BJOS
Brazilian Journal of Oral Sciences

Original Article

Volume 21
2022
e227095

Number of erupted teeth at the age of 12 and 24 months: a maternal report validation study

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Aim: To verify the validity of maternal reports on the number of deciduous teeth erupted in their children. **Methods:** This cross-sectional study was performed with children enrolled in a Birth Cohort at the age of 12 months in the first stage and 24 months in the second stage. At both stages, children were clinically examined, and mothers reported the number of teeth of their children. Comparison between groups was performed using the Mann-Whitney non-paired Wilcoxon test. Level of agreement between two methods were estimated by the Observed Agreement, Weighted Kappa and Intraclass Correlation coefficients. **Results:** A total of 125 children were examined in the first stage, with mean number of reported teeth of 6.2. In the second stage, 149 children were examined, with mean number of reported teeth of 15.9. High level of agreement, kappa values and intraclass correlation coefficients were observed for both arches in both periods ($p<0.001$). **Conclusions:** Maternal report on the number of teeth erupted in children was reliable and valid. Thus, it seems to be a useful instrument for collecting data in population-based epidemiological studies targeting young children.

Keywords: Pediatric dentistry. Epidemiology. Tooth eruption. Tooth, deciduous.

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Editor: Altair A. Del Bel Cury

Received: September 24, 2021
Accepted: May 29, 2022

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Introduction

Follow up and evaluation of children's development stages is crucial to obtain health data, allowing the early identification of any disorder and the establishment of an appropriate care plan[1]. The eruption of primary teeth usually begins 6–8 months after birth and it is an important marker of the child's development process, associated with overall growth and metabolic functions[2,3]. The eruption process can be altered due to several genetic and environmental issues, such as maternal habits, maternal childbearing age, gestational period, child's head circumference, birth length and weight, eating habits, ethnicity and socioeconomic factors[2].

The process of deciduous teeth emergence has already been associated with many aspects of children growth, including motor development, where infants developing faster in the first 6 months of life have also earlier onset of tooth emergence[3]. In addition, primary teeth eruption should be regarded as a potential predictor for nutritional status. Significant delay may occur in tooth eruption when a malnutrition episode occurs in the first year of life[4]. On the other hand, children with accelerated weight gain in the first three months of life have earlier eruption of the first tooth[2]. A longitudinal follow-up evaluated the anthropometric indices of teenagers at the age of 17 years and found that the early eruption of primary teeth can be an important predictor of obesity in adolescence[5]. In addition, when tooth eruption does not follow a regular pattern, it may negatively influence children's chewing pattern, mouth growth[6] and can also be a predictor for dental caries[7].

Clinical oral examination has been considered the best method to determine the oral health status. Nevertheless, clinical examinations present many difficulties concerning operational aspects, such as high cost, need for trained personnel, time constraints and exam protocol accuracy[8,9]. In large epidemiological population-based studies, these difficulties may preclude the data collection process. Thus, using self-reported oral health measurements has become a common practice in large-scale oral health epidemiological studies, as it is a simple, fast and low cost method[10].

Previous studies have used the number of erupted deciduous teeth reported by the mother as an instrument to monitor the tooth eruption process[11,12]. However, despite the recognized advantages of using the self-reported number of teeth, there is lack of information in literature on its validity and reproducibility when compared to clinical examination.

Since primary teeth eruption may be an important marker of child development, there is a need for a validated instrument suitable for use in population-based epidemiological studies. We hypothesized that mothers can correctly recognize and report the number of teeth of their children. Thus, the aim of this study was to test the validity of maternal reports regarding the number of deciduous teeth erupted at the age of 12 and 24 months compared to clinical examination.

Material and methods

This cross-sectional study was reported in accordance with the STROBE guidelines and involved a sample of participants of the 2015 birth cohort of Pelotas[13]. Pelotas

is a city in southern Brazil recognized worldwide for birth cohort studies carried out in its population. Unlike previous studies, the 2015 Birth Cohort started monitoring its participants during the gestational period with mothers of potential participants living in the urban area of Pelotas. The cohort study has performed prenatal, perinatal, three-, twelve- and twenty-four-month follow-ups of the children so far. As inclusion criteria, child should be enrolled in the 2015 birth cohort of Pelotas and have already participated in 12-month or 24- month cohort follow-ups. Exclusion criterion considered mothers who were not able to answer the question or perform the tooth count.

Three dentists, graduate students, with experience in epidemiological surveys were selected for the fieldwork. To ensure reliability, examiners participated on a calibration process prior to oral examinations, evaluating children at the same age group of those who were not included in the final sample. The lowest intra-class correlation coefficient (ICC) was 0.82.

Sample size calculation was carried out using the tool proposed by Arifin[14]. Sample size of 55 and 253 children was required for ICC and Kappa estimation, respectively. The sample size calculation for ICC considered 0.7 as the lowest acceptable ICC, 0.80 as expected ICC, significance level of $\alpha = 0.05$ for one-tailed test and power of 80%. The measurement was taken on one occasion, two times (two replicates) and the expected dropout rate was 10%. The sample size calculation for kappa statistics used the follow parameters: 0.6 as minimum acceptable kappa, 0.95 as expected ICC, 96% as the proportion of any erupted teeth at 12 months (p=0.96) (data not shown), significance level of $\alpha=0.05$, statistical power of 80% and expected dropout rate of 10%. The validity of maternal reports of deciduous teeth erupted at 12 and 24 months was evaluated in two distinct samples of children enrolled in the 2015 birth cohort of Pelotas. About 10% of the 1,384 mother-child dyads who had been monitored in the birth cohort between April and July/2016 and met the inclusion criteria were randomly selected and invited to participate. The sample was selected with the aim of verifying the quality of information collected in the general cohort study (with the reapplication of general questionnaires) and as a source for the validation study.

Interviews with mothers and clinical examination of children were performed. Mothers were asked about the number of deciduous teeth in the superior and inferior arch through the following questions: 1) How many teeth does your child have in the maxillary part of the mouth? and" 2) How many teeth does your child have in the mandibular part of the mouth?". Mothers were instructed to consider as erupted even elements with only a small visible part. Standardized figures of deciduous teeth with different eruption degrees were used to illustrate and guide mothers (Figure 1a and Figure 1b). Mothers who were not aware about the number of teeth in their children were encouraged to give an approximate answer. Subsequently, children were clinically evaluated using the knee-to-knee technique with the participation of mothers. Examiners used disposable gloves and mask, natural lighting, and gauze when necessary. All biosafety precepts were in accordance with the original World Health Organization recommendation. The number of teeth was counted separately for each arch.

To validate the number of deciduous teeth erupted at 24 months, all mother-child dyads that had been monitored between October and November/2017 and met the

inclusion criteria were invited to participate. Interviews with mothers and clinical examination of children were performed at the dental clinic of the Epidemiological Research Centre during the 24-month follow-up period. Mothers were asked about the number of deciduous teeth in the superior and inferior arch using the same questions used in the 12-month evaluation, and oral examination was conducted using the same previously described methodology.

Sociodemographic information was obtained from the interview performed at the 12 and 24-month follow-ups. Maternal age was categorized into less than 30 years and 30 years or more, maternal schooling categorized until 8 years of study and 9 years or more, skin color (self-referred) classified in white, or non-white and family income divided into tertiles.

Statistical Analysis

Absolute and relative frequencies were described for each variable. Nonparametric distribution was identified using the Shapiro-Wilk test. Comparison between groups was performed using the Mann-Whitney non-paired Wilcoxon test (non-parametric test). The number of teeth in the superior and inferior arch reported by mothers was compared with the number of teeth observed in dental examinations. The level of agreement between the two methods was estimated by the observed agreement (OA) and the Weighted Kappa statistics. Kappa-value equal to one means that the methods are in complete agreement. Intraclass correlation coefficients were also estimated. All analyses were performed using the Stata 14.0 software (StataCorp. College St, TX, USA).

Ethical aspects

This study was approved the Human Research Ethics Committee of the Federal University of Pelotas under Protocol number 717.271. Interviews with mothers and clinical examination of children were performed after signing the informed consent form. Orientations regarding child oral health care were given after examination. In cases of the need for dental treatment or dental follow-up, the child was referred to the School of Dentistry (Federal University of Pelotas) or to the Public Health System.

Results

A total of 125 children aged 11-14 months were evaluated for the validation of maternal reports about number of deciduous teeth erupted at 12 months and 149 children aged 23-25 months participated of the validation of maternal reports at 24 months. The mean age of children was 12.2 months and 24.3 months, respectively (Data not shown).

Table 1 shows the samples according to demographic and socioeconomic characteristics. In both samples, more than 60% of mothers were younger than 30 years, presented nine or more years of formal education and self-declared as white skin color.

Table 1. Distribution of total number of teeth according to demographic and socioeconomic characteristics considering clinical examination. 12-months follow up (125 children) and 24-months follow up (n=149 children). Pelotas, Brazil, 2019.

Variables	Clinical examined number of teeth			
	12-months follow up		24 months follow up	
	n	P-value*	n	P-value*
Demographic and socioeconomic characteristics				
Maternal Age		0.19		0.90
<30 years	61		76	
≥30 years	46		75	
Maternal Schooling		0.82		0.49
0-8 years	42		49	
≥9 years	83		102	
Household Income		0.89		0.73
1st tertile (lower)	41		51	
2nd and 3rd tertiles	80		100	
Skin color		0.10		0.12
White	79		106	
Non-white	29		45	

Nonparametric distribution was identified using the Shapiro-Wilk test. Comparison between groups was performed using the Mann-Whitney non-paired Wilcoxon test (non-parametric test). *p value <0.05.

The minimum number of erupted teeth was zero and the maximum number was twelve at the 12-month follow up. In the 24-month follow up, the number of teeth ranged from seven to twelve (Data not shown). Table 2 presents descriptive analysis of self-reported and dental clinical examination of the number of teeth in the total sample and stratified by sex. In the 12-month follow up, the mean number of present teeth was 6.2, being 3.3 the mean of maxillary teeth and 2.9 the mean of mandibular teeth. In the 24-month follow up, children presented mean number of 15.9 erupted teeth. The same mean number (7.9) for maxillary and mandibular teeth was observed. No differences were observed regarding number of teeth among boys and girls at 12 and 24-month follow-ups (Table 2).

Table 3 describes the observed agreement, kappa statistics and intraclass correlation coefficient for the number of maxillary and mandibular teeth reported by mothers compared with clinical examination for both samples. High level of agreement, kappa values and intraclass coefficients were observed for both arches. Table 4 presents the validity of the number of teeth according to sociodemographic characteristics. The findings revealed that sociodemographic variables did not influence the agreement between self-reporting and clinical examination.

Table 2. Distribution of the number of teeth identified in clinical examination according to children's sex. Pelotas, Brazil, 2019.

Variables	Total sample	Children's sex		
	Mean (SD)	Female Mean (SD)	Male Mean (SD)	P-value*
12 months of age (n=125 children)				
Number of present teeth	6.2 (2.2)	6.6 (3.1)	5.9 (2.5)	0.11
Number of present maxillary teeth	3.3 (1.5)	3.5 (1.7)	3.0 (1.6)	0.04
Number of present mandibular teeth	2.9 (1.2)	3.1 (1.6)	2.8 (1.9)	0.40
24 months of age (n=149 children)				
Number of present teeth	15.9 (1.6)	15.7 (2.1)	16.0 (1.9)	0.31
Number of present maxillary teeth	7.9 (0.7)	7.78 (1.1)	8.05 (0.8)	0.07
Number of present mandibular teeth	7.9 (0.9)	7.94 (1.1)	7.96 (1.2)	0.80

*p value <0.05

Table 3. Observed agreement, Kappa index and intraclass correlation coefficient of number of teeth reported by mothers compared to clinical examination. 12-month (125 children) and 24-month (149 children) follow-up. Pelotas, Brazil, 2019.

Variables	Mother Report Mean (SD)	Clinical Examination Mean (SD)	OA (%)	WK	ICC	P-value*
12 months of age (n=125 children)						
Number of present maxillary teeth	3.27 (1.63)	3.26 (1.64)	98.7	0.947	0.973	<0.001
Number of present mandibular teeth	2.90 (1.38)	2.96 (1.37)	98.5	0.927	0.949	<0.001
24 months of age (n=149 children)						
Number of present maxillary teeth	7.97 (1.15)	7.92 (0.98)	95.9	0.659	0.749	<0.001
Number of present mandibular teeth	8.01 (1.33)	7.95 (1.18)	95.4	0.738	0.812	<0.001

OA = Observed agreement. ICC = Intraclass Correlation coefficient. WK = Weighted Kappa. SD = Standard Deviation. *p value <0.05.

Table 4. Observed agreement, Kappa index and intraclass correlation coefficient of clinical examination and self-reported number of teeth according to sociodemographic information. 12-months (125 children) and 24 months (149 children) follow-up. Pelotas, Brazil, 2019.

12 months follow up					24 months follow up				
Variables	OA (%)	WK	ICC	P-value*	Variables	OA (%)	WK	ICC	P-value*
Number of maxillary teeth					Number of maxillary teeth				
Maternal Age					*Maternal Age*				
<30 years	99.0	0.964	0.985	<0.001	<30 years	96.1	0.681	0.826	<0.001
≥30 years	97.8	0.917	0.959	<0.001	≥30 years	93.1	0.634	0.192	<0.001
Maternal Schooling					*Maternal Schooling*				
0-8 years	98.9	0.962	0.987	<0.001	0-8 years	92.5	0.614	0.618	<0.001
≥9 years	98.4	0.938	0.965	<0.001	≥9 years	96.1	0.677	0.818	<0.001

Continue

Continuation

Household Income					*Household Income*				
1st tertile (lower)	98.3	0.929	0.972	<0.001	1st tertile (lower)	92.5	0.585	0.607	<0.001
2nd and 3rd tertiles	98.9	0.962	0.982	<0.001	2nd and 3rd tertiles	96.2	0.698	0.852	<0.001
Skin color					*Skin color*				
White	98.9	0.959	0.983	<0.001	White	95.8	0.674	0.814	<0.001
Non-white	97.9	0.935	0.961	<0.001	Non-white	93.2	0.600	0.656	<0.001
Number of mandibular teeth					**Number of mandibular teeth**				
Maternal Age					*Maternal Age*				
<30 years	98.8	0.952	0.974	<0.001	<30 years	95.6	0.773	0.892	<0.001
≥30 years	96.3	0.842	0.855	<0.001	≥30 years	93.2	0.694	0.719	<0.001
Maternal Schooling					*Maternal Schooling*				
0-8 years	97.8	0.911	0.937	<0.001	0-8 years	89.4	0.595	0.716	<0.001
≥9 years	98.6	0.943	0.967	<0.001	≥9 years	96.8	0.805	0.863	<0.001
Household Income					*Household Income*				
1st tertile (lower)	97.1	0.881	0.933	<0.001	1st tertile (lower)	94.7	0.774	0.829	<0.001
2nd and 3rd tertiles	98.7	0.944	0.954	<0.001	2nd and 3rd tertiles	95.4	0.714	0.789	<0.001
Skin color					*Skin color*				
White	97.9	0.922	0.945	<0.001	White	96.2	0.786	0.874	<0.001
Non-white	97.1	0.896	0.900	<0.001	Non-white	88.4	0.608	0.550	<0.001

OA = Observed agreement. ICC = Intraclass correlation coefficient. WK = Weighted Kappa. *p value <0.05.

Discussion

This study investigated the agreement level between number of teeth reported by mothers and number of teeth observed in clinical examination in both samples (mothers and children) enrolled in the 12 and 24-month follow-ups of the 2015 Birth Cohort study of Pelotas. Our findings revealed high agreement level between maternal report and clinical examination regarding number of teeth in both periods, showing that the maternal report is a reliable and valid instrument for this purpose. To the best of our knowledge, this is the first study to demonstrate that the use of maternal report to collect data on the number of deciduous erupted teeth in children is a valid tool.

There is substantial variability among individuals in the tooth eruption time[15-17], however, there is no consensus about the eruption time being different in terms of sex. Some studies have indicated that tooth eruption occurs more quickly in boys[17], compared to girls, other studies have shown the opposite relationship[18]. In this study, no difference in the tooth eruption time was observed between sexes. Other child and maternal factors could explain the difference in tooth eruption. Findings of previous studies have shown that lower mean number of teeth was observed in early preterm children, shorter children at birth and at 12 months of age. Also, higher number of teeth was observed in children whose mothers had excessive weight gain during

pregnancy, those who smoked during pregnancy, children with greater weight at birth and at 12 months of age. Bastos et al.[19] also identified relationship between dental eruption and nutritional status of children, with children shorter than 49 cm having, on average, less pairs of erupted teeth at 6 months of age. Twelve-month-old children presenting height-for-age deficit at 6 months of age and females also presented less pairs of erupted teeth in this sample.

Recent researches about the use of oral-health self-report have pointed out that great variation on agreement levels may occur across socioeconomic strata, which could affect the validity of self-reported measures[20,21]. Regarding self-reported information on dental caries in adolescents, for instance, this method presents high specificity and sensitivity in relation to clinical examination, but higher schooling levels led to even higher sensitivity and positive predictive values. Socioeconomic level also influences maternal report on the presence of dental plaque in their children, which demonstrated not to be a valid method[22]. However, our study evidenced that counting the number of erupted teeth in young children reported by mothers is a reliable method, despite sociodemographic conditions like maternal schooling or family income. It could be hypothesized that this influence was not found because the question about the number of teeth does not have a correct or desirable answer, opposed to results obtained when questioning about the presence of caries or dental plaque.

The number of erupted teeth in the first two years of life may also be related to anthropometric measures in childhood[2,5] and adolescence. It has been suggested that early deciduous teeth eruption may be an indicator of obesity at the age of 17 years[5]. Likewise, association between pattern of weight gain and eruption of the deciduous dentition has been observed. According to Un Lam and colleagues[2], the higher the weight gain in the first three months of life, the earlier the eruption of the first deciduous teeth[2]. Therefore, the eruption process may be an important indicator of future health changes. Regarding younger children, distress behavior can be observed when facing health procedures[23], due to their difficulties to understand the process and control emotions[24]. The success of procedures in pediatric dentistry depends mainly on child behavior and uncooperative temperament may predict the failure of dental care[25]. This process may be a barrier to the development of epidemiological surveys targeting children. Thus, in pediatric dentistry, finding a suitable tool to evaluate deciduous teeth, which that does not rely only upon children's collaboration during the execution of procedures and possible to be used in epidemiological surveys is of fundamental importance.

Regarding oral health, this measure is also significant since early eruption of deciduous teeth may be considered a risk factor for dental caries in the future[7]. Knowledge about the process of deciduous teeth eruption is fundamental to guide health actions for the promotion and prevention of oral diseases in children. In Brazil, the last national oral health survey showed that the lowest rate of dental caries reduction was observed among 5-years-old children. In addition, it showed that 80% of primary teeth affected by caries remained untreated[26]. Dental caries in the deciduous dentition affects approximately 9% of the world population[27], being ranked among the most prevalent chronic diseases worldwide. It is of relevance for clinicians and

policy makers, since dental caries in deciduous teeth is a risk factor of dental caries in permanent teeth[28].

In oral health surveys, data collection through clinical examination has already been considered as the only valid source of information[28]; however, it has disadvantages such as the need for large number of people involved, professionals with higher level of academic training (dentists), with high costs and requiring larger structures[8]. Maternal reporting has already been used in research involving children, such as motor development evaluation[29], and pubertal development[30], and the present study demonstrated the feasibility of using maternal report to count the number of erupted teeth in children, which is a simple, quick, and low-cost method.

Despite the promising results observed in this study, they should be analyzed with caution. Children participating in this sample were very young; therefore, presenting low number of teeth. In addition, at this stage of life, children are heavily dependent on maternal care, so mothers are probably more attentive and more participatory than usual.

It could be concluded that the maternal report on the number of teeth erupted in young children is a reliable and valid instrument compared to clinical examination performed by dentists. Thus, it seems to be a useful instrument for collecting deciduous teeth data in population-based epidemiological studies.

Acknowledgements

This article is based on data from the study "Pelotas Birth Cohort, 2015" conducted by Postgraduate Program in Epidemiology at Universidade Federal de Pelotas, with the collaboration of the Brazilian Public Health Association (ABRASCO). The 2015 Pelotas (Brazil) Birth Cohort is funded by the Wellcome Trust (095582). Funding for specific follow-up visits was also received from the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and Fundação de Amparo a Pesquisa do Estado do Rio Grande do Sul (FAPERGS). This study was also financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001. The authors declare that are not conflict of interests.

Data availability

Datasets related to this article cannot be shared at this moment because they are part of an ongoing research.

Conflict of Interest

None

Author contributions

E.R.S., M.G.C., F.F.D., A.H.D. and M.S.A. conceived the idea; E.R.S., F.S.C. and A.H. collected the data; M.G.C. and E.R.S. analysed the data; and all authors wrote and reviewed the manuscript.

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