or more. The prevalence of pain was lower (PR 0.64, 95% CI: 0.47, 0.88) in children whose mothers were able to control children's oral hygiene habits, meaning that tooth-brushing at least twice a day is a protection factor against dental pain.

The high experience of dental caries was strongly associated with the outcome; children exhibiting more caries (superior tertile dmf-s ≥4) presented a prevalence 4.8 times higher (95% CI: 3.30, 7.10) than those without caries (dmf-s = 0).

Discussion

This population-based study found a high prevalence of dental pain (16.5%) at the age of 5. Studies performed in Brazil, the United States, and England with children with primary dentition reported similar prevalence, varying from 9.1 to 15.6% [Slade, 2001; Barretto et al., 2004; Moura-Leite et al., 2008; Tickle et al., 2008; Oliveira and Colares, 2009; Lewis and Stout, 2010].

In the present study, no association with gender was observed in children aged 5, in agreement with previous reports from Barretto et al. [2009] (in children 8 and 9 years of age) and from Bastos et al. [2008] (at the age of 6). However, in older children, with socialization and the establishment of cultural rules and patterns, it is possible to detect a lower prevalence of dental pain in boys, explaining the fact that at the age of 12, girls reported a prevalence of dental pain that was 120% higher than did boys [Bastos et al., 2008].

Even though the results from this study show a higher prevalence of dental pain in dark-skinned children compared to white-skinned children, there is no scientific biological explanation of why ethnical differences could have a role in the expression of pain, or in dental caries. On the other hand, such higher pain experience could not be solely attributed to socioeconomic differences, because after adjustments in multivariate analysis, skin color remained statistically significant. This could result from the residual confusion of a variable not investigated. These differences could also be related to the inequity in access to services, such as exposure to fluoridated water and regular use of fluoride toothpaste, or the difference could be related to discrimination or the way individuals

Table 2. PR crude (PR*) and after adjustments (PR**) considering the theoretical model, for dental pain in children at the age of 5 years and socioeconomic variables and clinical and behavioral characteristics (Pelotas Birth Cohort, Pelotas, RS)

	PR* (95% CI)	p value	PR** (95% CI)	p value
Block 1				
Skin color		0.017		0.014
White	1		1	
Light-skinned black	1.26 (0.88–1.80)		1.27 (0.88–1.81)	
Dark-skinned black	1.58 (1.06–2.34)		1.60 (1.08–2.37)	
Gender of the child		0.226		0.194
Male	1		1	
Female	1.19 (0.89–1.60)		1.21 (0.90–1.61)	
Family income at birth		0.001		0.003
1st quartile (richest)	1		1	
2nd quartile	1.27 (0.78–2.05)		1.19 (0.73–1.94)	
3rd quartile	1.58 (0.98–2.53)		1.46 (0.90–2.36)	
4th quartile (poorest)	2.01 (1.28–3.18)		1.85 (1.16–2.95)	
Maternal schooling, years		0.003		0.009
≥12	1		1	
9–11	1.25 (0.68–2.30)		1.17 (0.63–2.15)	
5–8	1.80 (1.00–3.23)		1.64 (0.91–2.97)	
0–4	2.04 (1.07–3.91)		1.85 (0.96–3.56)	
Mothers' age, years		0.108		0.132
≤24	1		1	
25–34	0.57 (0.40–0.79)		0.57 (0.41–0.80)	
≥35	0.94 (0.62–1.43)		0.96 (0.63–1.46)	
Block 2				
Maternal self-reported oral health condition		0.018		0.128
Very good or good	1		1	
Regular	1.35 (0.98–1.87)		1.22 (0.88–1.70)	
Bad or very bad	1.53 (1.03–2.29)		1.34 (0.88–2.02)	
Number of teeth of the mother		0.003		0.009
≥20	1		1	
<10 in one arch	1.69 (1.12–2.53)		1.66 (1.09–2.53)	
<10 in both arches	1.72 (1.09–2.73)		1.63 (1.01–2.61)	
Block 3				
Mothers are able to convince children to brush teeth at least 2×/day		0.002		0.006
No	1		1	
Yes	0.61 (0.45–0.63)		0.64 (0.47–0.88)	
Block 4				
dmf-s at 5 years (tertiles)		<0.001		<0.001
0	1		1	
1–3	1.89 (1.13–3.18)		1.85 (1.10–3.13)	
≥4	5.17 (3.58–7.44)		4.84 (3.30–7.10)	

Variables that presented a value $p \geq 0.25$ in bivariate analysis were not included in multivariate analysis models.

feel and express pain [Antunes et al., 2006; Bastos et al., 2008, 2009]. Therefore, new investigations are required to understand these differences.

The relationship between socioeconomic factors and oral health is well established in the literature, and populations with higher income and higher educational levels present better health indicators [Honkala et al., 2001; Barretto et al., 2004; Galobardes et al., 2006; Peres et al., 2007; Bastos et al., 2008; Moura-Leite et al., 2008; Correa et al., 2010]. Family income directly reflects the access to goods, such as oral hygiene products, and to health services, impacting on the health status of individuals [Ga-

lobardes et al., 2006]. Here a strong association was found between these two indicators and dental pain in the primary dentition, since children with mothers with lower schooling or from families of lower income exhibited 85% higher prevalence of dental pain. A higher education level improves the access of mothers to education about health and to healthier foods, allowing individuals to communicate better and to look for health services [Galobardes et al., 2006], thus improving the general health conditions of their children.

The observation that intermediate maternal age (25–34 years) acted as a protection factor for dental pain in their children compared to younger mothers was previously reported in the literature [Paunio et al., 1993; Mattila et al., 2000; Hallett and O'Rourke, 2006], which detected that younger mothers were a risk factor for caries development in their children. In this context, younger mothers are indifferent to controlling the habits and attitudes of their children (like diet and oral hygiene) [Hallett and O'Rourke, 2006], which could explain the higher development of dental caries in early infancy.

Recent reports investigated the importance of family context, and the oral health conditions of parents influence the oral health of their children [Weintraub et al., 2010; Shearer et al., 2011]. Shearer et al. [2011] observed that individuals whose mothers reported worse oral health when they were at the age of 5 presented a higher prevalence of dental caries at the age of 32.

Maternal tooth loss, expressed by the number of arches with less than 10 teeth, was significantly associated with a higher prevalence of pain in their children aged 5. The association of maternal tooth loss and higher prevalence of untreated caries in their children was already observed [Roberts et al., 2009; Dye et al., 2011], but this maternal characteristic was not yet associated with dental pain. It is plausible that mothers with higher tooth loss were, during their life course, less educated about attitudes promoting oral health, or they could have less access to qualified health services. Thus, these mothers could have more difficulties transmitting positive behaviors to their sons/daughters, reflecting a higher occurrence of dental caries and dental pain.

Regarding oral health habits and behaviors, Honkala et al. [2001] observed that failure to brush the teeth at least once a day increases the chance of suffering dental pain by 50%. In our study, mothers who could persuade their kids to brush their teeth at least twice a day were a protection factor against dental pain.

The experience of caries in the deciduous teeth was the strongest variable associated with dental pain in this population. Pain prevalence was 5 times higher in those individuals located in the superior tertile of dental caries compared to the inferior tertile. The number of teeth affected is associated with the severity of caries and also with pain. Although in the last decade a significant reduction in caries prevalence has been observed in Brazil, in deciduous dentition, this reduction was lower than in permanent dentition [Brasil, 2010]. Comparing the index of caries in the Pelotas 2004 Birth Cohort at the age 5 with other cohorts in the same city (Pelotas 1993 Birth Cohort), a small reduction of 3% was observed between the two generations [Peres et al., 2010]. Nevertheless, this decrease was not due to higher use of dental services, since 95% of the dmf-s index in the 2004 cohort was constituted by the component D (decayed teeth). Additionally, 68% of these children never visited a dental office, and, among those who did, approximately 12% of the visits were due to dental pain. Similarly, Wigen et al. [2009] showed that children without early access to dentists had a higher probability (OR = 2.1) of experiencing caries at 5 years. Our findings highlight the importance of treating dental caries in the primary dentition in order to prevent the occurrence of dental pain. The significantly higher pain observed in those children presenting higher caries levels warrants intervention, i.e., restorations, prevention or extraction. Despite the lack of evidence for the effectiveness of dental fillings for the treatment of caries in the primary dentition in relation to extractions, and also between restorative treatments, restorations can reduce the occurrence of dental pain, keeping the deciduous teeth in place to provide space for permanent teeth and maintaining the chewing function [Yengopal et al., 2009]. The sealing of dental caries without its removal in primary teeth has also been presented as an alternative treatment, showing similar or even better results than standard restorations performed by general dental practitioners [Innes et al., 2011].

There are some limitations to this study, like the cross-sectional design, which does not allow for determining causality between some variables investigated and outcome; however, the use of data collected in previous studies of this cohort gives strength to our study. Another limitation is the probability of overestimating the prevalence of dental pain, compared to other studies that opted to document pain history for intervals of time smaller than 6 months. In addition, in our study, the mothers reported their children's pain, since the questionnaire was directed to them. Directing the questions to the mother or responsible party is the method more commonly used, because other studies showed that children of this age can

underreport dental pain as a consequence of memory bias. Thus, using parental reporting is a good substitute [Ratnayake and Ekanayake, 2005].

In contrast to other studies, our investigation was not restricted to children who were in school. Only 53.5% of these children were attending a preschool or a day-care, and this was a positive point for our investigation. A lower probability of memory bias regarding birth data (birth cohort study) and the good validation for the maternal determination of oral health are other strong points of our study. Moreover, the large sample size, study design, high reproducibility found, and the statistical analysis approach provide high validity to the findings.

Socioeconomic, clinical, and behavioral characteristics of the mothers and the children's caries experience at the age of 5 were strongly associated with the prevalence of dental pain in the primary dentition. The results of this study also reinforce the hypothesis that mothers' oral health is a strong predictor of the oral health condition of their sons/daughters.

Considering the vulnerability of children at this stage of life, it is important to recognize that prevention and treatment in oral health should be implemented before the age of 5, taking not only the children into consideration but also the family context in which they live.

Acknowledgments

The authors thank the Brazilian government agency CNPq for study funding (Process 402372/2008-5 to K.G.P.) and the Brazilian government agency CAPES for the scholarship provided to the first author.

The article is based on the data collected in the study '2004 Pelotas Birth Cohort' administered by the Graduate Program in Epidemiology, Federal University of Pelotas.

The authors also would like to thank Colgate for providing the oral hygiene kits that were given to the children enrolled in the study.

Disclosure Statement

The authors declare that there are no conflicts of interest.

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