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The impact of birth characteristics, breast-feeding and vital statistics on the eruption of primary teeth among healthy infants in Saudi Arabia

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The impact of birth characteristics, breast-feeding and vital statistics on the eruption of primary teeth among healthy infants in Saudi Arabia

Original Article

Running Head : Factors affecting the eruption of primary teeth

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Abstract

Objectives: This study aimed to explore the impact of gender, birth weight, maternal age, type of delivery, gestational age and feeding practices on the eruption of teeth in the first year of life.

Design: A cross-sectional observational study design was used

Setting: A primary health care setting in Riyadh, Saudi Arabia

Participants: All infants reporting for vaccination to a well-baby clinic (n=422) were included in the study. Infants with chronic childhood illnesses, those who were below the 5th percentile in height or weight, infants with congenital birth defects, chronic illnesses, infants who were born pre-term, and low-birth weight infants were excluded from the study.

Outcome Measures: The type of delivery, birth weight, age of mother, height and weight and feeding practices were recorded by the examiner and this was followed by a clinical examination to determine the presence or absence of each tooth. Regression models were developed to determine the effect of the different variables on the presence of primary teeth.

Results There was a significant association between the weight of the child and the number of erupted primary teeth. No association was observed between birth-weight, height, or maternal age at the time of birth and the number of erupted primary teeth. Children who were exclusively breastfed were significantly more likely to have an erupted first primary tooth earlier than non-breastfed group.

Conclusions: Breastfeeding and the weight of the child may have an influence on the eruption of primary teeth in the first year of life.

Key Words:

Disturbances in dental development, First Erupted tooth, Primary teeth,

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Strengths and Linitations of this paper

Strengths

One of the first papers from the region to address the issue of factors affecting the eruption of primary teeth

Looks at the impact of vital statistics, birth-type and feeding characteristics on the eruption of primary teeth

Applies regression modelling to look for influences of different variables on the eruption of primary teeth

Linitation

The study uses a cross-sectional rather than longitudinal cohort study design

Introduction

The ages at which the primary teeth erupt are of great significance in relation to growth and development of the child. It has been thought that eruption of deciduous teeth play an essential role in the proper alignment, spacing and occlusion of permanent teeth[1]. Several variables have been thought to influence the eruption of the primary teeth including ethnicity[2],socioeconomic status [3] and nutrition status([4].A recent genome-wide association study has shown that loci associated with height and craniofacial distances can impact the eruption of primary teeth[5].

In addition to genetic factors, environmental factors such as maternal smoking [6], height and weight of a newborn at the time of birth [7] and nutrition status have been shown to play a role in the eruption of the primary teeth. A few reports have focused on the discerning effect of nutrition in early age of a child, including breast milk. It has been suggested that the act of breastfeeding is encourages proper

growth of the mouth, jaw as well as secretion of hormones for proper digestion[7]. This concept has been used to suggest that breastfeeding may advance the eruption of primary teeth [8] .

The relationship between ethnicity and the timing of eruption of primary teeth is a complicated one. While there is definite evidence to show that children from different geographic regions have different eruption patterns of the primary teeth [9-12]; it is not clear how much of this difference can be attributed to ethnicity. There is some evidence from Saudi Arabia to suggest that the eruption of primary teeth in Saudi children occurs a later stage when compared to Caucasian children [13], but there has been no attempt made to study the factors that affect the eruption of primary teeth in Arab children. Furthermore, data from existing longitudinal studies are often plagued by the confounding effects of socio-economic factors, overall nutritional status and overall maternal health, which vary from country to country and can often vary between different groups within the same country [14-16].

A majority of the existing literature on the eruption of primary teeth has focused on the chronology of eruption, with little attention placed on the role of confounding factors on the chronology of eruption. Studies that have looked at factors affecting the eruption of primary teeth have focused on children with underlying medical conditions, or nutritional deficiencies. Little attention has been paid to the factors influencing the eruption of teeth in healthy infants. The aim of this study was to examine the possible confounding factors that affect the eruption of primary teeth in the first year of life in a population of medically healthy Saudi infants.

Methodology

Study design and setting

This study was conducted from October 2016 to March 2017 among infants (age < 12 months) of parents who attended the vaccination (well baby) clinic at the King Abdullah Specialist Children Hospital, National Guard Health Affairs, Riyadh, Saudi Arabia.

Ethical considerations

Ethical approval for the conduct of this study was obtained from the Institutional Review Board of the Riyadh Colleges of Dentistry and Pharmacy (FPGRP/43535005/41). And approved by the Institutional Review Board (IRB) of King Abdullah International Medical Research Center (SP16/224/R). Informed consent was obtained in writing from the parents of the infants.

Sample size

A power analysis for multiple regressions was applied to determine the sample size, using the G power sample size calculator (<http://www.gpower.hhu.de/>). The calculation was based on 5 regression variables, an effect size of 0.02 (poor effect), alpha level 0.05, and a power of 95%. The minimum calculated sample size was 125 subjects.

Sample Characteristics

The sample was selected using non-random convenience sampling of the children attending the well-baby clinic. The sample included all children aged below 12 months who were deemed to be medically fit. The sample excluded infants with congenital birth defects, chronic illnesses, infants who were born pre-term, and low-birth weight infants.

Data Collection

Demographic data of the family including date of birth, gender, number of siblings, rank in the family and socioeconomic data were recorded in an Arabic by the parent. Data on the age of the parents at the time of birth, type of delivery (vaginal or caesarian section), twinning (yes/no; if yes, identical/not

identical), type of delivery (normal/C section) and feeding practices (breast feeding/breast + bottle feeding/bottle feeding only) were recorded by one of the investigators (KA) after interviewing the parents. The birth weight of the child was obtained from the medical records of the child

The height (in cm) and weight (in kg) of the child were obtained from the record made on the day of the examination. The height and weight were then transformed into a percentile value for age using the WHO standards for infant growth[17].

An intra-oral examination was conducted using the WHO type II protocol (Additional lighting and mouth mirror, but no radiographs). For the purpose of this study, an erupted tooth was defined as any tooth with any part of its crown penetrating the gingiva and visible in the oral cavity.

Statistical analysis

Data obtained was coded, entered in, and analyzed using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA). Descriptive and inferential statistical analysis was performed. Descriptive analysis was used to describe the data. Mean \pm Standard Deviation (SD) was used to describe parametric continuous variables and median (interquartile range for non-parametric continuous data). Categorical variables were described using frequency and percentage. The t test was used to compare between the means of two groups. Linear regression model developed to examine the total number of teeth present as the dependent variable. Binary logistic regression models were developed to examine the different factors affecting the presence or absence of teeth. A p-value < 0.05 was considered statistically significant for all tests.

Results

The study sample comprised 422 children aged between 1day until 12 months of age with a mean age of 7.2 months and standard deviation of 3.45. The sample comprised 206 males (48.8%) and 216 females

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(51.2%). There was no significant difference in the mean age of the male (7.2 months +/- 3.1 month) and female (7.2 months +/- 3.4 months) subjects ($t=0.131$, $p=0.904$).

When the other demographic factors were tabulated it was observed that the mean age of the fathers at the time of delivery was 35.2 years (+/- 7.8 years) and the mothers was 30.7 years (+/-6.07). A total of 291 children in this sample were born by normal vaginal delivery while 131 were born by caesarian section. The height and weight characteristics of the population are summarized in Table 1.

When the feeding characteristics of the population were documented it was observed that only 90 children were exclusively breastfed. Most of the children ($n=212$) had received a combination of breast feeding and bottle feeding while 120 children had never been breastfed (Table 1).

A chart showing the percentage of children with an erupted tooth at each given age was developed. It was observed that by the end of the first year over 98.7% of the children had at least one erupted tooth. 98.1% of the sample had a lower central incisor, 82.1% had an upper central incisor, 49.2% had an upper lateral incisor and only 18.5% had a lower lateral incisor erupted in the oral cavity (Fig 1).

The gender of the child, age of the mother at the time of birth of the child, the type of delivery, the number of siblings and the order of birth were placed in a linear regression model with the total number of teeth in the oral cavity as a dependent variable. There was a significant association ($p<0.001$) between the gender of the child and the total number of emerged teeth with females having significantly more erupted than their male counterparts. The model showed no significant association between the age of the mother at the time of the child's birth, the number of siblings, or the order of birth; and the number of primary teeth in the oral cavity of the infant (Table 2).

The height percentile, weight percentile and birth weight were placed in a linear regression model with the total number of teeth in the oral cavity as the dependent variable. It was observed that while the height percentile and birth weight had no significant relationship with the number of teeth in the oral cavity there was a significant positive relationship between the weight percentile and number of teeth in the oral cavity suggesting that heavier children were likely to have more erupted teeth in the first year of life (Table 3).

Children were categorized into those exclusively breastfed up to six months and those who were not exclusively breast fed. This factor was compared to the presence or absence of a tooth in the oral cavity. It was observed that overall children who were exclusively breastfed were significantly more likely to have an erupted primary tooth. When the model was further split according to months it was observed that this observation was only significant up to the eighth month of life, following which there was no significant impact of breastfeeding on the number of erupted teeth (Table 4).

Discussion

While there have been studies that have looked extensively on the timing of eruption of primary teeth and individual factors that influence the eruption of these teeth, there have been few studies that have focused on the relationship between the different factors [14-16]. There is little data on the subject from the Middle East and this study aimed to address that gap.

The pattern observed in our study was similar to the pattern of eruption observed by other researchers. The lower central incisor was the first to erupt followed by the upper central incisors. While it is difficult to differentiate between the upper and lower teeth in the sequence of eruption, our study confirmed the previously observed sequence of central incisor followed by the lateral incisors [18]. The fact that

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this study only focused on the first year of life meant that we had inadequate data to comment on the eruption timing and pattern of the canines and molars.

Sexual dimorphism has been extensively studied previously with the traditional view stating that girls generally showed an earlier eruption of teeth than boys [9, 19]. Our results support the conventional view and are in contrast to other studies that have found no gender difference in the timing of eruption of primary teeth [11, 20-23].

Previous literature has shown a relationship of malnourishment to failure to thrive, and the delayed eruption of teeth [24-27]. The fact that the number of erupted teeth in our study was significantly associated with the weight of the child seems to suggest that even among children who are not malnourished nutritional status may be an important factor affecting the emergence of the primary teeth. Interestingly, we found no association between the birth weight of the child and the timing of eruption of the first primary tooth. This in contrast to Nitani et al who found birth weight to be associated with the emergence of the primary dentition, with heavier babies showing earlier eruption patterns [28]. However, it must be remembered that the current study focused only on healthy children and malnourished children were not included in the sample.

There is a growing strong interest in the role of breastfeeding on the emergence of the first primary tooth[8]. It has been hypothesized that early sucking activity influences the growth of the cranio-facial complex [29]. It has been proposed that breast feeding is the ideal stimulus for the physiological development of both the muscular and skeletal components of the oro-facial complex [30]. The results of our study seem to support this hypothesis, as we found a significantly greater presence of the first primary tooth in children aged below 7 months who were breastfed. However, our results also seem to suggest that any benefit that breast-feeding may have on the emergence of the first primary tooth was neutralized by the eighth month of life.

This study used a cross sectional design rather than a longitudinal design that followed children from birth[9, 10, 17]. However this approach was deemed more practical since the aim of this study was to look at the associated factors and not the actual age of eruption. Furthermore, by only selecting healthy children this study aimed to remove confounding factors such as malnutrition or chronic illness.

Conclusions

Within the limitation of this study we can conclude that breastfed infants show an earlier emergence of primary teeth than those who are not. However, these differences disappear after the 7th month. The weight of the child is strongly associated with the emergence of primary teeth in the first year of life of healthy infants. The results of this study indicate that factors such as the height of the child, birth weight of the child, maternal age or order of birth do not seem to influence the emergence of primary teeth in healthy infants.

Sources of Support

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Competing interest statement

We have read and understood BMJ policy on declaration of interests and declare that we have no competing interests

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Author Contributions

SCP and KA conceptualized and designed the study. KA and MB were responsible for collection of Data and AA and SCP were responsible for analysis of the data. All the authors contributed equally to the preparation of the manuscript.

For peer review only

References

1. Sajjadian N, Shajari H, Jahadi R, Barakat MG, Sajjadian A: **Relationship between birth weight and time of first deciduous tooth eruption in 143 consecutively born infants.** *Pediatrics & Neonatology* 2010, **51**(4):235-237.
2. Tanguay R, Demirjian A, Thibault H: **Sexual dimorphism in the emergence of the deciduous teeth.** *Journal of dental research* 1984, **63**(1):65-68.
3. Enwonwu CO: **Influence of socio-economic conditions on dental development in Nigerian children.** *Archives of oral biology* 1973, **18**(1):95-107.
4. Al-Othman AM, Saeed AA, Bani IA, Al-Murshed KS: **Mothers' practices during pregnancy, lactation and care of their children in Riyadh, Saudi Arabia.** *Saudi medical journal* 2002, **23**(8):909-914.
5. Pillas D, Hoggart CJ, Evans DM, O'Reilly PF, Sipilä K, Lähdesmäki R, Millwood IY, Kaakinen M, Netuveli G, Blane D: **Genome-wide association study reveals multiple loci associated with primary tooth development during infancy.** *PLoS Genet* 2010, **6**(2):e1000856.
6. Rantakallio P, Mäkinen H: **Number of teeth at the age of one year in relation to maternal smoking.** *Annals of human biology* 1984, **11**(1):45-52.
7. Garn SM, Nagy JM, Sandusky ST, Trowbridge F: **Economic impact on tooth emergence.** *American journal of physical anthropology* 1973, **39**(2):233-237.
8. Oziegbe EO, Adekoya-Sofowora CA, Esan TA, Owotade FJ, Folayan MO: **Breastfeeding pattern and eruption of primary teeth in Nigerian children.** *Pediatric Dental Journal* 2010, **20**(1):1-6.
9. Magnússon TE: **Emergence of primary teeth and onset of dental stages in Icelandic children.** *Community dentistry and oral epidemiology* 1982, **10**(2):91-97.
10. Holman DJ, Jones RE: **Longitudinal analysis of deciduous tooth emergence: II. Parametric survival analysis in Bangladeshi, Guatemalan, Japanese, and Javanese children.** *American journal of physical anthropology* 1998, **105**(2):209-230.
11. Holman DJ, Jones RE: **Longitudinal analysis of deciduous tooth emergence: III. Sexual dimorphism in Bangladeshi, Guatemalan, Japanese, and Javanese children.** *American journal of physical anthropology* 2003, **122**(3):269-278.
12. Townsend N, Hammel E: **Age estimation from the number of teeth erupted in young children: an aid to demographic surveys.** *Demography* 1990, **27**(1):165-174.
13. Al-Jasser NM, Bello LL: **Time of eruption of primary dentition in Saudi children.** *The journal of contemporary dental practice* 2003, **4**(3):65-75.
14. Psoter WJ, Reid BC, Katz RV: **Malnutrition and dental caries: a review of the literature.** *Caries research* 2005, **39**(6):441-447.
15. Ramos SRP, Gugisch RC, Fraiz FC: **The influence of gestational age and birth weight of the newborn on tooth eruption.** *Journal of Applied Oral Science* 2006, **14**(4):228-232.
16. Warren JJ, Fontana M, Blanchette DR, Dawson DV, Drake DR, Levy SM, Kolker JL, Phipps KR: **Timing of primary tooth emergence among US racial and ethnic groups.** *Journal of public health dentistry* 2016.

17. Tudehope D, Gibbons K, Cormack B, Bloomfield F: **Growth monitoring of low birthweight infants: what references to use?** *Journal of paediatrics and child health* 2012, **48**(9):759-767.

18. Liversidge H: **4 Variation in modern human dental development.** *Patterns of growth and development in the genus Homo* 2003, **37**:73.

19. Kitamura S: **A study on the time and order of eruption of human teeth II (in Tokyo, Japan).** *Shikwa gakuho* 1942, **47**:352-368.

20. Enwonwu CO: **Influence of socio-economic conditions on dental development in Nigerian children.** *Archives of oral biology* 1973, **18**(1):95-IN15.

21. McGregor IA, Thomson AM, Billewicz WZ: **The development of primary teeth in children from a group of Gambian villages, and critical examination of its use for estimating age.** *Br J Nutr* 1968, **22**(2):307-314.

22. Roche A, Barkla D, Maritz JS: **Deciduous eruption in Melbourne children.** *Australian Dental Journal* 1964, **9**(2):106-108.

23. Yun DJ: **Eruption of primary teeth in Korean rural children.** *American journal of physical anthropology* 1957, **15**(2):261-268.

24. Reddy VR: **Eruption of deciduous teeth among the children of Gulbarga, south India.** *Indian J Med Res* 1981, **73**:772-781.

25. Delgado H, Habicht JP, Yarbrough C, Lechtig A, Martorell R, Malina RM, Klein R: **Nutritional status and the timing of deciduous tooth eruption.** *The American journal of clinical nutrition* 1975, **28**(3):216-224.

26. Truswell A, Hansen D: **Eruption of deciduous teeth in protein-calorie malnutrition.** *J Trop Pediatr* 1973, **19**:214-216.

27. Robinow M, Richards T, Anderson M: **The eruption of deciduous teeth.** *Growth* 1942, **6**(2).

28. Ntani G, Day PF, Baird J, Godfrey KM, Robinson SM, Cooper C, Inskip HM: **Maternal and early life factors of tooth emergence patterns and number of teeth at 1 and 2 years of age.** *Journal of developmental origins of health and disease* 2015, **6**(04):299-307.

29. Palmer B: **The influence of breastfeeding on the development of the oral cavity: a commentary.** *Journal of Human Lactation* 1998, **14**(2):93-98.

30. Viggiano D, Fasano D, Monaco G, Strohmenger L: **Breast feeding, bottle feeding, and non-nutritive sucking; effects on occlusion in deciduous dentition.** *Archives of disease in childhood* 2004, **89**(12):1121-1123.

Table 1 – Demographic data and vital statistics of the study population

		N	%	Mean	Standard Deviation
Gender	Male	206	48.8%		
	Female	216	51.2%		
Type of delivery	Normal	291	69.0%		
	C section	131	31.0%		
	Assisted Vaginal	0	0.0%		
Type of Feeding	Breastfeeding only	90	21.3%		
	Breastfeeding + Bottlefeeding	212	50.2%		
	Bottle feeding only	120	28.4%		
Birth weight (kg)				3.1	.4
Height (cm)				65.9	6.7
Height Percentile				27.80	23.84
Weight (kg)				7.6	1.8
Weight Percentile				40.01	30.36

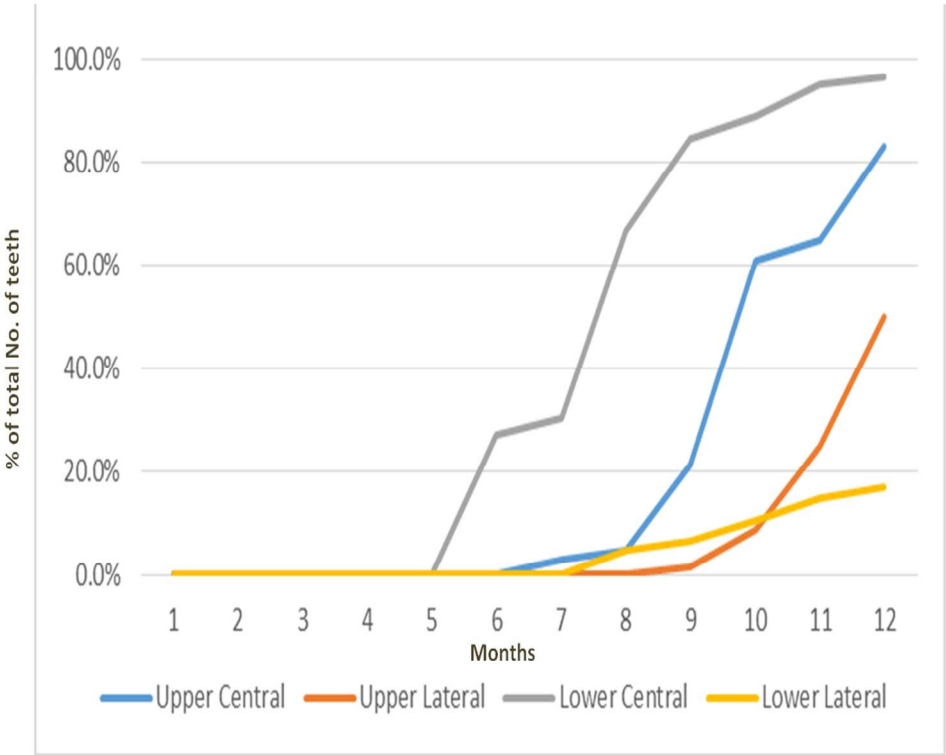


Fig 1: percentage of children in the population with an erupted primary tooth

Table 2 – Effect of Gender, Birthing, and Familial Factors on the eruption of primary teeth

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.752	.796		.945	.345
	Gender	.677	.205	.160	3.308	.001*
	Age of mother at the time of delivery	-.006	.026	-.016	-.216	.829
	Type of delivery	-.037	.222	-.008	-.168	.867
	Number of siblings	.018	.083	.016	.216	.829

a. Dependent Variable: Total_teeth

*association significant at $p < 0.05$

Table 3 – Effect of height, weight and birthweight on the eruption of teeth

Model		Unstandardized		Standardize	t	Sig.
		Coefficients		d		
				Coefficients		
		B	Std. Error	Beta		
1	(Constant)	.926	.732		1.265	.206
	Height	.000	.005	-.003	-.058	.954
	Percentile					
	Weight	.017	.004	.236	4.469	.000*
	Percentile					
	Birth weight	.005	.238	.001	.021	.983
	(kg)					
a. Dependent Variable: Total number of primary teeth						

*association significant at p<0.05

Table 4 : Relationship between breastfeeding and eruption of primary teeth

Age in months	B	S.E.	df	p-value	Exp(B)
<7.0	-1.922	.926	1	.018 ^b	.146
8.0	-1.021	1.049	1	.032 ^b	.234
9.0	1.466	.989	1	.138	4.333
10.0	1.426	1.389	1	.188	3.567
11.0	1.266	1.089	1	.238	5.333
12.0	1.403	1.245	1	.260	4.067
Overall	1.888	.304	1	.000	6.608

a. Variable(s) entered on step 1: Child breast fed or not

b. Association significant at $p < 0.05$

c. Calculated using a binomial regression

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6
		(b) Describe any methods used to examine subgroups and interactions	6
		(c) Explain how missing data were addressed	6
		(d) If applicable, describe analytical methods taking account of sampling strategy	6
		(e) Describe any sensitivity analyses	6
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	NA
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7,14
		(b) Indicate number of participants with missing data for each variable of interest	7,14
Outcome data	15*	Report numbers of outcome events or summary measures	7,15,16
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7,17
		(b) Report category boundaries when continuous variables were categorized	7,8
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	8,9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9
Generalisability	21	Discuss the generalisability (external validity) of the study results	9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The impact of birth characteristics, breast-feeding and vital statistics on the eruption of primary teeth among healthy infants in Saudi Arabia - an observational study

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The impact of birth characteristics, breast-feeding and vital statistics on the eruption of primary teeth among healthy infants in Saudi Arabia - an observational study

Original Article

Running Head : Factors affecting the eruption of primary teeth

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Abstract

Objectives: This study aimed to explore the impact of gender, birth weight, maternal age, type of delivery, gestational age and feeding practices on the eruption of teeth in the first year of life.

Design: A cross-sectional observational study design was used

Setting: A primary health care setting in Riyadh, Saudi Arabia

Participants: All children in their first year of life attending a vaccination clinic (n=422) were included in the study. Infants with chronic childhood illnesses, those who were below the 5th percentile in height or weight, infants with congenital birth defects, chronic illnesses, infants who were born pre-term, and low-birth weight infants were excluded from the study.

Outcome Measures: The type of delivery, birth weight, age of mother, height and weight percentile for age, and feeding practices were recorded by the examiner and this was followed by a clinical examination to determine the presence or absence of each tooth. Regression models were developed to determine the effect of the different variables on the presence of primary teeth.

Results There was a significant association between the weight percentile of the child (adjusted for age) and the number of erupted primary teeth. No association was observed between birth-weight, height percentile for age, or maternal age at the time of birth and the number of erupted primary teeth. Children who were exclusively breastfed were significantly more likely to have an erupted first primary tooth earlier than non-breastfed group.

Conclusions: Breastfeeding and the weight of the child may have an influence on the eruption of primary teeth in the first year of life.

Key Words:

Disturbances in dental development, First Erupted tooth, Primary teeth,

Strengths and Limitationsof this paper

Strengths

- Provides an overview of the factors affecting the eruption of primary teeth in the first year of life
- Uses a cross sectional approach to look at the impact of vital statistics, birth-type and feeding characteristics on the eruption of primary teeth
- Applies regression modelling to look for influences of different variables on the eruption of primary teeth

Limitation

- The study uses a cross-sectional rather than longitudinal cohort study design
- The study design seeks to look at an overall trend rather than the specifics of a particular birth cohort

Introduction

The ages at which the primary teeth erupt are of great significance in relation to growth and development of the child. It has been thought that eruption of deciduous teeth play an essential role in the proper alignment, spacing and occlusion of permanent teeth[1]. Several variables have been thought to influence the eruption of the primary teeth including ethnicity[2],socioeconomic status [3] and nutrition status([4].A recent genome-wide association study has shown that loci associated with height and craniofacial distances can impact the eruption of primary teeth in the first year of the child’s life[5].

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3 In addition to genetic factors, environmental factors such as maternal smoking [6], height and weight of
4 a newborn at the time of birth [7] and nutrition status have been shown to play a role in the eruption of
5 the first primary tooth. A few reports have focused on the discerning effect of nutrition in early age of a
6 child, including breast milk. It has been suggested that the act of breastfeeding encourages proper
7 growth of the mouth and jaw, as well as secretion of hormones for proper digestion[7]. This concept has
8 been used to suggest that breastfeeding may advance the eruption of primary teeth [8] .
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17 The relationship between ethnicity and the timing of eruption of the first primary tooth is a complicated
18 one. While there is definite evidence to show that children from different geographic regions have
19 different eruption patterns of the primary teeth [9-12]; it is not clear how much of this difference can be
20 attributed to ethnicity. There is some evidence from Saudi Arabia to suggest that the eruption of
21 primary teeth in Saudi children occurs a later stage when compared to Caucasian children [13], but there
22 has been no attempt made to study the factors that affect the eruption of the eruption pattern in the
23 first year of life . Furthermore, data from existing longitudinal studies are often plagued by the
24 confounding effects of socio-economic factors, overall nutritional status and overall maternal health,
25 which vary from country to country and can often vary between different groups within the same
26 country [14-16].
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43 Most studies on the eruption of primary teeth in the first year of life have focused on children with
44 underlying medical conditions, or nutritional deficiencies. Little attention has been paid to the factors
45 influencing the eruption of teeth in healthy infants. The aim of this study was to examine the possible
46 confounding factors that affect the eruption of primary teeth in the first year of life in a population of
47 medically healthy Saudi infants.
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55 Methodology

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3 *Study design and setting*

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6 This study was conducted from October 2016 to March 2017 among infants (age < 12 months) of

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8 parents who attended the vaccination (well baby) clinic at the King Abdullah Specialist Children Hospital,

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10 National Guard Health Affairs, Riyadh, Saudi Arabia; a publically funded free hospital. The study design

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12 aimed to examine each child once.

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16 *Ethical considerations*

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18 Ethical approval for the conduct of this study was obtained from the Institutional Review Board of the

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20 Riyadh Colleges of Dentistry and Pharmacy (FPGRP/43535005/41). And approved by the Institutional

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22 Review Board (IRB) of King Abdullah International Medical Research Center (SP16/224/R). Informed

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24 consent was obtained in writing from the parents of the infants.

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28 *Sample size*

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31 A power analysis for multiple regressions was applied to determine the power of the achieved sample,

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33 using the G power sample size calculator (<http://www.gpower.hhu.de/>). The post hoc sample power

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35 was calculated for a regression model utilizing the seven eventual predictors namely; birth weight,

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37 weight for age (percentile), height for age (percentile), age of the mother at birth, gender of the child ,

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39 type of delivery and type of feeding practice. It was observed that the final sample of 422 children when

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41 computed for an effect size of 0.05 (small effect size), and alpha of 0.05 yielded an actual power of 0.94.

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45 *Sample Characteristics*

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48 The sample was selected using non-random convenience sampling of the children attending the

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50 vaccination clinic. The sample included all children aged below 12 months who were deemed to be

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52 medically fit. The sample excluded infants with congenital birth defects, chronic illnesses, infants who

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3 were born pre-term, and low-birth weight infants. All children who met the inclusion criteria were
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5 included in the final analysis.
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7 8 *Data Collection* 9

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11 Demographic data of the family including date of birth, gender, number of siblings, rank in the family
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13 and socioeconomic data were recorded in an Arabic by the parent. Data on the age of the parents at the
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15 time of birth, type of delivery (vaginal or caesarian section), twinning (yes/no; if yes, identical/not
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17 identical), type of delivery (normal/C section) and feeding practices (breast feeding/breast + bottle
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19 feeding/bottle feeding only) were recorded by one of the investigators (KA) after interviewing the
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21 parents. The birth weight of the child was obtained from the medical records of the child.
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25 The height (in cm) and weight (in kg) of the child were obtained from the record made on the day of the
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27 examination. The height and weight were then transformed into a percentile value for age using the
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29 WHO standards for infant growth[17].
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33 All intra-oral examinations were conducted by a single examiner (KA) who was calibrated using the WHO
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35 criteria for an erupted tooth. For the purpose of this study, an erupted tooth was defined as any tooth
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37 with any part of its crown penetrating the gingiva and visible in the oral cavity. The examiner was
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39 calibrated for intra-examiner variability by re-examining 20 children and applying the kappa statistic.
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41 The recall examinations showed low intra-examiner variability (Kappa=0.925).
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45 The intra-oral examination was conducted in the vaccination clinic with the child placed in the mother's
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47 lap and examined using the knee-to-knee position. The oral cavity was examined with a mouth-mirror
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49 and using a head-lamp without the use of radiographs.
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52 *Statistical analysis* 53 54 55 56 57 58 59 60

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3 Data obtained was coded, entered in, and analyzed using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA).
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5 Descriptive and inferential statistical analysis was performed. Descriptive analysis was used to describe
6
7 the data. Mean \pm Standard Deviation (SD) was used to describe parametric continuous variables and
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9 median (interquartile range for non-parametric continuous data). Categorical variables were described
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11 using frequency and percentage. The t test was used to compare mean age between males and females.
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14 Linear regression model developed to examine the total number of teeth present as the dependent
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16 variable. Binary logistic regression models were developed to examine the different factors affecting the
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18 presence or absence of teeth. A p-value < 0.05 was considered statistically significant for all tests.
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22 **Results**

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24 The study sample comprised 422 children aged between 1day until 12 months of age with a mean age of
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26 7.2 months and standard deviation of 3.45. The sample comprised 206 males (48.8%) and 216 females
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28 (51.2%). There was no significant difference in the mean age of the male (7.2 months +/- 3.1 month) and
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30 female (7.2 months +/- 3.4 months) subjects (t=0.131, p=0.904).
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34 When the other demographic factors were tabulated it was observed that the mean age of the fathers
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36 at the time of delivery was 35.2 years (+/- 7.8 years) and the mothers was 30.7 years (+/-6.07). A total of
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38 291 children in this sample were born by normal vaginal delivery while 131 were born by caesarian
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40 section. The height and weight of the population was converted into the percentile for age using the
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42 WHO standards. The height and weight characteristics are summarized in Table 1.
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46 When the feeding characteristics of the population were documented it was observed that only 90
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48 children were exclusively breastfed. Most of the children (n=212) had received a combination of breast
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50 feeding and bottle feeding while 120 children had never been breastfed (Table 1).
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54 A chart showing the percentage of children with an erupted tooth at each given age was developed. It
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56 was observed that by the end of the first year over 98.7% of the children had at least one erupted tooth.
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98.1% of the sample had a lower central incisor, 82.1% had an upper central incisor, 49.2% had an upper lateral incisor and only 18.5% had a lower lateral incisor erupted in the oral cavity (Fig 1).

The gender of the child, age of the mother at the time of birth of the child, the type of delivery, the number of siblings and the order of birth were placed in a linear regression model with the total number of teeth in the oral cavity as a dependent variable. There was a significant association ($p < 0.001$) between the gender of the child and the total number of emerged teeth with females having significantly more erupted than their male counterparts. The model showed no significant association between the age of the mother at the time of the child's birth, the number of siblings, or the order of birth; and the number of primary teeth in the oral cavity of the infant (Table 2).

The height percentile, weight percentile and birth weight were placed in a linear regression model with the total number of teeth in the oral cavity as the dependent variable. It was observed that while the height percentile and birth weight had no significant relationship with the number of teeth in the oral cavity there was a significant positive relationship between the weight percentile and number of teeth in the oral cavity suggesting that heavier children were likely to have more erupted teeth in the first year of life (Table 3).

Children were categorized into those exclusively breastfed up to six months and those who were not exclusively breast fed. This factor was compared to the presence or absence of a tooth in the oral cavity. It was observed that overall children who were exclusively breastfed were significantly more likely to have an erupted primary tooth. When the model was further split according to months it was observed that this observation was only significant up to the eighth month of life, following which there was no significant impact of breastfeeding on the number of erupted teeth (Table 4).

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3 **Discussion**

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6 While there have been studies that have looked extensively on the timing of eruption of primary teeth

7 and individual factors that influence the eruption of these teeth, there have been few studies that have

8 focused on the relationship between the different factors [14-16]. There is little data on the subject

9 from the Middle East and this study aimed to address that gap. Many studies examining the eruption of

10 teeth have looked at the eruption time of the teeth in a single cohort over a period of time [9-11,16].

11 While this cohort model has the advantage of following a single child over a time period it is susceptible

12 to memory bias as it relies on the mother to recall when the particular tooth erupted. In this study we

13 chose a cross sectional study design that focused on the presence or absence of a particular tooth and a

14 single examination of the child.

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16

17 The pattern observed in our study was similar to the pattern of eruption observed by other researchers.

18 The lower central incisor was the first to erupt followed by the upper central incisors. While it is difficult

19 to differentiate between the upper and lower teeth in the sequence of eruption, our study confirmed

20 the previously observed sequence of central incisor followed by the lateral incisors [18]. The fact that

21 this study only focused on the first year of life meant that we had inadequate data to comment on the

22 eruption timing and pattern of the canines and molars.

23

24

25 Sexual dimorphism has been extensively studied previously with the traditional view stating that girls

26 generally showed an earlier eruption of teeth than boys [9, 19]. Our results support the conventional

27 view and are in contrast to other studies that have found no gender difference in the timing of eruption

28 of primary teeth [11, 20-23].

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31 Previous literature has shown a relationship of malnourishment to failure to thrive, and the delayed

32 eruption of teeth [24-27]. The fact that the number of erupted teeth in our study was significantly

33 associated with the weight of the child seems to suggest that even among children who are not

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malnourished nutritional status may be an important factor affecting the emergence of the primary teeth. Interestingly, we found no association between the birth weight of the child and the timing of eruption of the first primary tooth. This in contrast to Nitani et al who found birth weight to be associated with the emergence of the primary dentition, with heavier babies showing earlier eruption patterns [28]. However, it must be remembered that the current study focused only on healthy children and malnourished children were not included in the sample.

There is a growing strong interest in the role of breastfeeding on the emergence of the first primary tooth[8]. It has been hypothesized that early sucking activity influences the growth of the cranio-facial complex [29]. It has been proposed that breast feeding is the ideal stimulus for the physiological development of both the muscular and skeletal components of the oro-facial complex [30]. This study seems to support the hypothesis and suggest a positive relationship between breastfeeding and the emergence of the first permanent tooth. However, the absence of a relationship between the number of teeth present and the feeding status in older children suggests that more research is needed into the possible impact of breastfeeding on the emergence of subsequent teeth.

This study used a cross sectional design rather than a longitudinal design that followed children from birth[9, 10, 17]. The cross-sectional design with the use of the objective examination of the presence or absence of a tooth was designed to exclude the possible memory recall bias of mothers. The cross sectional design cannot be used to accurately predict the age of eruption, however, it must be remembered that the aim of this study was to look at the associated factors and not the actual age of eruption. Furthermore, by only selecting healthy children this study aimed to remove confounding factors such as malnutrition or chronic illness.

Conclusions

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Within the limitations of this study we can conclude that there seems to be a positive association between breastfeeding and the emergence of the first primary tooth. . The weight (percentile for age) of the child is strongly associated with the emergence of primary teeth in the first year of life of healthy infants. The results of this study indicate that factors such as the height (percentile for age) of the child, birth weight of the child, maternal age or order of birth do not seem to influence the emergence of primary teeth in healthy infants.

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Competing interest statement

We have read and understood BMJ policy on declaration of interests and declare that we have no competing interests

Author Contributions

SCP and KA conceptualized and designed the study. KA and MB were responsible for collection of Data and AA and SCP were responsible for analysis of the data. All the authors contributed equally to the preparation of the manuscript.

Data Sharing Statement

No additional data available

For peer review only

References

1. Sajjadian N, Shajari H, Jahadi R, Barakat MG, Sajjadian A: **Relationship between birth weight and time of first deciduous tooth eruption in 143 consecutively born infants.** *Pediatrics & Neonatology* 2010, **51**(4):235-237.
2. Tanguay R, Demirjian A, Thibault H: **Sexual dimorphism in the emergence of the deciduous teeth.** *Journal of dental research* 1984, **63**(1):65-68.
3. Enwonwu CO: **Influence of socio-economic conditions on dental development in Nigerian children.** *Archives of oral biology* 1973, **18**(1):95-107.
4. Al-Othman AM, Saeed AA, Bani IA, Al-Murshed KS: **Mothers' practices during pregnancy, lactation and care of their children in Riyadh, Saudi Arabia.** *Saudi medical journal* 2002, **23**(8):909-914.
5. Pillas D, Hoggart CJ, Evans DM, O'Reilly PF, Sipilä K, Lähdesmäki R, Millwood IY, Kaakinen M, Netuveli G, Blane D: **Genome-wide association study reveals multiple loci associated with primary tooth development during infancy.** *PLoS Genet* 2010, **6**(2):e1000856.
6. Rantakallio P, Mäkinen H: **Number of teeth at the age of one year in relation to maternal smoking.** *Annals of human biology* 1984, **11**(1):45-52.
7. Garn SM, Nagy JM, Sandusky ST, Trowbridge F: **Economic impact on tooth emergence.** *American journal of physical anthropology* 1973, **39**(2):233-237.
8. Oziegbe EO, Adekoya-Sofowora CA, Esan TA, Owotade FJ, Folayan MO: **Breastfeeding pattern and eruption of primary teeth in Nigerian children.** *Pediatric Dental Journal* 2010, **20**(1):1-6.
9. Magnússon TE: **Emergence of primary teeth and onset of dental stages in Icelandic children.** *Community dentistry and oral epidemiology* 1982, **10**(2):91-97.
10. Holman DJ, Jones RE: **Longitudinal analysis of deciduous tooth emergence: II. Parametric survival analysis in Bangladeshi, Guatemalan, Japanese, and Javanese children.** *American journal of physical anthropology* 1998, **105**(2):209-230.
11. Holman DJ, Jones RE: **Longitudinal analysis of deciduous tooth emergence: III. Sexual dimorphism in Bangladeshi, Guatemalan, Japanese, and Javanese children.** *American journal of physical anthropology* 2003, **122**(3):269-278.
12. Townsend N, Hammel E: **Age estimation from the number of teeth erupted in young children: an aid to demographic surveys.** *Demography* 1990, **27**(1):165-174.
13. Al-Jasser NM, Bello LL: **Time of eruption of primary dentition in Saudi children.** *The journal of contemporary dental practice* 2003, **4**(3):65-75.
14. Psoter WJ, Reid BC, Katz RV: **Malnutrition and dental caries: a review of the literature.** *Caries research* 2005, **39**(6):441-447.
15. Ramos SRP, Gugisch RC, Fraiz FC: **The influence of gestational age and birth weight of the newborn on tooth eruption.** *Journal of Applied Oral Science* 2006, **14**(4):228-232.
16. Warren JJ, Fontana M, Blanchette DR, Dawson DV, Drake DR, Levy SM, Kolker JL, Phipps KR: **Timing of primary tooth emergence among US racial and ethnic groups.** *Journal of public health dentistry* 2016.

17. Tudehope D, Gibbons K, Cormack B, Bloomfield F: **Growth monitoring of low birthweight infants: what references to use?** *Journal of paediatrics and child health* 2012, **48**(9):759-767.
18. Liversidge H: **4 Variation in modern human dental development.** *Patterns of growth and development in the genus Homo* 2003, **37**:73.
19. Kitamura S: **A study on the time and order of eruption of human teeth II (in Tokyo, Japan).** *Shikwa gakuho* 1942, **47**:352-368.
20. Enwonwu CO: **Influence of socio-economic conditions on dental development in Nigerian children.** *Archives of oral biology* 1973, **18**(1):95-IN15.
21. McGregor IA, Thomson AM, Billewicz WZ: **The development of primary teeth in children from a group of Gambian villages, and critical examination of its use for estimating age.** *Br J Nutr* 1968, **22**(2):307-314.
22. Roche A, Barkla D, Maritz JS: **Deciduous eruption in Melbourne children.** *Australian Dental Journal* 1964, **9**(2):106-108.
23. Yun DJ: **Eruption of primary teeth in Korean rural children.** *American journal of physical anthropology* 1957, **15**(2):261-268.
24. Reddy VR: **Eruption of deciduous teeth among the children of Gulbarga, south India.** *Indian J Med Res* 1981, **73**:772-781.
25. Delgado H, Habicht JP, Yarbrough C, Lechtig A, Martorell R, Malina RM, Klein R: **Nutritional status and the timing of deciduous tooth eruption.** *The American journal of clinical nutrition* 1975, **28**(3):216-224.
26. Truswell A, Hansen D: **Eruption of deciduous teeth in protein-calorie malnutrition.** *J Trop Pediatr* 1973, **19**:214-216.
27. Robinow M, Richards T, Anderson M: **The eruption of deciduous teeth.** *Growth* 1942, **6**(2).
28. Ntani G, Day PF, Baird J, Godfrey KM, Robinson SM, Cooper C, Inskip HM: **Maternal and early life factors of tooth emergence patterns and number of teeth at 1 and 2 years of age.** *Journal of developmental origins of health and disease* 2015, **6**(04):299-307.
29. Palmer B: **The influence of breastfeeding on the development of the oral cavity: a commentary.** *Journal of Human Lactation* 1998, **14**(2):93-98.
30. Viggiano D, Fasano D, Monaco G, Strohmenger L: **Breast feeding, bottle feeding, and non-nutritive sucking; effects on occlusion in deciduous dentition.** *Archives of disease in childhood* 2004, **89**(12):1121-1123.

Table 1 – Demographic data and vital statistics of the study population

		N	%	Mean	Standard Deviation
Gender	Male	206	48.8%		
	Female	216	51.2%		
Type of delivery	Normal	291	69.0%		
	C section	131	31.0%		
	Assisted Vaginal	0	0.0%		
Type of Feeding	Breastfeeding only	90	21.3%		
	Breastfeeding +				
	Bottlefeeding	212	50.2%		
	Bottle feeding only	120	28.4%		
Birth weight (kg)				3.1	.4
Height (cm)				65.9	6.7
Height Percentile				27.80	23.84
Weight (kg)				7.6	1.8
Weight Percentile				40.01	30.36

Fig 1: percentage of children in the population with an erupted primary tooth

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Table 2 – Effect of Gender, Birthing, and Familial Factors on the eruption of primary teeth

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
Model		B	Std. Error	Beta		
1	(Constant)	.752	.796		.945	.345
	Gender	.677	.205	.160	3.308	.001*
	Age of mother at the time of delivery	-.006	.026	-.016	-.216	.829
	Type of delivery	-.037	.222	-.008	-.168	.867
	Number of siblings	.018	.083	.016	.216	.829
a. Dependent Variable: Total number of teeth present in the oral cavity						

*association significant at p<0.05

Table 3 – Effect of height, weight and birthweight on the eruption of teeth

Model		Unstandardized		Standardize	t	Sig.
		Coefficients		d		
		B	Std. Error	Beta		
1	(Constant)	.926	.732		1.265	.206
	Height	.000	.005	-.003	-.058	.954
	Percentile					
	Weight	.017	.004	.236	4.469	.000*
	Percentile					
	Birth weight	.005	.238	.001	.021	.983
	(kg)					
a. Dependent Variable: Total number of primary teeth						

*association significant at $p < 0.05$

Note: Height and weight are calculated as the percentile for age using the WHO criteria

Table 4 : Relationship between breastfeeding and eruption of primary teeth

Age in months	B	S.E.	df	p-value	Exp(B)
<7.0	-1.922	.926	1	.018 ^b	.146
8.0	-1.021	1.049	1	.032 ^b	.234
9.0	1.466	.989	1	.138	4.333
10.0	1.426	1.389	1	.188	3.567
11.0	1.266	1.089	1	.238	5.333
12.0	1.403	1.245	1	.260	4.067
Overall	1.888	.304	1	.000	6.608

- a. Variable(s) entered on step 1: Child exclusively breast fed or not
- b. Association significant at p<0.05
- c. Calculated using a binomial regression

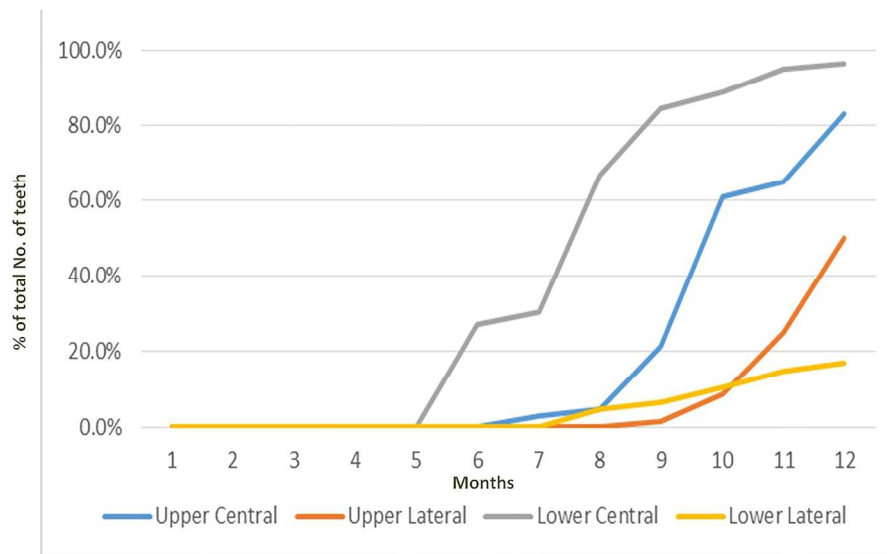


Fig 1 : Percentage of the population with erupted teeth

359x210mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6
		(b) Describe any methods used to examine subgroups and interactions	6
		(c) Explain how missing data were addressed	6
		(d) If applicable, describe analytical methods taking account of sampling strategy	6
		(e) Describe any sensitivity analyses	6
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	NA
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7,14
		(b) Indicate number of participants with missing data for each variable of interest	7,14
Outcome data	15*	Report numbers of outcome events or summary measures	7,15,16
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7,17
		(b) Report category boundaries when continuous variables were categorized	7,8
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	8,9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9
Generalisability	21	Discuss the generalisability (external validity) of the study results	9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The impact of birth characteristics, breast-feeding and vital statistics on the eruption of primary teeth among healthy infants in Saudi Arabia - an observational study

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The impact of birth characteristics, breast-feeding and vital statistics on the eruption of primary teeth among healthy infants in Saudi Arabia - an observational study

Original Article

Running Head : Factors affecting the eruption of primary teeth

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Abstract

Objectives: This study aimed to explore the impact of gender, birth weight, maternal age, type of delivery, gestational age and feeding practices on the eruption of teeth in children with no underlying medical conditions or developmental defects in their first year of life.

Design: A cross-sectional observational study design was used

Setting: A primary health care setting in Riyadh, Saudi Arabia

Participants: All children in their first year of life attending a vaccination clinic (n=422) were included in the study. Infants with chronic childhood illnesses, those who were below the 5th percentile in height or weight, infants with congenital birth defects, chronic illnesses, infants who were born pre-term, and low-birth weight infants were excluded from the study.

Outcome Measures: The type of delivery, birth weight, age of mother, height and weight percentile for age (as plotted on the WHO growth chart for infants) and feeding practices were recorded by the examiner and this was followed by a clinical examination to determine the presence or absence of each tooth. Regression models were developed to determine the effect of the different variables on the presence of primary teeth.

Results There was a significant association between the weight percentile of the child (adjusted for age) and the number of erupted primary teeth, suggesting that heavier children have an earlier eruption of teeth. No association was observed between birth-weight, height percentile for age, or maternal age at the time of birth and the number of erupted primary teeth. Children who were exclusively breastfed were significantly more likely to have an erupted first primary tooth earlier than non-breastfed group.

Conclusions: Breastfeeding and the weight of the child may have an influence on the eruption of primary teeth in the first year of life.

Key Words: Disturbances in dental development, First Erupted tooth, Primary teeth,

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Strengths and Limitations of this paper

- Used a cross-sectional design to study the impact of vital statistics, birth type and feeding characteristics on the eruption of primary teeth.
- Studied children without underlying medical conditions in order to avoid the confounding effects of underlying diseases and developmental disorders.
- Despite the lack of a cohort design, the study looked at a large sample of children.
- Although the study did not use a randomized sample, it provides an overview of the factors that influence the eruption of teeth in healthy children

Introduction

The ages at which the primary teeth erupt are of great significance in relation to growth and development of the child. It has been thought that eruption of deciduous teeth play an essential role in the proper alignment, spacing and occlusion of permanent teeth[1]. Several variables have been thought to influence the eruption of the primary teeth including ethnicity[2], socioeconomic status [3] and nutrition status([4].A recent genome-wide association study has shown that loci associated with height and craniofacial distances can impact the eruption of primary teeth in the first year of the child’s life[5].

In addition to genetic factors, environmental factors such as maternal smoking [6], height and weight of a newborn at the time of birth [7] and nutrition status have been shown to play a role in the eruption of the first primary tooth. A few reports have focused on the discerning effect of nutrition in early age of a child, including breast milk. It has been suggested that the act of breastfeeding encourages proper

growth of the mouth and jaw, as well as secretion of hormones for proper digestion[7]. This concept has been used to suggest that breastfeeding may advance the eruption of primary teeth [8] .

The relationship between ethnicity and the timing of eruption of the first primary tooth is a complicated one. While there is definite evidence to show that children from different geographic regions have different eruption patterns of the primary teeth [9-12]; it is not clear how much of this difference can be attributed to ethnicity. There is some evidence from Saudi Arabia to suggest that the eruption of primary teeth in Saudi children occurs a later stage when compared to Caucasian children [13], but there has been no attempt made to study the factors that affect the eruption of the eruption pattern in the first year of life . Furthermore, data from existing longitudinal studies are often plagued by the confounding effects of socio-economic factors, overall nutritional status and overall maternal health, which vary from country to country and can often vary between different groups within the same country [14-16].

Most studies on the eruption of primary teeth in the first year of life have focused on children with underlying medical conditions, or nutritional deficiencies. Little attention has been paid to the factors influencing the eruption of teeth in healthy infants. The aim of this study was to examine the possible confounding factors that affect the eruption of primary teeth in the first year of life in a population of medically healthy Saudi infants.

Methodology

Study design and setting

This study was conducted from October 2016 to March 2017 among infants (age < 12 months) of parents who attended the vaccination (well baby) clinic at the King Abdullah Specialist Children Hospital, National Guard Health Affairs, Riyadh, Saudi Arabia; a publically funded free hospital. The study design aimed to examine each child once.

Ethical considerations

Ethical approval for the conduct of this study was obtained from the Institutional Review Board of the Riyadh Colleges of Dentistry and Pharmacy (FPGRP/43535005/41). And approved by the Institutional Review Board (IRB) of King Abdullah International Medical Research Center (SP16/224/R). Informed consent was obtained in writing from the parents of the infants.

Sample size

A power analysis for multiple regressions was applied to determine the power of the achieved sample, using the G power sample size calculator (<http://www.gpower.hhu.de/>). The post hoc sample power was calculated for a regression model utilizing the seven eventual predictors namely; birth weight, weight for age (percentile), height for age (percentile), age of the mother at birth, gender of the child , type of delivery and type of feeding practice. It was observed that the final sample of 422 children when computed for an effect size of 0.05 (small effect size), and alpha of 0.05 yielded an actual power of 0.94.

Sample Characteristics

The sample was selected using non-random convenience sampling of the children attending the vaccination (well-baby) clinic of the hospital. This was a publically funded free clinic that was responsible for providing vaccinations for children without underlying medical conditions. The sample included all children aged below 12 months who were deemed to be medically fit. The sample excluded infants with congenital birth defects, chronic illnesses, infants who were born pre-term, and low-birth weight infants

(children with birth weight below 2500g). All children who met the inclusion criteria were included in the final analysis.

Data Collection

All children in the sample were seen only once except for the children who were examined for the purpose of calibration (n=20). Demographic data of the family including date of birth, gender, number of siblings, rank in the family and socioeconomic data were recorded in an Arabic by the parent. Data on the age of the parents at the time of birth, type of delivery (vaginal or caesarian section), twinning (yes/no; if yes, identical/not identical), type of delivery (normal/C section) and feeding practices (breast feeding/breast + bottle feeding/bottle feeding only) were recorded by one of the investigators (KA) after interviewing the parents. The birth weight of the child was obtained from the medical records of the child.

The height (in cm) and weight (in kg) of the child were obtained from the record made on the day of the examination. The height and weight were then transformed into a percentile value for age using the WHO standards for infant growth[17].

All intra-oral examinations were conducted by a single examiner (KA) who was calibrated using the WHO criteria for an erupted tooth. Natal and neonatal teeth were not included in the analysis of teeth present in order to avoid a skew in the age of tooth eruption. For the purpose of this study, an erupted tooth was defined as any tooth with any part of its crown penetrating the gingiva and visible in the oral cavity. The examiner was calibrated for intra-examiner variability by re-examining 20 children after a gap of two weeks and applying the kappa statistic. The recall examinations showed low intra-examiner variability (Kappa=0.925).

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The intra-oral examination was conducted in the vaccination clinic with the child placed in the mother’s lap and examined using the knee-to-knee position. The oral cavity was examined with a mouth-mirror and using a head-lamp without the use of radiographs. *Statistical analysis*

Data obtained was coded, entered in, and analyzed using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA). Descriptive and inferential statistical analysis was performed. Descriptive analysis was used to describe the data. Mean \pm Standard Deviation (SD) was used to describe parametric continuous variables and median (interquartile range for non-parametric continuous data). Categorical variables were described using frequency and percentage. The t test was used to compare mean age between males and females. Linear regression model developed to examine the total number of teeth present as the dependent variable. Binary logistic regression models were developed to examine the different factors affecting the presence or absence of teeth. A p-value < 0.05 was considered statistically significant for all tests.

Results

The study sample comprised 422 children aged between 1day until 12 months of age with a mean age of 7.2 months and standard deviation of 3.45. The sample comprised 206 males (48.8%) and 216 females (51.2%). There was no significant difference in the mean age of the male (7.2 months \pm 3.1 month) and female (7.2 months \pm 3.4 months) subjects ($t=0.131$, $p=0.904$).

When the other demographic factors were tabulated it was observed that the mean age of the fathers at the time of delivery was 35.2 years (\pm 7.8 years) and the mothers was 30.7 years (\pm 6.07). A total of 291 children in this sample were born by normal vaginal delivery while 131 were born by caesarian

section. The height and weight of the population was converted into the percentile for age using the WHO standards. The height and weight characteristics are summarized in Table 1.

When the feeding characteristics of the population were documented it was observed that only 90 children were exclusively breastfed. Most of the children (n=212) had received a combination of breast feeding and bottle feeding while 120 children had never been breastfed (Table 1).

A chart showing the percentage of children with an erupted tooth at each given age was developed. It was observed that by the end of the first year over 98.7% of the children had at least one erupted tooth. 98.1% of the sample had a lower central incisor, 82.1% had an upper central incisor, 49.2% had an upper lateral incisor and only 18.5% had a lower lateral incisor erupted in the oral cavity. Natal and neonatal teeth were not included in the tabulation of the figure(Fig 1).

The gender of the child, age of the mother at the time of birth of the child, the type of delivery, the number of siblings and the order of birth were placed in a linear regression model with the total number of teeth in the oral cavity as a dependent variable. There was a significant association ($p<0.001$) between the gender of the child and the total number of emerged teeth with females having significantly more erupted than their male counterparts. The model showed no significant association between the age of the mother at the time of the child's birth, the number of siblings, or the order of birth; and the number of primary teeth in the oral cavity of the infant (Table 2).

The height percentile, weight percentile and birth weight were placed in a linear regression model with the total number of teeth in the oral cavity as the dependent variable. It was observed that while the height percentile and birth weight had no significant relationship with the number of teeth in the oral cavity there was a significant positive relationship between the weight percentile and number of teeth

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3 in the oral cavity suggesting that heavier children were likely to have more erupted teeth in the first year
4 of life (Table 3).
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8 Children were categorized into those exclusively breastfed up to six months and those who were not
9 exclusively breast fed. This factor was compared to the presence or absence of a tooth in the oral cavity.
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11 It was observed that overall children who were exclusively breastfed were significantly more likely to
12 have an erupted primary tooth. When the model was further split according to months it was observed
13 that this observation was only significant up to the eighth month of life, following which there was no
14 significant impact of breastfeeding on the number of erupted teeth (Table 4).
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26 **Discussion**

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28 While there have been studies that have looked extensively on the timing of eruption of primary teeth
29 and individual factors that influence the eruption of these teeth, there have been few studies that have
30 focused on the relationship between the different factors [14-16]. There is little data on the subject
31 from the Middle East and this study aimed to address that gap. Many studies examining the eruption of
32 teeth have looked at the eruption time of the teeth in a single cohort over a period of time [9-11,16].
33 While this cohort model has the advantage of following a single child over a time period it is susceptible
34 to memory bias as it relies on the mother to recall when the particular tooth erupted. In this study we
35 chose a cross sectional study design that focused on the presence or absence of a particular tooth and a
36 single examination of the child.
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50 The pattern observed in our study was similar to the pattern of eruption observed by other researchers.
51 The lower central incisor was the first to erupt followed by the upper central incisors. While it is difficult
52 to differentiate between the upper and lower teeth in the sequence of eruption, our study confirmed
53 the previously observed sequence of central incisor followed by the lateral incisors [18]. The fact that
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3 this study only focused on the first year of life meant that we had inadequate data to comment on the
4 eruption timing and pattern of the canines and molars.
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8 Sexual dimorphism has been extensively studied previously with the traditional view stating that girls
9 generally showed an earlier eruption of teeth than boys [9, 19]. Our results support the conventional
10 view and are in contrast to other studies that have found no gender difference in the timing of eruption
11 of primary teeth [11, 20-23].
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17 Previous literature has shown a relationship of malnourishment to failure to thrive, and the delayed
18 eruption of teeth [24-27]. The fact that the number of erupted teeth in our study was significantly
19 associated with the weight of the child seems to suggest that even among children who are not
20 malnourished nutritional status may be an important factor affecting the emergence of the primary
21 teeth. Interestingly, we found no association between the birth weight of the child and the timing of
22 eruption of the first primary tooth. This in contrast to Nitani et al who found birth weight to be
23 associated with the emergence of the primary dentition, with heavier babies showing earlier eruption
24 patterns [28]. However, it must be remembered that the current study focused only on healthy children
25 and malnourished children were not included in the sample.
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39 It is usually accepted that teeth emerge into the oral cavity only after the sixth month of life. However
40 teeth may erupt earlier[5-8] due to a variety of factors. Natal teeth are teeth present at birth, while
41 neonatal teeth are teeth that emerge within the first four weeks of the child's life [1,9]. In this study,
42 natal and neonatal teeth were excluded from analysis to prevent the possibility of skewed data.
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49 There is a growing strong interest in the role of breastfeeding on the emergence of the first primary
50 tooth[8]. It has been hypothesized that early sucking activity influences the growth of the cranio-facial
51 complex [29]. It has been proposed that breast feeding is the ideal stimulus for the physiological
52 development of both the muscular and skeletal components of the oro-facial complex [30]. This study
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seems to support the hypothesis and suggest a positive relationship between breastfeeding and the emergence of the first permanent tooth. However, the absence of a relationship between the number of teeth present and the feeding status in older children suggests that more research is needed into the possible impact of breastfeeding on the emergence of subsequent teeth.

The findings regarding breastfeeding and tooth eruption have been reported in studies from the United States [29] and Italy [30]. The results of this study suggest that the role of breastfeeding would seem to be a general finding that goes beyond nationality or ethnicity. This study however is focused on medically fit children born at term. Its results cannot be compared to those of studies that have examined the role of malnutrition, pre-term delivery or the overall medical status of children on the eruption of the first primary tooth.

This study used a cross sectional design rather than a longitudinal design that followed children from birth[9, 10, 17]. One of the limitations of the cross sectional study design is memory recall bias; where the mother cannot accurately recall the age of eruption of the tooth. The cross sectional design cannot be used to accurately predict the age of eruption, however, it must be remembered that the aim of this study was to look at the associated factors and not the actual age of eruption. Furthermore, by only selecting healthy children this study aimed to remove confounding factors such as malnutrition or chronic illness.

Conclusions

Within the limitations of this study we can conclude that there seems to be a positive association between breastfeeding and the emergence of the first primary tooth. The weight (percentile for age) of the child is strongly associated with the emergence of primary teeth in the first year of life of healthy infants and heavier children are likely to have more erupted teeth for a given age than their lighter

counterparts. The results of this study indicate that factors such as the height (percentile for age) of the child, birth weight of the child, maternal age or order of birth do not seem to influence the emergence of primary teeth in healthy infants.

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Competing interest statement

We have read and understood BMJ policy on declaration of interests and declare that we have no competing interests

Author Contributions

SCP and KA conceptualized and designed the study. KA and MB were responsible for collection of Data and AA and SCP were responsible for analysis of the data. All the authors contributed equally to the preparation of the manuscript.

Data Sharing Statement

No additional data available

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References

1. Sajjadian N, Shajari H, Jahadi R, Barakat MG, Sajjadian A: **Relationship between birth weight and time of first deciduous tooth eruption in 143 consecutively born infants.** *Pediatrics & Neonatology* 2010, **51**(4):235-237.
2. Tanguay R, Demirjian A, Thibault H: **Sexual dimorphism in the emergence of the deciduous teeth.** *Journal of dental research* 1984, **63**(1):65-68.
3. Enwonwu CO: **Influence of socio-economic conditions on dental development in Nigerian children.** *Archives of oral biology* 1973, **18**(1):95-107.
4. Al-Othman AM, Saeed AA, Bani IA, Al-Murshed KS: **Mothers' practices during pregnancy, lactation and care of their children in Riyadh, Saudi Arabia.** *Saudi medical journal* 2002, **23**(8):909-914.
5. Pillas D, Hoggart CJ, Evans DM, O'Reilly PF, Sipilä K, Lähdesmäki R, Millwood IY, Kaakinen M, Netuveli G, Blane D: **Genome-wide association study reveals multiple loci associated with primary tooth development during infancy.** *PLoS Genet* 2010, **6**(2):e1000856.
6. Rantakallio P, Mäkinen H: **Number of teeth at the age of one year in relation to maternal smoking.** *Annals of human biology* 1984, **11**(1):45-52.
7. Garn SM, Nagy JM, Sandusky ST, Trowbridge F: **Economic impact on tooth emergence.** *American journal of physical anthropology* 1973, **39**(2):233-237.
8. Oziegbe EO, Adekoya-Sofowora CA, Esan TA, Owotade FJ, Folayan MO: **Breastfeeding pattern and eruption of primary teeth in Nigerian children.** *Pediatric Dental Journal* 2010, **20**(1):1-6.
9. Magnússon TE: **Emergence of primary teeth and onset of dental stages in Icelandic children.** *Community dentistry and oral epidemiology* 1982, **10**(2):91-97.
10. Holman DJ, Jones RE: **Longitudinal analysis of deciduous tooth emergence: II. Parametric survival analysis in Bangladeshi, Guatemalan, Japanese, and Javanese children.** *American journal of physical anthropology* 1998, **105**(2):209-230.
11. Holman DJ, Jones RE: **Longitudinal analysis of deciduous tooth emergence: III. Sexual dimorphism in Bangladeshi, Guatemalan, Japanese, and Javanese children.** *American journal of physical anthropology* 2003, **122**(3):269-278.
12. Townsend N, Hammel E: **Age estimation from the number of teeth erupted in young children: an aid to demographic surveys.** *Demography* 1990, **27**(1):165-174.
13. Al-Jasser NM, Bello LL: **Time of eruption of primary dentition in Saudi children.** *The journal of contemporary dental practice* 2003, **4**(3):65-75.
14. Psoter WJ, Reid BC, Katz RV: **Malnutrition and dental caries: a review of the literature.** *Caries research* 2005, **39**(6):441-447.
15. Ramos SRP, Gugisch RC, Fraiz FC: **The influence of gestational age and birth weight of the newborn on tooth eruption.** *Journal of Applied Oral Science* 2006, **14**(4):228-232.
16. Warren JJ, Fontana M, Blanchette DR, Dawson DV, Drake DR, Levy SM, Kolker JL, Phipps KR: **Timing of primary tooth emergence among US racial and ethnic groups.** *Journal of public health dentistry* 2016.

17. Tudehope D, Gibbons K, Cormack B, Bloomfield F: **Growth monitoring of low birthweight infants: what references to use?** *Journal of paediatrics and child health* 2012, **48**(9):759-767.

18. Liversidge H: **4 Variation in modern human dental development.** *Patterns of growth and development in the genus Homo* 2003, **37**:73.

19. Kitamura S: **A study on the time and order of eruption of human teeth II (in Tokyo, Japan).** *Shikwa gakuho* 1942, **47**:352-368.

20. Enwonwu CO: **Influence of socio-economic conditions on dental development in Nigerian children.** *Archives of oral biology* 1973, **18**(1):95-IN15.

21. McGregor IA, Thomson AM, Billewicz WZ: **The development of primary teeth in children from a group of Gambian villages, and critical examination of its use for estimating age.** *Br J Nutr* 1968, **22**(2):307-314.

22. Roche A, Barkla D, Maritz JS: **Deciduous eruption in Melbourne children.** *Australian Dental Journal* 1964, **9**(2):106-108.

23. Yun DJ: **Eruption of primary teeth in Korean rural children.** *American journal of physical anthropology* 1957, **15**(2):261-268.

24. Reddy VR: **Eruption of deciduous teeth among the children of Gulbarga, south India.** *Indian J Med Res* 1981, **73**:772-781.

25. Delgado H, Habicht JP, Yarbrough C, Lechtig A, Martorell R, Malina RM, Klein R: **Nutritional status and the timing of deciduous tooth eruption.** *The American journal of clinical nutrition* 1975, **28**(3):216-224.

26. Truswell A, Hansen D: **Eruption of deciduous teeth in protein-calorie malnutrition.** *J Trop Pediatr* 1973, **19**:214-216.

27. Robinow M, Richards T, Anderson M: **The eruption of deciduous teeth.** *Growth* 1942, **6**(2).

28. Ntani G, Day PF, Baird J, Godfrey KM, Robinson SM, Cooper C, Inskip HM: **Maternal and early life factors of tooth emergence patterns and number of teeth at 1 and 2 years of age.** *Journal of developmental origins of health and disease* 2015, **6**(04):299-307.

29. Palmer B: **The influence of breastfeeding on the development of the oral cavity: a commentary.** *Journal of Human Lactation* 1998, **14**(2):93-98.

30. Viggiano D, Fasano D, Monaco G, Strohmenger L: **Breast feeding, bottle feeding, and non-nutritive sucking; effects on occlusion in deciduous dentition.** *Archives of disease in childhood* 2004, **89**(12):1121-1123.

Figure 1: Percentage of the population with erupted teeth

Table 1 – Demographic data and vital statistics of the study population

		N	%	Mean	Standard Deviation
Gender	Male	206	48.8%		
	Female	216	51.2%		
Type of delivery	Normal	291	69.0%		
	C section	131	31.0%		
	Assisted Vaginal	0	0.0%		
Type of Feeding	Breastfeeding only	90	21.3%		
	Breastfeeding +	212	50.2%		
	Bottlefeeding				
	Bottle feeding only	120	28.4%		
Birth weight (kg)				3.1	.4
Height (cm)				65.9	6.7
Mean WHO height percentile for Age				27.80	23.84
Weight (kg)				7.6	1.8
Mean WHO weight percentile for Age				40.01	30.36

Table 2 – Effect of Gender, Birthing, and Familial Factors on the eruption of primary teeth

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
Model		B	Std. Error	Beta		
1	(Constant)	.752	.796		.945	.345
	Gender	.677	.205	.160	3.308	.001*
	Age of mother at the time of delivery	-.006	.026	-.016	-.216	.829
	Type of delivery	-.037	.222	-.008	-.168	.867
	Number of siblings	.018	.083	.016	.216	.829
a. Dependent Variable: Total number of teeth present in the oral cavity						

*association significant at p<0.05, regression indicates significantly earlier eruption in females

Table 3 – Effect of height, weight and birthweight on the eruption of teeth

Model		Unstandardized		Standardize	t	Sig.
		Coefficients		d		
		B	Std. Error	Beta		
1	(Constant)	.926	.732		1.265	.206
	Height	.000	.005	-.003	-.058	.954
	Percentile					
	Weight	.017	.004	.236	4.469	.000*
	Percentile					
	Birth weight	.005	.238	.001	.021	.983
	(kg)					

a. Dependent Variable: Total number of primary teeth

a) Height and weight are calculated as the percentile for age using the WHO criteria

b) Positive beta indicates positive association with the variable

* Suggests significant positive ($p < 0.05$) indicating that heavier children of the same age will have more erupted teeth than their lighter counterparts

Table 4 : Relationship between breastfeeding and eruption of primary teeth

Age in months	B	S.E.	df	p-value	Exp(B)
<7.0	-1.922	.926	1	.018 ^b	.146
8.0	-1.021	1.049	1	.032 ^b	.234
9.0	1.466	.989	1	.138	4.333
10.0	1.426	1.389	1	.188	3.567
11.0	1.266	1.089	1	.238	5.333
12.0	1.403	1.245	1	.260	4.067
Overall	1.888	.304	1	.000	6.608

- a. Variable(s) entered on step 1: Child exclusively breast fed or not
- b. Association significant at p<0.05
- c. Calculated using a binomial regression

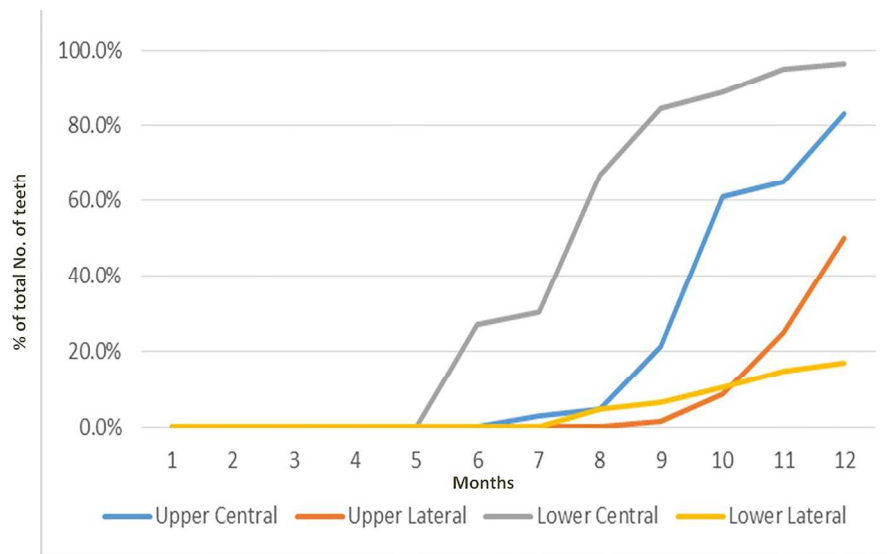


Fig 1 : Percentage of the population with erupted teeth

359x210mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6
		(b) Describe any methods used to examine subgroups and interactions	6
		(c) Explain how missing data were addressed	6
		(d) If applicable, describe analytical methods taking account of sampling strategy	6
		(e) Describe any sensitivity analyses	6
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	NA
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7,14
		(b) Indicate number of participants with missing data for each variable of interest	7,14
Outcome data	15*	Report numbers of outcome events or summary measures	7,15,16
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7,17
		(b) Report category boundaries when continuous variables were categorized	7,8
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	8,9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9
Generalisability	21	Discuss the generalisability (external validity) of the study results	9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.