The relationship between the number of erupted primary teeth and the child´s height and weight: a cross-sectional study

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The objective of this study is to determine the correlation between the number of erupted primary teeth, the age, sex and the somatic measures of weight and height (length) in a Brazilian population based cross sectional study. A systematic sampling was used. Complete and consistent data were obtained from 870 of a total of 908 children from birth to 36 months of age. Statistical analysis comprised a multiple regression equation, where the number of erupted primary teeth was modeled as the dependent variable and the initial specification included the following independent variables: age, sex, birth-length, birth-weight, weight and length measured at the examination of the child. Results showed that in this study, 86% of the variation of the number of erupted primary teeth was explained by age and height of children (p<0.001). Age and height showed a stronger correlation with the number of erupted primary teeth than all the tested variables together. It was concluded that primary teeth eruption is highly influenced by age and height (length) of the child. Using the best regression equation found, a chart was constructed where the variation of the number of erupted primary teeth is given according to age and height of the child.

J Clin Pediatr Dent 29(4): 357-362, 2005

INTRODUCTION

Dental eruption is part of a general growth and development of the child. The chronological age indicates how long a child has been growing and developing, while the height and weight shows how much the child has grown physically. The patterns of (length) height and weight according to the age of the child have been established on growth charts. The most commonly used are from the National Center for Health Statistics, USA - World Health Organization[1] (NCHS - WHO, 2000, developed in collaboration with the Center for Chronic Disease Prevention and Health Promotion (known as the CDC Growth Charts). New charts, based in more representative samples for worldwide use, are being elaborated by WHO, but are not available yet.

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Pediatricians to evaluate the height and weight according to the age and sex of the child use these charts. They are also useful in Public Health studies in which growth assessment defines health and nutritional status of the children, who belong to the referred population.[2]

One of the authors, who first studied the eruption of primary teeth was Minot, in 1873. Later, Kronfeld and Schour[3] developed a primary and permanent teeth eruption chronology table. Later, many investigations on the primary teeth eruption chronology were performed on various populations applying more accurate methodologies.[4-9]

Dental age in infants may be estimated clinically by counting the number of erupted teeth. It has been considered as useful complementary data for evaluation of growth and development, especially when employed together with the measurements of height and weight.[10,11]

Seow *et al*.[12] investigated dental eruption in low birth-weight and prematurely born children, compared with a controlled group of normal birth-weight children. They found a considerable delay of dental eruption in very low birth-weight children, mostly among children, who had not completed 24 months of age. However, when the exact age of prematurely born children was provided, no relevant difference was detected.

The aim of the present study was to verify the correlation between the number of erupted primary teeth and the somatic measurements of height and weight to the age and sex of the child.

MATERIALS AND METHODS

The study protocol was previously submitted to the Ethics in Research Committee at the School of Dentistry of the University of Sao Paulo and approved in accordance to the written statement - number 72/00.

We examined 908 children between the age birth to 36 months. Sample size corresponded to nearly 1.5% of the entire population at this age in Guarulhos city, state of Sao Paulo, Brazil. These children were selected and examined during the National Vaccination Campaign, which takes place every year in all Basic Health Units of the city (BHU). We chose 16 of these BHU that were equally distributed around the four main regions of the city. We also used a systematic sampling, where the number of children to be examined at each BHU was determined based on the number of children that had been vaccinated at each BHU in the last campaign. We randomly selected a first child and then proceeded by selecting every nth child (e.g. n=8) where *n* depended on the number of children that should be examined at each BHU.

In each of the 16 BHU a work-team was assigned consisting of a professor of Pediatric Dentistry as the examiner, a dentist from the Municipal Service to help at the exam and to fill in the files, and also two dental students to call the children and to interview the mothers to obtain information such as: date of birth, birth-weight and birth-length of her child. All of them were previously calibrated for the task and a pilot study with all the participants was done during an earlier vaccination campaign.

The mother or person responsible for the child had been informed about this investigation and those who were willing to participate were asked to sign a written consent form.

A separate room from where the vaccination was taking place was assigned for the study. The dental students first interviewed the mothers and obtained information regarding the date of birth, sex, birth-weight, and birth-length of the child. Then, the child was measured and weighed by the nurse, who worked at the BHU and was used to doing the job as a routine and also part of an evaluation of the child. The procedures of measurement of weight and length followed the recommendations of the Report of the WHO Expert Committee.[13]

Each child was weighed without any clothes, diapers or shoes. Children younger than 24 months of age were weighed lying down or sitting on a leveled pan scale with a beam and movable weights and a 16 kilograms capacity, calibrated to within a precision of 10g. The infant was placed on the scale so that the weight was distributed equally to the center of the pan. Weight was recorded when the child was lying quietly. Children over 24 months or those who were already able to stand by themselves, were weighed in the standing up position on a platform scale, calibrated to within a precision of 100g. The child should stand still in the center of the platform, with the body weight evenly distributed between both feet.

The length of infants were also measured from head to heels lying down in a supine position with an anthropometric bar, composed of a vertical board with an attached metric rule and a horizontal headboard that could be brought into contact with the uppermost point on the head. The crown of the head of the infant should touch the stationary vertical headboard. The head was held with the line of vision aligned perpendicular to the plane of the measuring surface. The shoulders and buttocks were flat against the table top, with the shoulders and hips aligned at right angles to the long axis of the body. The legs were extended at the hips and knees and lay flat against the table top. The measurer should ensure that the legs remained flat on the table and then shift the movable board against the heels. The length was recorded from the nearest 0.1 cm.

After measuring, the oral examination was performed in the knee to knee position with the head of the child on the lap of the professional and the trunk and legs on the lap of the mother.[13] Clinical examination was done with disposable dental mirrors and a small hand flashlight. During this examination, any child, who had dental cavities or any other oral problem, was referred for treatment. All mothers received information about preventive oral care. We considered that a tooth was erupted if any part of it had pierced the gingival mucosa.

Statistical Analysis

The variation of the number of erupted teeth was modeled as the dependent variable in a multiple regression equation. The initial specification included the following independent variables: sex (1= male ; 2 = female) – (S); age (months) – (A); birth-weight (grams - g) – (BW); birth-length (centimeters - cm) – (BL); weight at the time of the exam (g) – (W); height (length) at the time of the exam (cm) – (L).

The multiple regression analysis is done using the following equation:

$$y = B_1X_1 + B_2X_2 + ...+ B_{m-1}X_{m-1} + e$$

where,

y = dependent variable (number of erupted teeth – NET)

$X_1, X_2, ..., X_{m-1}$ = independent variables (S, A, BW, BL, W, L)

$B_1, B_2,....B_{m-1}$ = coefficient of the independent variables

e = “error term.” It is a random variable with unknown variance, which represents the effect of all possible factors for which measures could not be directly obtained.

Starting from this initial specification, several combinations of the considered independent variables, as well as polynomial transformations for these variables were analyzed through a sequence of tests. These included traditional tests for the significance of parameters and the validity of the usual assumptions concerning the hypothesis of the residuals covariance matrix. This specification search was aided by the multiple correlation coefficient (R^2)[15], and the Schwarz Information Criterion calculated for each considered specification.[16]

The percentage of the variation of the dependent variable (number of erupted teeth) that can be explained by the studied independent variables (S, A, BW, BL, W, L) ranged from 0 to 1. The Schwarz Information Criterion indicates as the best specification the one that includes the independent variables, which maximize the joint probability distribution of the observed sample while penalizing the inclusion of unnecessary variables in the model.

Data processing and analysis was done using the statistical program STATA (version 7).

RESULTS

The final sample was constituted of 870 children, which corresponds to 95.8% of the examined children. We excluded 38 files for incomplete or inconsistent information.

Table 1. shows our sample distribution according to age and sex. It can be observed a reasonable distribution of boys and girls and also of children at each range of age.

Table 1.. Sample distribution according to age and sex

Age (months)	Boys	Girls	Total	%
0 to 6	53	63	116	13,3
7 to 12	85	66	145	16,7
13 to 18	101	85	186	21,4
19 to 24	81	75	156	17.9
25 to 30	93	86	179	20,6
31 to 36	44	44	88	10,1
Total	457	413	870	100

Table 2. Results of the chosen model of multiple regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C (constant)	23.33763	6.566677	3.553949	0.0004
Height (cm)	-83.14669	17.71282	-4.694154	0.0000
Age (months)	1.035514	0.077157	13.42092	0.0000
Height^2 (cm)	61.68338	11.06293	5.575682	0.0000
Age^2 (months)	-0.011988	0.001792	-6.691494	0.0000

R-squared	0.858537	Mean dependent var	10.66175
Adjusted R-squared	0.857837	S.D. dependent var	7.314704
S.E. of regression	2.757977	Akaike info criterion	4.873003
Sum squared resid	6146.001	Schwarz criterion	4.901913
Log likelihood	-1975.876	F-statistic	1225.935
Durbin-Watson stat	1.973028	Prob(F-statistic)	0.000000

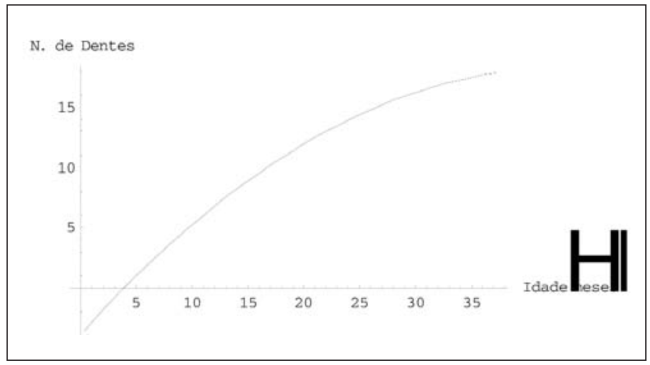


Figure 1. Variation of the number of erupted primary teeth according to age

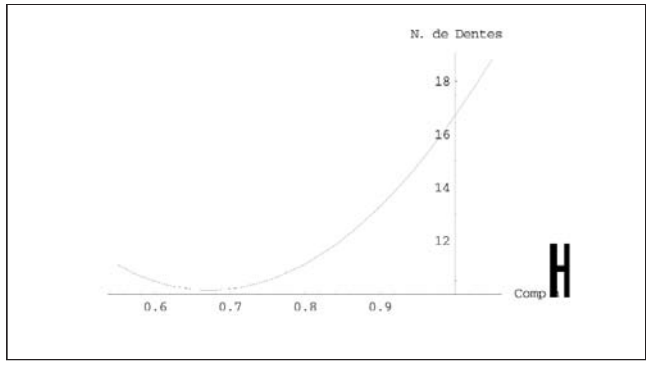


Figure 2. Variation of the number of erupted teeth according to height (length)

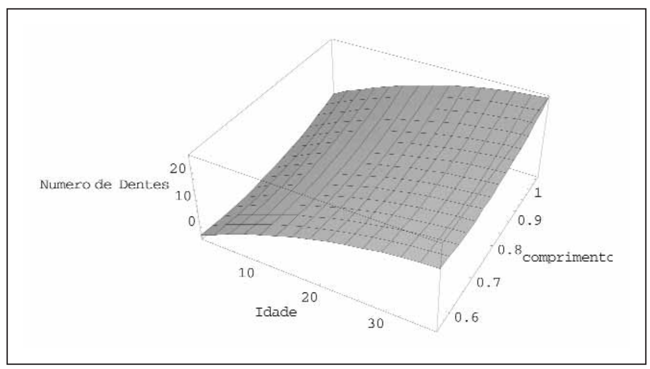
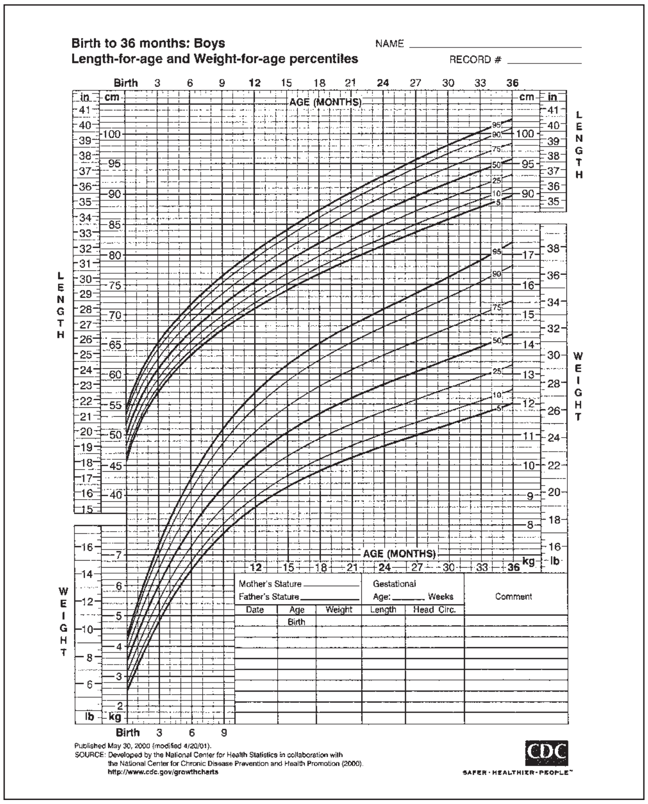
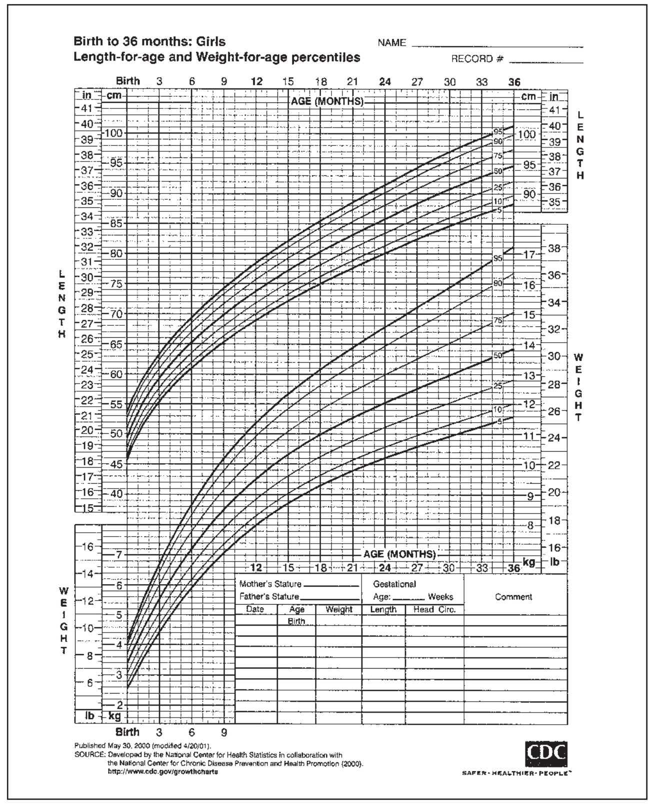


Figure 3. Representation of the number of erupted primary teeth according to age and height (length)

The final specification for the multiple regression model as chosen was the one that simultaneously maximized the multiple correlation coefficient and minimized the Schwarz Information Criterion, including a second degree polynomial transformation for the variables age and length. The results for this chosen model are expressed in Table 2.

The R^2 showed a value of 0.857 and all the estimated coefficients are statistically significant ($p<0.001$). It means that, in our study, 86% of the variation in the number of erupted primary (NET) teeth was explained by the chosen variables, that is age (A) and length (L). The representation of the variation of the NET according to age (Figure 1) and according to length (Figure 2)





and together is showed in Figure 3.

The independent variables of age and length showed a stronger correlation with the number of erupted primary teeth than all the studied variables together or of any other variables combination.

Figure 3 represents the best regression found and from this regression derives the following equation:

$$NET = 1.03\,x - 0.0119\,x^2 - 83.14\,y + 61.68\,y^2 + 23{,}33$$

where:

X = age (months) – (A) y = length (cm) – (L)

The above formula allows the calculation of the probable NET according to age (months) and length (centimeters), which is expressed in Figure 4. The length for age range used to create Figure 4 is the same as the one presented on the CDC growth chart (length-for-age from birth to 36 months boys and girls).

DISCUSSION

In our study, information regarding child birth-weight and birth-length were collected based on information given by mothers. Although we eliminated from our sample every child about whom we had inconsistent information, this method is susceptible to recall bias. Victora *et al.*[17] in a representative cohort prospective study, where mothers were asked about the birth weight of the child, 9 or 15 months after birth, found that over 60% among the mothers could tell the exact weight and about 80% were wrong in around 100g of the real weight and 90% were wrong in about 250g.

Considering the statistical analysis, if we stratified the sample according to age and tested the effect of length on the number of erupted teeth, we would obtain less information, since we would work with smaller samples instead of the whole sample containing all ages. The stratification of the sample could present greater confidence intervals, weakening the results.

Based on the methodology applied and also on our sample, we found that the chronology of eruption of primary teeth was influenced not only by the age, but also by the height (length) of the child. For instance, if we consider two infants with 10 months of age, it is expected that the taller one should have more erupted teeth than the shorter one, regardless of the birth-weight and birth-length.

According to Grivu *et al.*[18] and Billewicz *et al.*[19] children with higher measures of birth-weight and birth-length had earlier dental eruption up to 20 months of age. Trupkin[20], Seow *et al.*[12], Fadavi *et al.*[21], also observed that primary teeth eruption occurred later in children with low birth-weight. However, Karlberg *et al.*[22] found that most infants (82.9% of the sample) born small for gestational age showed a catch-up growth during the first 6 months of age. At this point, one can ask what happens with the primary teeth eruption chronology if a child, who was born with low birth-weight gets into a catch-up growth and has an increase in his/her rhythm

height (centimeters) / age (months)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
97																					19	20	20	20	20	20	20	20	20	20	20	97
96																				18	19	19	20	20	20	20	20	20	20	20	20	96
95																			18	18	19	19	19	20	20	20	20	20	20	20	20	95
94																		17	17	18	18	19	19	19	20	20	20	20	20	20	20	94
93																	16	16	17	17	18	18	19	19	19	20	20	20	20	20	20	93
92																15	16	16	17	17	18	18	18	19	19	19	20	20	20	20	20	92
91															14	15	15	16	16	17	17	18	18	18	19	19	19	20	20	20	20	91
90														13	14	15	15	16	16	17	17	17	18	18	18	19	19	19	19	20	20	90
89													12	13	14	14	15	15	16	16	17	17	17	18	18	18	19	19	19	19	20	89
88												12	12	13	13	14	15	15	16	16	16	17	17	18	18	18	18	19	19	19	19	88
87												11	12	13	13	14	14	15	15	16	16	17	17	17	18	18	18	18	19	19	19	87
86											11	11	12	12	13	14	14	15	15	15	16	16	17	17	17	18	18	18	18	19	19	86
85										10	10	11	12	12	13	13	14	14	15	15	16	16	16	17	17	17	18	18	18	18		85
84									9	9	10	11	11	12	13	13	14	14	15	15	15	16	16	17	17	17	17	18				84
83								8	9	9	10	11	11	12	12	13	13	14	14	15	15	16	16	16	17	17						83
82							7	8	8	9	10	10	11	12	12	13	13	14	14	15	15	15	16	16	16							82
81						6	7	7	8	9	10	10	11	11	12	12	13	14	14	14	15	15	16	16								81
80					5	6	7	7	8	9	9	10	11	11	12	12	13	13	14	14	15	15	15									80
79				4	5	6	6	7	8	9	9	10	10	11	12	12	13	13	14	14	15											79
78				4	5	6	6	7	8	8	9	10	10	11	11	12	13	13	14													78
77			3	4	5	5	6	7	7	8	9	10	10	11	11	12	12															77
76		2	3	4	4	5	6	7	7	8	9	9	10	11	11	12																76
75		2	3	4	4	5	6	7	7	8	9	9	10	11																		75
74	1	2	3	3	4	5	6	7	7	8	9	9	10																			74
73	1	2	3	3	4	5	6	6	7	8	9	9	10																			73
72	1	2	2	3	4	5	6	6	7	8	8	9																				72
71	1	2	2	3	4	5	6	6	7	8	8																					71
70	1	2	2	3	4	5	6	6	7																							70
69	1	2	2	3	4	5	6	6	7																							69
68	1	1	2	3	4	5	6	6																								68
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	

Figure 4: Number of erupted primary teeth, according to age and heigth

Figure 4.

of growth, changing from a lower to a higher percentage of length for their age? According to our results, low birth-weight children may have as many teeth as those with a normal birth-weight or even more, as long as they catch up with their growth, and thus, growing the same height or even taller, for their age, than normal birth-weight children.

It is important to observe that two variables may be highly correlated and yet have no cause-effect correlation between them. This is why the method of multiple regression is indicated whenever a dependent variable may be affected by more than one independent variable. A positive correlation between birth-weight and the number of erupted primary teeth is expected because both represent the same phenomenon of somatic growth.

Nevertheless, once we are able to compare the influence of both birth-weight and length over the NET, it becomes clear that length is the variable with the greatest statistical relevance. It is only made possible through multiple regression.

The chart proposed in this study shows that dental eruption may be included as a part integrated to the routine pediatric examination of infants and considered according to age and length / height as a more global evaluation of physical growth and development of the child. Further studies should evaluate, thus, confirming or not our results.

CONCLUSION

The present study investigated the correlation between eruption of primary teeth, age, sex and the somatic measurements of height and weight. The results indicated that the greatest correlation was between the number of erupted teeth and the age and height (length) of the child. The application of this correlation was put in practice by constructing a chart, where the number of erupted primary teeth can be considered together with the age and height of the child, in a more integrated evaluation of growth and development.

ACKNOWLEDGMENTS

Professor Paulo Picchetti for the statistical analysis. Professor Dr. Marco Aurélio Peres and Professor Karen Peres for the contribution to the written article and to CAPES (Centro de Aperfeiçoamento de Pessoal de Nível Superior) for the financial support.

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