

Emergence of the first permanent molar in 5-6-year-old children: implications from a longitudinal analysis for occlusal caries prevention

*Irrompimento do primeiro molar permanente em crianças de 5 e 6 anos de idade: implicações da análise longitudinal para prevenção da cárie oclusal**

Abstract

The timing of tooth emergence is of considerable importance in the planning of prevention of occlusal caries. **Objective:** The aim was to estimate the trends of emergence of the first permanent molars in girls and boys between 5-6 years of age, since more children are included in the first grade after Brazilian elementary education has been extended from eight to nine years of duration. **Methods:** Dental spaces of 497 children aged 60 months or older were examined four times by a calibrated dentist ($\kappa > 0.97$) during 18 months in a longitudinal study. The first permanent molar was considered emerged when any tooth surface could be reached by a ball point probe. Participants' age was measured in months; 95% confidence intervals were obtained for prevalence and incidence values for each sex in three age groups - 60.0 to 65.9; 66.0 to 71.9; 72.0 to 77.9 months. Incidence rate ratios were estimated by Poisson regression analysis. **Results:** The majority of children from 66.0 to 71.9 months and 72.0 to 77.9 months presented at least one emerged permanent molar. For each three children in the 66.0-71.9-month group, at least one had all four permanent molars emerged. **Conclusion:** The emergence trends observed justify the need for specific protection and surveillance measures for occlusal caries prevention.

Keywords: Epidemiology. Tooth eruption. Permanent dentition. Molar. Age. Gender.

Paulo Frazão

Departamento de Prática de Saúde Pública da Faculdade de Saúde Pública da Universidade de São Paulo.

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Correspondência: Prof. Paulo Frazão. Departamento de Prática de Saúde Pública, Faculdade de Saúde Pública, Universidade de São Paulo, Av. Dr. Arnaldo 715 São Paulo, SP, CEP 01246-904. E-mail: pafrazao@usp.br

Resumo

O tempo de irrompimento dentário é essencial para o planejamento de medidas de prevenção da cárie oclusal. Com a ampliação do ensino fundamental de oito para nove anos de duração, um número maior de crianças entre cinco e seis anos de idade é incluído na primeira série do ensino fundamental. **Objetivo:** O objetivo foi estimar as tendências do irrompimento dos primeiros molares permanentes em meninos e meninas de 5 e 6 anos de idade. **Métodos:** Em estudo longitudinal, espaços dentários de 497 crianças de 60 meses e mais de idade foram examinados quatro vezes por um dentista calibrado ($\kappa > 0,97$) durante 18 meses. O primeiro molar permanente foi considerado irrompido quando qualquer parte de sua superfície podia ser tocada por uma sonda de ponta esférica. A idade dos participantes foi medida em meses. Intervalos para 95% de confiança dos valores de prevalência e incidência foram apurados conforme o sexo para três coortes etárias: 60,0 a 65,9; 66,0 a 71,9; 72,0 a 77,9 meses. A razão entre as taxas de incidência foi estimada por meio de análise de regressão de Poisson. **Resultados.** A maioria das crianças entre 66,0 e 71,9 meses e entre 72,0 e 77,9 meses tem pelo menos um molar permanente irrompido. No grupo de 66,0 a 71,9 meses, de cada três crianças pelo menos uma apresentou os quatro primeiros molares permanentes irrompidos. **Conclusão.** As tendências de irrompimento observadas justificam a necessidade da adoção de medidas de vigilância e de proteção específica em relação à lesão de cárie oclusal.

Palavras-chave: Epidemiologia. Erupção dentária. Dentição permanente. Molar. Idade. Sexo.

Introduction

The majority of caries lesions in school-aged population is concentrated on the masticatory surfaces of the first permanent molars, whose pits and fissures are less benefited by treatment with fluoride than smooth surfaces^{1,2}. Initial occlusal caries lesions occur during the first 36 months after emergence of this tooth group³⁻⁵. Given this intra-oral distribution and the challenges to control it in the population groups that are more vulnerable to this disease, knowledge about the timing of tooth emergence is essential to plan diagnostic, preventive and therapeutic measures⁶.

Several factors can be associated with the timing of permanent tooth emergence, such as gender, ethnicity, environment and socioeconomic level⁷. As these factors can vary from one area to another, there is not a standard table applicable to all children. In a city of Southern Brazil, a longitudinal study with 359 children showed that tooth emergence depends on nutritional and developmental characteristics measured at birth and during the first year of life. Children showing a height-for-age deficit at six months of age had a higher probability of their first molars not emerging at the age of six years⁸. Given the variability of emergence patterns, they should be originated from the populations to which they will be applied⁹.

In Brazil, with the extension of primary education from eight to nine years of duration, a higher number of children aged six years have been found in the first grade. Official Report CNE/CEB 6/2005, approved on June 8th 2005, defines that "educational systems must establish the conditions for the enrollment of six-year-old children in primary education, according to their chronological age: those aged six years or those who are going to turn six years at the beginning of the school year". Brazilian states were obliged by law to implement this change in primary education by 2010¹⁰.

With this extension, specific programs aimed at the prevention of occlusal caries in

the first permanent molars could be directed towards newly enrolled children (aged six years) who had one or more partially or completely emerged first permanent molars. In this sense, information about first permanent molar emergence in the oral cavity and the effect of demographic factors can be useful to guide the planning of studies on the activities and materials aimed at occlusal caries prevention and to subsidize the implementation of oral health actions in primary health care.

The present study, part of the broader research project entitled "*Custo-efetividade da Escovação Dental Supervisionada na Prevenção da Cárie Dentária Infantil*" (Cost-effectiveness of Supervised Toothbrushing in Child Dental Caries Prevention), aimed to estimate the emergence trends of first permanent molars in children aged from 5 to 6 years and to quantify the differences between boys and girls in this life cycle.

Methods

The main research project was approved by the *Comitê de Ética em Pesquisa da Universidade Católica de Santos* (Catholic University of Santos Research Ethics Committee – Process 4843-20-2005).

The study population was comprised of all children aged 60 months of age or more, enrolled in the six public primary education units situated in an impoverished area of the city of São Vicente, SP, Brazil.

In a longitudinal study, dental spaces corresponding to the first permanent molars were analyzed four times by a calibrated dentist ($\kappa > 0.97$) during 18 months (from May 2007 to November 2008). The dentist was calibrated by a standard-examiner before the first and third exam cycles. Training courses lasted 20 hours and were held in a primary education unit not selected for this study. Individuals were examined in the supine position, under natural lighting conditions, on the schoolyard, using a wooden spatula, flat mirror and ball point probe. The first permanent molar was considered emerged when any part of its

surface could be reached by the ball point probe. Age was measured in days between the date of birth and the exam day. The year was standardized as 360 days and 12 months and the value was converted into the month unit. In the present study, data on children aged between 60.0 and 77.9 months in any of the exams were analyzed.

As the emergence incidence values are not constant throughout time, varying according to each individual's age, the study population was stratified into three age cohorts: between 60.0 and 65.9 months; between 66.0 and 71.9 months; and between 72.0 and 77.9 months. Population size characteristics in each age cohort enabled estimation with a margin of error between 5.0 and 7.5%. Pearson's chi-square test was applied in each age cohort to evaluate the differences in composition between sexes.

The prevalence of individuals was estimated according to the number of molars emerged in each age cohort. Incidence rate was analyzed and 95% confidence intervals were compared according to sex and age. Incidence rate ratio was estimated to compare tooth emergence between boys and girls in each age cohort, using Poisson regression model. A value of $p < 0.05$ was adopted to reject the null hypothesis. Stata 10.0 software was used.

Results

A total of 497 children aged between 5 and 6 years participated in this study, of which 311 were evaluated in the first exam, 473 in the second exam, and 497 in the third exam. Of these, 24 participated in only one follow-up, 162 in two follow-ups, and 311 in three follow-ups, comprising 1,281 observations. Table 1 shows the distribution of observations according to sex and age cohort in each follow-up. There was a balance between sexes in all age cohorts ($p > 0.05$).

Figure 1 shows the proportion of girls and boys in each age cohort, according to the number of emerged permanent molars in each follow-up. A higher proportion of emerged teeth were observed in older age

Table 1 - Number and percentage of observations according to sex and age group in each follow-up. São Vicente, SP, Brazil, 2008.

Tabela 1 - Número e percentual de observações segundo sexo e coorte etária em cada seguimento. São Vicente, SP, Brasil, 2008.

Age Cohort	Follow-up	SEX				TOTAL	%
		Girls	%	Boys	%		
60.0 to 65.9 ^a							
	First	117	49.0	122	51.0	239	100.0
	Second	132	53.0	117	47.0	249	100.0
	Third	25	52.1	23	47.9	48	100.0
	TOTAL	274	51.1	262	48.9	536	100.0
66.0 to 71.9 ^b							
	First	20	57.1	15	42.9	35	100.0
	Second	88	49.4	90	50.6	178	100.0
	Third	133	51.6	125	48.4	258	100.0
	TOTAL	241	51.2	230	48.8	471	100.0
72.0 to 77.9 ^c							
	First	21	56.8	16	43.2	37	100.0
	Second	27	58.7	19	41.3	46	100.0
	Third	97	50.8	94	49.2	191	100.0
	TOTAL	145	52.9	129	47.1	274	100.0

Chi-square (Pearson) between sexes in each cohort ^a p=0.662; ^b p=0.695; ^c p=0.553
 Qui-Quadrado (Pearson) entre sexos em cada coorte ^a p=0,662; ^b p=0,695; ^c p=0,553

groups. Less than 40% of children had two or more molars emerged between the ages of 60.0 to 65.9 months.

Table 2 shows the distribution of girls and boys according to the number of molars emerged. In the younger age cohort, half of the children did not have any emerged molars. Between 66.0 and 71.9 months of age, 60.1% of girls had two or more molars emerged, whereas 50.4% of boys showed this condition. Between 66.0 and 71.9 months and between 72.0 and 77.9 months, the majority of children were found to have at least one permanent molar emerged. Among girls, rates varied from 76.9% to 89.7%, for each age cohort respectively, whereas these rates varied between 60.8% and 77.7% among boys.

Mean values and respective confidence intervals of emerged molar incidence are shown in Table 3. There was a slight and not statistically significant advantage for girls in the two younger age cohorts (between

60.0 and 65.9 months and between 66.0 and 71.9 months). This trend was then inverted, favoring boys in the age cohort from 72.0 to 77.9 months, thus revealing that these trends do not have the same direction in short time intervals, such as those considered in the present study.

Differences in incidence as a function of demographic characteristics were estimated using Poisson regression model to check these trends. Thus, the effect of sex in the incidence rate of first permanent molar emergence was evaluated in each age cohort, considering girls as the reference category. Boys and girls showed incidence values that were statistically different in the age cohorts included in the interval from 60.0 to 77.9 months of age. The results are shown in Table 4. The incidence of tooth emergence was 29% and 25% higher in girls, when compared to boys, in the age cohorts from 60.0 to 65.9 months and 66.0 to 71.9 months, respectively, whereas this

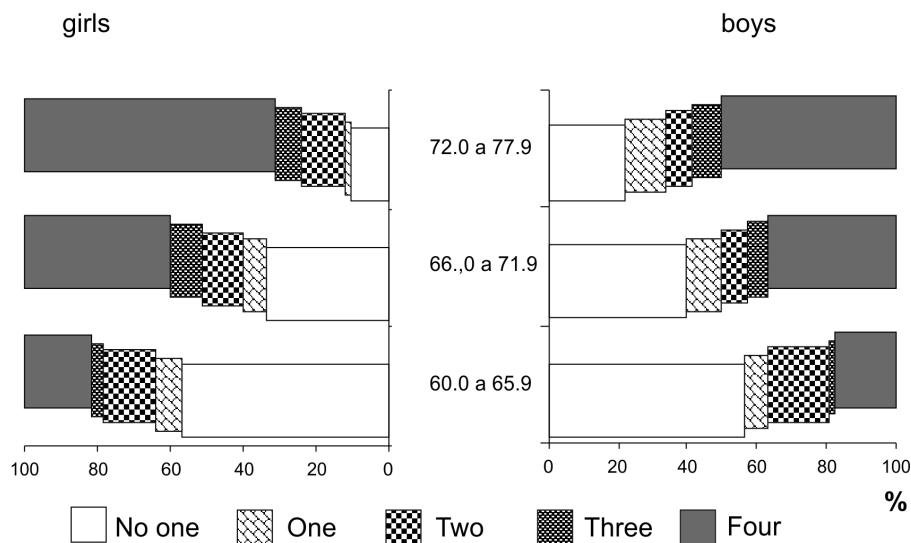


Figure 1 - Percentage of children according to sex and number of first permanent molars emerged in each age group. São Vicente, SP, Brazil, 2008.

Figura 1 - Percentual de crianças segundo o sexo e o número de primeiros molares permanentes irrompidos em cada coorte etária. São Vicente, SP, Brasil, 2008.

Table 2 - Children according to emerged molars, sex and age group. São Vicente, SP, Brazil, 2008. Confidence intervals and point estimates.

Tabela 2 - Crianças segundo número de molares irrompidos, sexo e a coorte etária. São Vicente, SP, Brasil, 2008. Estimativas por ponto e por intervalo de confiança.

Age Cohort	Emerged Molar	Girls		Boys	
		%	CI 95%	%	CI 95%
60.0 to 65.9	None	56.8	48.3 - 65.3	56.5	47.4 - 65.5
	One	6.8	2.5 - 11.1	6.8	2.2 - 11.40
	Two	14.4	8.4 - 20.4	17.1	10.2 - 23.9
	Three	3.8	0.5 - 7.1	1.7	0.6 - 4.1
	Four	18.2	11.6 - 24.8	17.9	10.9 - 24.9
66.0 to 71.9	None	33.1	25.0 - 41.1	39.2	30.6 - 47.8
	One	6.8	2.5 - 11.1	10.4	5.0 - 15.8
	Two	11.3	5.9 - 16.7	8.0	3.2 - 12.8
	Three	9.0	4.1 - 13.9	5.6	1.5 - 9.6
	Four	39.8	31.5 - 48.2	36.8	28.3 - 45.3
72.0 to 77.9	None	10.3	4.2 - 16.4	22.3	13.9 - 30.8
	One	2.1	0.80 - 4.9	11.7	5.1 - 18.2
	Two	11.3	4.9 - 17.7	7.4	2.1 - 12.8
	Three	7.2	2.0 - 12.4	8.5	2.8 - 14.2
	Four	69.1	59.8 - 78.3	50.1	39.8 - 60.2

Table 3 - Incidence of emergence of first permanent molar according to sex in each age group. Mean values and confidence intervals.

Tabela 3 - Incidência de irrompimento do primeiro molar permanente segundo sexo em cada coorte etária. Média e intervalo de confiança.

Age Cohort	Both	Girls	Boys
60.0 a 65.9	0.72 [0.63 – 0.82]	0.83 [0.69 – 0.97]	0.61 [0.48 – 0.74]
66.0 a 71.9	0.97 [0.85 – 1.09]	1.10 [0.94 – 1.27]	0.83 [0.67 – 1.00]
72.0 a 77.9	0.60 [0.48 – 0.72]	0.46 [0.33 – 0.59]	0.75 [0.55 – 0.95]
TOTAL	0.65 [0.60 – 0.71]	0.69 [0.62 – 0.77]	0.61 [0.54 – 0.69]

Table 4 - Relative risk values* (RR) and 95% confidence intervals for emergence incidence of first permanent molar among girls and boys in each age group. Estimates from Poisson regression analysis.

Tabela 4 - Valores de risco relativo* (RR) e intervalos de confiança (95%) para a incidência do irrompimento do primeiro molar permanente entre meninas e meninos em cada coorte etária. Estimativas obtidas por análise de regressão de Poisson.

Age Cohort	Number Children / Observations	RR	[IC 95%]	Value p**
60.0 to 65.9	481 / 536	0.71	[0.51 – 0.98]	0.040
66.0 to 71.9	464 / 471	0.75	[0.57 – 0.98]	0.035
72.0 to 77.9	258 / 274	1.54	[0.99 – 2.38]	0.052

* Ratio between incidence rates - Girls as reference category; ** Wald test

* Razão entre as taxas de incidência - Meninas como categoria de referência; ** Teste de Wald

incidence was 50% higher in boys in the oldest age cohort.

Discussion

Knowledge about the time of first permanent molar emergence is essential to plan diagnostic, preventive and therapeutic measures⁶, given the fact that a higher dental caries burden in a relevant number of children is concentrated in this tooth group.

With the extension of primary education from eight to nine years of duration, a higher number of children aged six years tend to be included in the first grade of primary education, thus making it necessary to evaluate the relevance of specific programs aimed at occlusal caries prevention in first

permanent molars. When tooth emergence is investigated, it is impossible to assess the exact moment this occurs. One alternative is to analyze this phenomenon between two exams. The collected data enabled the production of valid information about the presence of first permanent molars, according to the age cohorts defined in intervals of six months, separated into boys and girls. In certain studies, this information was produced from annual exams^{11,12}.

Using the data obtained in conjunction with the educational system, it is possible to estimate the number of children and emerged molars that require attention and surveillance, using specific measures which must be object of more in-depth studies. By providing resources for future studies

and for the planning of oral health actions in primary health care, the main findings were the prevalence rates of two or more emerged molars in each age cohort and the incidence rates estimating differences between boys and girls.

With the use of a longitudinal study, researchers investigated the emergence of the first permanent molars in a group of 69 children¹³. Tooth emergence was observed in intervals not longer than four months, until functional occlusion was obtained. In girls, the first molar emerged at the age of 73.6 months (6.1 years), whereas mean age was 75.2 months among boys (6.3 years), without statistically significant differences. A great variation in age of tooth emergence was found (in girls, between 63 and 92 months of age; in boys, between 62 and 94 months), with the duration of emergence of the four molars corresponding to a total time of 15.4 months in girls (variation from 5 to 32 months) and 15.0 months in boys (variation from 7 to 28 months).

In a different study¹¹, which followed the same type of design, although with a much larger sample (more than 30,000 records of children from the public dental service of Denmark), emergence of all permanent teeth was described. Authors concluded that teeth emerge firstly in girls, rather than in boys – the difference varied between two to ten months, without a clear dependence on the age of tooth emergence or type of tooth. Age distribution during tooth emergence corresponded to a normal curve for teeth with a low proportion of aplasia. In the present study, there was also a trend towards earlier tooth emergence in girls. First permanent molar emergence was compared in three age cohorts, with a higher emergence incidence trend in girls, in the two younger age cohorts. In the oldest age cohort, this trend inverted, showing that such trends do not have the same direction in short time intervals.

Differences in mean age of permanent tooth emergence between girls and boys was also observed in other studies^{7,12,14}. In addition, hereditary factors, ethnicity,

place of residence (urban or rural), and nutritional and hormonal characteristics are aspects that have been investigated in the literature^{7,9}.

Although socioeconomic condition can have an effect on general body growth, its impact on tooth emergence remains controversial^{9,15}. A longitudinal analysis with Brazilian children did not show an association between socioeconomic variables and tooth emergence⁸. For this reason, the fact that this study was conducted with a population living in a low-income area may not represent a limitation to the generalization of the results.

It is admitted that there is an uncertainty of 4 to 5 months as to the emergence age corresponding to the mean time interval (in months) between exams. However, as this interval was similar in both sexes, the comparison shown between girls and boys can be considered valid. In addition to this gender difference, the prevalence rate values of emerged molars in the three age cohorts studied were an important result found. Between 66.0 and 71.9 months of age and between 72.0 and 77.9 months, two age groups that begin to be included in the first grade due to the primary education extension, the majority of children were found to have at least one emerged permanent molar, a fact that justifies the adoption of surveillance measures and specific protection against occlusal caries lesion.

Children with four emerged molars can require more individualized measures towards occlusal caries lesion. In the age group between 66.0 and 71.9 months, at least one of each three children had their four first permanent molars emerged. In the age group between 72.0 and 77.9 months, 69.1% [CI95% 59.8 – 78.3] of girls and 50% [CI95% 39.8 – 60.2] of boys were in this condition.

In recent years, a reduction in caries has been observed among Brazilian schoolchildren. One of the reasons pointed out are supervised tooth-brushing programs, where fluoride toothpaste is used¹⁶. São Vicente and several other cities have maintained supervised tooth-brushing

programs funded by the *Fundo Nacional de Saúde* (Brazilian Health Fund)¹⁷. Many dental assistants are involved and a large amount of resources is spent annually. This action consists of oral health education and dental plaque observation, followed by supervised tooth-brushing with fluoride toothpaste, conducted by dental assistants every three months¹⁸. Oral health care has been considered one of the dimensions of primary health care and coverage of the above mentioned action has been one of the indicators established in the primary health care statement¹⁹. The majority of programs focus on the first grades of primary school, the period when the first permanent teeth emerge, among which the first molar is most frequently affected by caries, reason why protection measures are needed²⁰. The results shown justify the efforts aimed at

the newly enrolled schoolchildren, with the extension of primary education.

Conclusion

The incidence of tooth emergence was 29% and 25% higher in girls, when compared to boys, in the age cohorts of 60.0 to 65.9 months and 66.0 to 71.9 months, respectively, whereas this incidence was 50% higher in boys, in the oldest age cohort. Between 66.0 and 71.9 months and between 72.0 and 77.9 months, the two age groups that begin to be included in the first grade with the extension of primary education, the majority of children were found to have at least one emerged permanent molar, a fact that has important repercussions for the adoption of specific surveillance and protection measures against occlusal caries lesion.

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