



Median Ages of Eruption of the Primary Teeth in White and Hispanic Children From Arizona

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Abstract

Purpose: The purpose of this project was to establish median eruption ages of primary teeth and evaluate eruption differences between contralateral teeth by gender, ethnicity, and household income. Data was derived from a caries study of preschool children.

Methods: A total of 4,277 white (non-Hispanic) and Hispanic preschool children from Arizona were visually examined for caries and tooth eruption status by 5 examiners between February 1994 and September 1995. Analyses of eruption status were conducted using logistic regression to produce an eruption probability distribution from which median eruption ages for the primary teeth were determined. Possible differences in eruption timing between contralateral teeth by gender, ethnicity, and household income were examined.

Results: Eruption status of 1 tooth was significantly predictive of the pair-matched tooth for all pairs. Differences were found for the maxillary central incisor (gender) and the mandibular second molar (ethnicity). Eruption ages did not vary by household income. Median eruption ages for each of the 10 primary teeth are presented.

Conclusions: This study provides contemporary median eruption ages for primary teeth. (*Pediatr Dent.* 2003;25:257-261)

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Few studies of primary teeth eruption ages have been conducted.^{1,2} No peer-reviewed studies of primary dentition eruption ages in Hispanic US children have been published, nor have any primary dentition eruption age studies of a population-based US sample been conducted since 1960.³ Reports of primary dentition eruption timing from 2 Canadian samples were published during the period between 1960 and 2001, however, differences in methods and data presentation preclude meaningful comparisons across studies.^{4,5} The purpose of this project was to establish median eruption ages of the individual primary teeth in white (non-Hispanic) and Hispanic children residing in Arizona. Data was derived from a caries study of preschool children.

Additionally, the evaluation of possible eruption differences between contralateral teeth by gender, ethnicity, and household income (a measure of socioeconomic status) were secondary objectives of the study in order to assess these factors as potential confounders in the aggregated analyses. The secondary analyses were conducted due to the limited number of previous studies investigating these factors and/or the inconsistency of earlier findings. With regard to gender and the eruption of primary teeth, previous studies have reported either nonsignificant differences or an earlier eruption in males.⁴ In terms of race, Lavelle reported no statistical difference between African American and white children for the primary dentition, while Garn et al found African American children to have advanced eruption of the permanent

dentition relative to white children.^{6,7} Garn et al also reported a slight delay in the eruption of permanent teeth in children from lower socioeconomic strata relative to children in higher SES strata. Lavelle suggested no difference in primary tooth eruption by SES level, although it is unclear as to how this was determined.^{6,7,8}

A number of considerations have motivated this study of contemporary primary dentition eruption in a large, representative, contemporary US cohort. Eruption age distributions for the primary dentition may have utility in modeling dental caries activity, in assessing risk factors in analytic studies of early childhood caries, and for the assessment of age groupings in field anthropologic studies.⁶⁻¹¹ Moreover, there is a risk that inappropriate clinical and/or public health interventions may be applied if these interventions are based on reports utilizing inaccurate eruption ages.

Methods

The original sampled cohort of Arizona children and the methods of examination have been described elsewhere.^{9,10} Briefly, 5,171 Arizona preschool children were visually examined for caries (and tooth eruption status) by 5 examiners between February 1994 and September 1995. The examiners were calibrated on dmfs and paired interexaminer reliability was at least $\kappa=0.97$. An additional reliability assessment was not formally conducted. The examiners participated in the field examinations for various periods. The children were recruited from Head Start programs, WIC programs, health fairs, private day care centers in the Phoenix and Tucson areas, and other recruitment sites located in 30 additional Arizona communities. These communities were stratified by population size. Each of the study communities had a minimum sample size of 25 preschool children in each age-year (ie, <1, 1, 2, 3, and 4).

The project included 4,277 children from the original sample who were identified by caregivers as white (non-Hispanic) or Hispanic. The mean (median) numbers of children for each 1-month age interval were: (1) white=32.5 (32); (2) Hispanic=45.3 (43); and (3) all children combined=77.8 (75). This provided sufficient numbers in each age-month for the analysis.

Tooth eruption was defined as having occurred if any tooth surface had pierced the alveolar mucosa. Gender of child, ethnicity of child (white/Hispanic), and caregivers' household income (<\$10,000, \$10,000 to <\$20,000, \$20,000 to <\$30,000, and \geq \$30,000) were reported by caregivers using self-administered structured questionnaires that were made available in English and Spanish.

Analyses were conducted using unconditional logistic regression with age as the single independent variable or as a covariate when contralateral tooth pairs, gender, ethnicity, and income were modeled.¹³⁻¹⁸ Age was entered as a continuous variable and defined in months plus 0.5 months to allow for an equal distribution of exact ages within an interval (ie, the average age for a 1-month age interval). The eruption times of contralateral teeth were

compared by regressing the eruption status of the right on the left-matched tooth while controlling for age. A statistically significant finding suggests an association (ie, if one tooth is erupted then the other is erupted) for each age-month. The initial results supported the use of eruption of either member of a contralateral pair of teeth as being representative of the eruption status for that tooth pair. Consequently, further analyses used this criterion for eruption status (ie, that any erupted tooth of a matched pair represented eruption). Differences in tooth eruption status by gender, ethnicity, and income were assessed for each tooth pair in separate multivariate models for each of these 3 covariates that controlled for age (months).

The median eruption ages and their 95% fiducial confidence intervals were derived from the probability distribution produced from logistic regression parameter estimates utilizing all data in aggregate.^{11,12} Fiducial confidence intervals are derived using a computational technique employed for "dose response" (ie, "age-eruption") type analyses and as used in this investigation, can be considered simple 95% confidence intervals. Eruption status was regressed on age and each covariate of interest. The median eruption age satisfies the formula: $\text{Probability}_{0.5} = 1 / (1 + \exp[-\beta_0 + \beta_1(\text{age}) + \beta_2(\text{covariate})])$.

For those teeth having a possible gender, ethnicity, or income difference in eruption age, separate analyses of the median eruption ages were produced.

Results

The study sample demographics are presented in Table 1. Fifty-eight percent of the sample was of Hispanic ethnicity. The Hispanic children were slightly younger, having a mean age of 35.3 ± 15.5 months compared to 36.6 ± 15.6 months for White children ($P=.008$), and Hispanic households were poorer ($P \leq .0009$). The gender distribution was comparable across ethnicity ($P=.628$), and for both groups slightly more males than females were sampled.

Logistic regression modeled the association between eruption status (erupted or not) of each left tooth and its contralateral right pair-matched tooth, and the models were statistically significant ($P \leq .001$) for all 10 tooth pairs when adjusted by age (in months). That is, having 1 tooth of a pair erupted or not was highly predictive of whether or not the pair-matched tooth was similarly erupted. This supported the subsequent analyses in treating either erupted tooth of a contralateral pair as representing "erupted" for that tooth pair in that individual.

Gender was a significant predictor of median eruption age for the maxillary central incisor ($P=.0013$) and maxillary canine ($P=.039$) teeth, with boys having earlier median eruption ages. However, when the P value was adjusted for multiple comparisons, the finding for the canines was not statistically significant. Additionally, when analyzed at the individual tooth level rather than as a contralateral pair, only the maxillary central incisors continued to demonstrate this gender difference, with males having a median

Table 1. Descriptive Characteristics of Study Sample: White and Hispanic Subjects by Age, Gender, and Income

	White	Hispanic	Total
N	1,787 (42%)	2,490 (58%)	4,277
Age (mean±months)*	36.6±15.6	35.3±15.5	
Gender†			
Female	843 (47%)	1,193 (48%)	2,036 (48%)
Male	943 (52%)	1,295 (52%)	2,238 (52%)
Total	1,786 (42%)	2,488 (58%)	4,274
Income‡			
<\$10,000	490 (31.1%)	1,201 (64.4%)	1,691 (49.1%)
\$10,000-<\$20,000	400 (25%)	476 (26%)	876 (25%)
\$20,000-<\$30,000	252 (16%)	134 (7%)	386 (11%)
\$30,000+	436 (28%)	55 (3%)	491 (14%)
Total	1,578 (46%)	1,866 (54%)	3,444

*Student's *t* test: *t*=2.627, *df*=4275, *P*=.008.

†Chi-square: 0.234, *df*=1, *P*=.628.

‡Chi-square: 617.49, *df*=3, *P*≤.0009.

eruption age 1 month earlier than females. The mandibular second molar was the sole tooth that demonstrated a statistically significant ethnically related difference, with White non-Hispanics showing a 1-month eruption delay (*P*=.0049) relative to Hispanics. Eruption ages were not statistically different by self-reported household income for any of the 10 tooth pairs (the range of *P* values for a linear trend of household income being *P*=.877 through *P*=.059, with most results being at the higher end of the probability values and unadjusted for multiple comparisons).

Median eruption ages for each of the 10 primary teeth along with 95% fiducial confidence intervals are presented in Table 2. These estimated eruption ages were based on the aggregated sample of children and derived from the eruption/age probability distribution produced by logistic regression. Additionally, eruption ages for the maxillary central incisor and mandibular second molar (ie, those teeth that demonstrated a statistically significant difference for eruption age) are presented by gender and ethnicity, respectively. Table 3 summarizes the modeling results.

Discussion

The findings presented here are consistent with previously reported median eruption ages of the primary dentition in white populations.^{1-4,6,13-17} The current findings will provide pediatric dentistry clinicians with contemporary tooth eruption ages for assessing dental growth and development, thus reassuring caregivers regarding development and defining the appropriate timing of preventive interventions for high-risk individuals or groups (eg, fluoride varnish ap-

Table 2. Primary Dentition Median Eruption Ages for White and Hispanic Children*

Arch	Tooth	Median eruption age (months)	95% CI	
			Lower	Upper
Maxillary	Central incisor	9.4†	9.1	9.7
	Lateral incisor	10.6	10.3	11.0
	Canine	19.5	19.1	19.8
	1st molar	15.7	15.3	16.0
Mandibular	2nd molar	27.9	27.5	28.3
	Central incisor	6.6	5.8	7.1
	Lateral incisor	12.5	12.1	12.9
	Canine	19.5	19.2	19.9
	1st molar	16.0	15.7	16.3
	2nd molar	27.0‡	26.7	27.4

*Cross-sectional sample with median eruption ages determined by utilizing logistic regression to produce an eruption probability distribution by age in months.

†Central incisor: females=9.9 months, males=9.0 months.

‡Second molar: Hispanics=26.5 months, whites=27.6 months.

Table 3. Summary of Results Based on Logistic Models of Tooth Eruption Status of Individual Teeth or Pair-matched Teeth for Contralateral Tooth and by Gender, Ethnicity, and Income

Variable	<i>P</i> value ≤.05
Contralateral tooth	All tooth pairs (<i>P</i> ≤.001; ie, all associated)
Gender	Maxillary central only (<i>P</i> ≤.001), males 1 month earlier (all other teeth NS*)
Ethnicity	Mandibular first molar (<i>P</i> =.005), Hispanic children 1 month earlier (all other teeth NS*)
Income	No statistically significant associations

*NS=not statistically significant at the ≤0.05 level.

plications). The findings are applicable to early childhood caries investigations, particularly in determining risk factor exposure timing to tooth susceptibility (ie, the presence and duration of a tooth in the oral environment at risk for exposure).

Contralateral differences in primary tooth eruption have been identified in a previous report,¹⁷ however, other studies found no such relationships.^{1,2} Utilizing a different modeling procedure than generally employed for human cross-sectional eruption data (ie, logistic rather than probit regression), these findings supported the lack of a right-left eruption difference and suggested that eruption of either tooth of a contralateral pair of specific teeth is an appropriate event measure for median eruption age studies. Additionally, the independent variable age was modeled

Table 4. Selected Comparisons of Central Tendencies (Means or Medians): Primary Dentition Eruption Ages of Present and Previous Reports

Arch	Present study	Range*	1994† Ramirez	1984† Tanguay	1984† Hitchcock	1982‡ Magnusson	1975‡¶ Lavelle	1944‡ Sandler
Maxillary								
Central incisor	9.4	8.9-9.6	9.4	9	8.9	9.1	9	9.6
Lateral incisor	10.6	10.2-11.5	10.7	10.2	10.3	10.3	11.3	11.5
Canine	19.5	16.6-18.7	18.7	18	18.0	17.8	16.6	18.3
First molar	15.7	15-16	15.3	15.1	15.1	15	16	15.1
Second molar	27.9	25.6-27.6	26.8	27.5	27.6	25.6	26.5	26.2
Mandibular								
Central incisor	6.6	7-8.8	7.2	7.2	7	7.5	8.8	7.8
Lateral incisor	12.5	11.9-13.1	12.3	12.1	11.9	11.9	13.1	12.4
Canine	19.5	18.2-20	19.0	18.3	18.4	18.7	20	18.2
First molar	16	15-16.6	15.7	15	15.1	15.8	16.6	15.7
Second molar	27	24.7-26.8	25.5	26.4	26.5	24.7	26.8	26

*Range of median eruption ages in cited studies.

†Longitudinal.

‡Cross-sectional.

¶Right side only.

rather than the alternatives of the natural log of age or the natural log of conceptional age, given that little difference in terms of median eruption age across these measures has been previously reported.^{18,19}

Reports have been inconsistent in terms of eruption age differences by gender for the primary dentition, although when differences were found, males were slightly advanced in their eruption relative to females.^{2-4,6,13,14} In the current analysis, only the maxillary central incisors demonstrated an eruption age difference by gender ($P=.0013$), with males having an eruption 1 month earlier—a finding generally consistent with the preponderance of reports in the literature. Notably, Tanguay et al also reported a gender difference in the median eruption age of the maxillary central incisor.⁴ The present analysis also revealed an ethnic difference in the median eruption age for the mandibular first molar ($P=.0049$), with Hispanic children having an eruption 1 month earlier. The median eruption ages in the current study are consistent with those reported by Ramirez et al, based on a sample of Spanish children.² The consistency of findings suggests limited, if any, eruption differences across ethnicity in the primary dentition, and does not mirror findings of racial eruption differences in the permanent teeth.⁷ No differences by household income were identified. However, income may affect eruption through a mechanism associated with inadequate nutrition,²⁰ and protein-energy deficiencies of such a magnitude may not be generally observed in the sampled population.

Caution should be exercised when these findings are interpreted, as the problem of multiple comparisons may be applicable (ie, statistically significant findings may be by chance alone when a number of comparisons are made without adjusting the level of statistical significance).^{21,22} The multiple comparison problem may be applicable to

both the gender and ethnic eruption age differences for the 2 identified teeth. However, these 2 P values (ie, for the maxillary centrals/gender and mandibular molar/ethnicity models) fall close to a conservative Bonferroni-adjusted significance level of 0.0017 for 30 comparisons (10 tooth pairs for gender, ethnicity, and income), suggesting that these eruption differences may be real.²¹

A secular trend in the eruption ages of some teeth has been reported by Brook²³ and hypothesized to be related to improving socioeconomic conditions. In a study by Helm, a sample examined in 1965 demonstrated permanent canines and second molars erupting earlier and premolars erupting later than in a 1913 cohort.²⁴ Although the diagnostic criteria appear similar across the studies, the samples were somewhat different in their urban-rural residence, and the Helm study was limited to canines, premolars, and second molars due to the age range of the sample. No evidence of a secular trend has been published regarding the primary dentition, and the findings presented here in combination with findings from previous studies (Table 4) fail to reveal any consistent trend in eruption ages over time. Compared to past studies, median eruption age in this study population for the maxillary canines tended toward a later eruption age. However, the 95% bounds of the confidence intervals for median eruption times of all other teeth (Table 2) were within the range of previously reported eruption ages.^{2,4,6,14,15,25} Notably, no statistically significant differences in eruption ages were observed for the income levels modeled in this analysis, which, if significant, would have provided support for a socioeconomic-driven trend in primary dentition eruption ages.

Strengths of this study were the large sample size, the ability to model 1-month age intervals and the general completeness of the eruption data (0%-100% eruption across age-months). The primary limitation of this study was its cross-sectional design. Therefore, rather than an observable distribution that a prospective study can yield, these analyses modeled the cross-sectional data to produce a probability distribution. Additionally, as with all self-reported information, household income data may exhibit some degree of misclassification.²⁶ However, the completeness and accuracy

of the eruption data, as well as the broad income categories and large sample size used in this study, diminish concerns with these limitations.

Conclusions

This report presents contemporary median eruption age estimates for 2 US ethnic groups: white and Hispanic. The findings demonstrate:

1. generally comparable median eruption ages of the primary dentition for contralateral-matched teeth by income, gender, and ethnicity;
2. little evidence of a secular trend in eruption ages when compared with previous reports.

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