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Research Article

Severe Early Childhood Caries (S-ECC) and General Health Status (GHS) in One to Two Year-Old Children Related to Bottle-Feeding, in Urban Indian Population- A Cross-Sectional Study

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Received: February 20, 2021; **Published:** May 28, 2021

Abstract

Background: Dental caries in children is a public health concern affecting more than 50% of children by 5 years of age in India with a high level of untreated disease. Improper feeding practice is a common risk factor for not only S-ECC but also poor general health; furthermore, S-ECC can be considered an earliest marker of many non-communicable diseases of adulthood. Few studies in Indian literature have assessed association of bottle-feeding with oral and general health, in the age-group of one-two years.

Aim: To assess S-ECC and General Health Status (GHS) in 1 - 2 year-old children in relation to feeding practices.

Objectives: To assess the prevalence of S-ECC and to evaluate the GHS w.r.t respiratory infections, gastrointestinal infections, constipation, developmental and nutritional parameters of children fed with or without bottle in the age group 1 - 2 years.

Methodology: 824 one to two year old children in General hospitals, well baby clinics and other private paediatric set ups were selected. The study tool recorded information such as the child's age, gender, feeding practice, mother's age, education, socioeconomic status, dmft, anaemia, respiratory infections, GI infections, constipation, developmental milestones and BMI (height and weight) of the child, etc.

Results: Out of the total population, 9.64% exhibited S-ECC. The odds of having S-ECC (OR = 0.15; $p < 0.0001$), gastrointestinal infections (OR = 0.59; $p = 0.0128$) were lesser in Non Bottlefed children as compared to bottle-fed and statistically significant. Bedtime bottle feeding amplified the risk of S-ECC in a regression analysis (OR = 2.38; $p = 0.0329$). Bottle-fed children had a higher risk of having multiple conditions (dental and GHS) together such as, caries with anaemia, caries with GI infections, caries with respiratory infections and caries with delayed milestones; the odds being statistically significant. Also, Children having caries had higher risk of developing anaemia, GI infections and constipation; the odds being statistically significant. Exclusive breast feeding had protective benefits against all conditions.

Conclusion: Bottle-fed children exhibited higher S-ECC and poor GHS w.r.t. gastrointestinal infections. Bottle-fed children also exhibited higher multiple conditions like GI infections, Respiratory infections and delayed milestones in combination with S-ECC.

Keywords: *Severe Early Childhood Caries (S-ECC); General Health Status (GHS); Bottle-Feeding*

Background

Despite the decline in the prevalence of dental caries in children in the western countries, caries in pre-school children remains a problem in both high income and low income countries. Early Childhood Caries (ECC) is now considered to be an epidemic specifically in the developing countries [1]. Dental caries in children is a public health concern affecting 60 - 90% of school children in industrialized countries being the most common disease in children, reportedly 5 times more common than asthma [2]. National Oral Health Survey, India, 2004 reported the prevalence of dental caries in India to be as high as 51.9% in 5 year old, 53.85% in 12 year old and 63.1% in 15 year old children. About 52.1% of Indian urban population at 5 years of age is affected by caries [3]. If left untreated, caries can lead to significant acute and chronic conditions, bacteraemia, early loss of teeth, malocclusion in the permanent dentition, high cost of treatment and low self-esteem. Thus, Severe Early Childhood Caries (S-ECC) may diminish the quality of life and be also related to poor general health [4].

In an editorial, Paul Casamassimo has termed S-ECC as a "Socially Transmitted Disease (STD)" occurring due to lifestyle change [5]. It is becoming a widespread, socio-behavioural dental condition seen among children throughout the world [6]. Thus, early childhood acts as a critical period for shaping and influencing the feeding and lifestyle behaviours that have implications for growth and development in infancy and future oral as well as general health [7]. Although the literature on the aetiology of dental caries is extensive, little is known about the aetiological pathways of dental caries in early childhood. This is highlighted by the fact that for the last 40 years, researchers have used different diagnostic criteria for dental caries in preschool children and refers to it by different names such as "Baby Bottle Tooth Decay", "Nursing Bottle Syndrome", "Nursing Bottle Caries", "Baby Bottle Caries" and "Maternally Derived *Streptococcus Mutans* Disease". In spite of having multi-factorial aetiology the focus still remains on the feeding practices that govern the oral environment and Dental biofilm [8]. Prolonged and night-time bottle-feeding practices in infants and toddlers generally are thought to provide the carbohydrate source that promotes high acid production by mutans streptococci and others leading to ECC [9].

Breast feeding is an optimal way to feed babies and has many benefits to mother and child. However, despite the worldwide increase in governmental, institutional and professional support for breast feeding, vast majority of babies receive at least some formula/cow's ("bottle") milk in the first year of life [10]. The World Health Organization (WHO) recommends exclusive breast feeding until six months of age and continued breast feeding for at least two years [11]. Infant-feeding practices are a key component of child caring practices and have been principally influenced by environmental, socio-cultural, economic and demographic factors [12]. Parents play an important role in defining the early childhood environment influencing a child's choices, preferences and quantities of food consumed [13].

Human Breast Milk (HBM) is exclusively designed for digestion and assimilation and even modern science and technology have not been able to provide a better substitute for HBM [14]. Addition of even a single feed of formula/cow's ("bottle") milk has two disadvantages; firstly it depresses the lactation capacity of the mother as the child will suck less and secondly addition of any other food or even water increases chances of specific infections [14].

A systematic review on formula-feed preparation published in 2003 identified five studies that reported a high frequency of errors in its composition [15]. In addition to the short-term health issues of hygiene and safety, it is likely that the inaccuracies in the measurement and over-concentration of bottle-feeds may contribute to overfeeding, rapid infancy weight gain and later, obesity. It has also been proposed that bottle-feeding gives the parents more control and the infant less self-regulation, thereby potentially superseding infant satiation clues [16]. This indicates the need to discourage bottle-feeding practices in infants as it may be associated with unnecessary excessive intake of energy, carbohydrates and proteins; low fat content and macronutrient imbalance [17]. Moreover, shorter duration of breast feeding and early bottle-feeding with cow's milk may play a role in the development of constipation and anal fissures in infants and young children [18]. Also, severe Iron Deficiency Anaemia (IDA) is associated with cow's milk consumption greater than 500 ml/day in the day or at the bed time [19]. Research has demonstrated that prolonged bottle-feeding can affect the sleep cycle, cause the formation of ECC due to increased colonization of cariogenic bacteria, affect oro-facial development, and cause respiratory diseases such as otitis

media and wheezing [20]. There is an increasing body of literature emphasizing the correlation between respiratory conditions including nocturnal cough, otitis media, sinusitis, chronic cough, etc. along with certain Gastrointestinal (GI) symptoms like regurgitation and vomiting, etc. as a result of prolonged bottle-feeding practices in infants [21]. Apart from GI and respiratory symptoms, there are studies establishing a positive correlation between cow's milk consumption before 12 months of age and delayed developmental milestones in infants after the first year of age [22].

Thus, bottle-feeding pre disposes children to many acute and chronic, dental and general conditions over a life course, compromising the quality of life [23]. Few studies have comprehensively assessed the effects of bottle-feeding on dental and general health, in the age-group of 1 - 2 years. The current investigation has addressed issues that are less explored and need-based.

Aim of the Study

To assess Severe Early Childhood Caries (S-ECC) and General Health Status (GHS) in one to two year-old children related to bottle-feeding, in urban Indian population

Objectives of the Study:

1. To assess the prevalence of S-ECC (S-ECC, measured as dmft) in one to two year old children
2. To evaluate the GHS with respect to respiratory, GI, developmental and nutritional parameters of children fed with or without bottle.

Methodology

The study was observational (cross-sectional). A sample frame of an urban area, adjacent to a metro city is chosen; from which, a representative sample of one to two year-old children were recruited from sample units, such as; general hospitals, well baby clinics and other private paediatric set-ups. Ethical clearance was obtained from the Institutional Review Board. Required permissions were taken from the concerned authorities and a written consent was obtained from the parent/s of children prior to beginning the study.

Study population: Children belonging to age not less than 12 months and not over 24 months at the time of recruitment were considered as the study population. Following eligibility criteria was taken into consideration.

Inclusion criteria:

1. Mothers who bottle-feed and/or breast-feed their children.
2. Mothers willing to receive information on feeding practices.
3. Mothers giving their consent for themselves and their children for their availability and follow up during the study period.

Exclusion criteria: Children with any known systemic disorders, physical or mental illness; thus impacting the parameters of the study (dental conditions and dietary practices).

Sample size: The sample size for the prevalence study was estimated using the formula based on Confidence Interval:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Where:

n = Sample size

Z = Confidence level at 95% (standard value of 1.96)

P = Expected prevalence of S-ECC (20%, P = 0.2)

d = Precision (5%, d = 0.05).

P (Estimated % of S-ECC and other health conditions)	N (Base sample size)	N x a (n x number of age groups)	N (Final sample size = base sample size + 10%* approximately)
0.2 (20%)	246	246x3=738	824

Table 1: *Sample size.*

**: 10% over-recruitment for possible recording errors or missing data.*

Study tool

The study tool had two parts; a self-administered questionnaire to be filled by parents and examination details to be filled by the investigator. Piloting of the study tool was done for validation and calibration. Then, the study tool was given to parents, the same was duly explained and the filled forms were collected on the same day.

824 infants were examined from 3 different set-ups (2 government general hospitals and 1 private Paediatric set up) across the urban area. The duration of the study was December 2016 to April 2017; approximately 5 months. A thorough dental examination was done by the principal investigator along with three assistant. The initial examination of children was carried out in the waiting area of the general hospital and Paediatric private set-ups where a good source of natural light was available. Whenever required the parent restrained the child and retracted the child's lips and cheeks. A single mouth mirror was used for the examination of the oral cavity. Cotton swabs were used to dry the mucosa/teeth. The principal investigator examined the children with a 'no touch' method; only when necessary, barrier protection and hand sanitization were used.

The study tool given to parents included basic information and information regarding mother's age, education status, SES (As per Kuppuswamy's modification [24]), parameters related to assessment of S-ECC, anaemia, respiratory infections, GI infections, constipation, developmental milestones and BMI (height and weight) of the child was recorded.

Study variables: Following were the variables associating feeding practices with dental caries and health status.

Independent variables: Feeding Parameters (bottle/non-bottle-feeding)	Dependent variables: Health Status Parameters	
Presence of sugar in bottle Bedtime bottle-feeding Other	S-ECC	dmft index Caries threshold was ICDAS code > 2 i.e. cavitated lesions
	Anaemia	Present/absent
	Respiratory	Present/absent
	GI	Present/absent
	Constipation	Present/absent
	Developmental	Milestones normal/delayed
	Nutritional	BMI (normal/overweight/underweight)

Table 2: *Variables of interest.*

Statistical analysis

Data obtained from the study were compiled on a Microsoft Excel sheet (version 2002). Data was subjected to statistical analyses using MedCalc statistical software for biomedical research (version 2014).

Descriptive statistics like mean, standard deviation, minimum and maximum values were calculated, frequencies and percentages were calculated. Odds ratio and Confidence Intervals were obtained for various parameters (feeding practices, S-ECC, anaemia, respiratory infections, GI infections, constipation, developmental status and nutritional status) to report the associations.

Multiple logistic regressions were used to report the additional effect of bedtime bottle feeding, sugar-use in bottles and frequency of bottle feeding on the caries status of infants.

Results

Table 3 reports characteristics of the study population. The mean and SD of age of the children and mothers age were 16.92 (± 5.57) months and 25 (± 3) years respectively. It was observed that, 56.38% were boys and 43.61% were girls. 55.55% of mothers had education completed ≤ 7th standard and 40.71% mothers were educated more than 7th standard. 80.89% belonged to Class I and 16.73% belonged to Class II. Presence and absence of grandparents was reported to be 28.85% and 71.19% respectively. The order of birth of 38.99% children was 1st and 61.00% were not 1st. Also, 95.12% were full term babies and 3.95% were pre term babies.

Parameter		Mean (± SD)/Count (%) (N = 824)	Mean (±SD)/Count (%) (N1 = 759)
Age of the child		17.07 (± 5.50)	16.92 (± 5.57)
Mother's age		25 (± 3)	25 (± 3)
Gender	Boys	461 (55.94%)	428 (56.38%)
	Girls	361 (44.05%)	329 (43.61%)
Mother's education	≤ 7th standard	460 (55.82%)	420 (55.55%)
	> 7th standard	364 (44.18%)	309 (40.71%)
Socio-Economic Status (SES)	Class I	663 (80.46%)	614 (80.89%)
	Class II	139 (19.53%)	127 (16.73%)
Grandparent/s' presence	No	586 (71.11%)	540 (71.19%)
	Yes	238 (28.89%)	219 (28.85%)
Order	1st	324 (39.32%)	296 (38.99%)
	Not 1st	500 (60.68%)	463 (61.00%)
Term of delivery	Full term	782 (94.90%)	722 (95.12%)
	Pre term	32 (5.1%)	30 (3.95%)

Table 3: *Characteristics of the study population.*

Out of the total population, 9.64% exhibited S-ECC. The odds in "non-bottle-fed" children as compared to "bottle-fed" were: for S-ECC (OR = 0.15; p < 0.0001), gastrointestinal infections (OR = 0.59; p = 0.0128), constipation (OR = 2.08; p = 0.0004), low BMI (OR = 0.1; p = 0.0002) as well high BMI (OR = 0.23; p < 0.0001); all statistically significant. Association of bottle-feeding practice with anaemia, respiratory infections and milestone delays was not statistically significant. The prevalence of Dental caries and General Health status in the study population is depicted in figure 1.

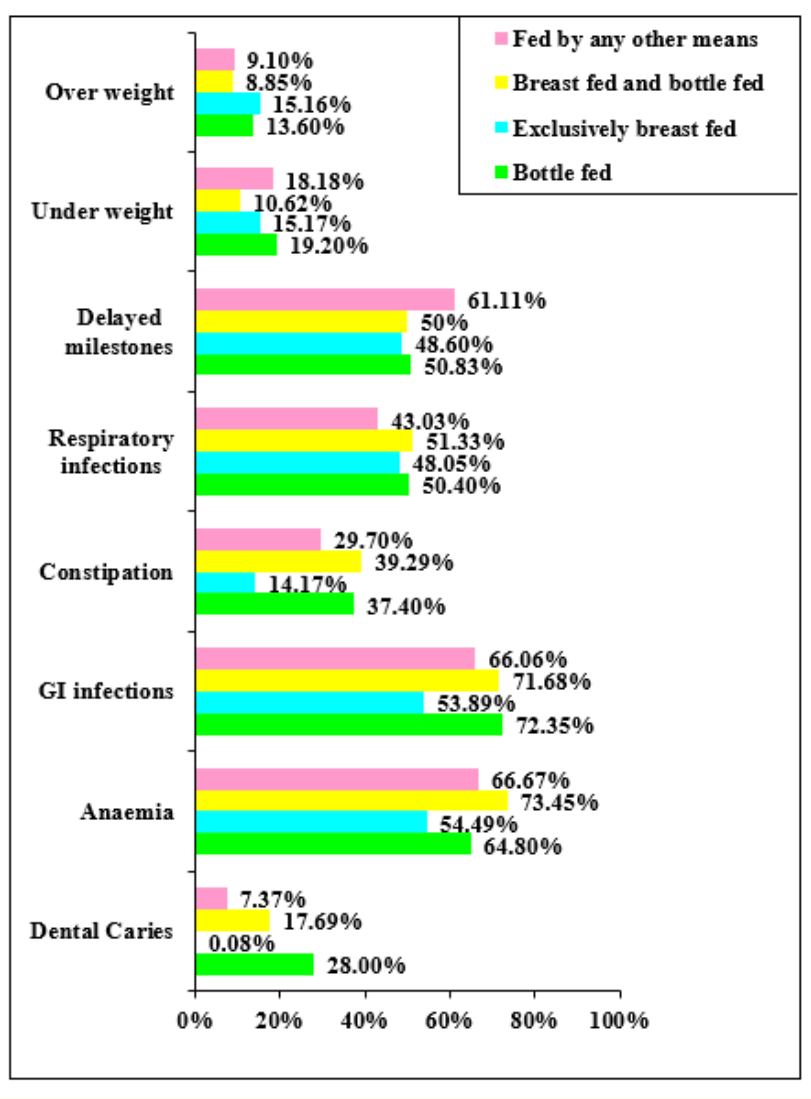

Figure 1: *Prevalence of dental caries and general health status in the study population.*

Table 4 reports the association between feeding habits and all GHS. The odds of having caries in non anaemic children were 0.58 (p = 0.0432) times compared to children who were anaemic and was statistically significant. The odds of having caries in children without Respiratory conditions were 0.84 (p = 0.4806) times compared to children with respiratory conditions and was statistically non significant. The odds of having caries in children without GI infections were 0.39 (p = 0.0016) times compared to children with GI infections and was statistically significant. The odds of having caries in children without constipation were 3.20 (p < 0.0001) times compared to children with constipation and was statistically significant (Table 5).

Parameter	OR	CI	p value	NNT	CI
Anaemia	0.5813	0.3435 to 0.9836	p = 0.0432*	24.040 (benefit)	12.279 to 569.942
Respiratory conditions	0.8419	0.5219 to 1.3581	p = 0.4806	70.386 (benefit)	39.648 to to 18.644
GI infections	0.3892	0.2167 to 0.6992	p = 0.0016*	14.681 (benefit)	9.185 to 36.553
Constipation	3.2012	1.9593 to 5.2303	P < 0.0001*	8.820 (harm)	14.677 to 6.304
Delayed milestones	1.1480	0.7084 to 1.8603	p = 0.5752	85.984 (harm)	19.131 to 34.47
BMI low	1.0909	0.5585 to 2.1310	p = 0.7990	144.100 (harm)	16.577 to 21.531
BMI high	1.4387	0.6419 to 3.2242	p = 0.3770	37.710 (harm)	11.76 to 31.253

Table 4: *Association between caries and multiple conditions (all GHS).*

	Non Bottle-fed Vs bottle-fed			Non-Exclusive breast fed Vs Exclusive breast-fed			Not breast-fed and bottle-fed Vs breast-fed and bottle-fed			Bottle &/or Breast-fed Vs Other feeding		
	OR (CI)	p value	NNT (CI)	OR (CI)	p value	NNT (CI)	OR (CI)	p value	NNT (CI)	OR (CI)	p value	NNT (CI)
Caries	0.15 (0.09-0.25)	0.0001*	4.46 (3.61-5.81) Benefit	9.91 (4.25-23.13)	0.0001*	7.78 (11.11-5.99) Harm	0.38 (0.21-0.67)	0.0007*	9.89 (6.35-22.36) Benefit	1.32 (0.70-2.52)	0.3922	
Anaemia	0.81 (0.55-1.20)	0.2927		1.57 (1.18-2.08)	0.0019*	9.37 (25.13 to 5.76) Benefit	0.51 (0.33 to 0.80)	0.0029*	.70 (4.07 to 18.89) Harm	0.72 (0.50 to 1.03)	0.0733	
Respiratory conditions	0.77 (0.52-1.12)	0.1689		0.96 (0.73-1.27)	0.7643		0.74 (0.50 to 1.09)	0.1313		1.09 (0.77 to 1.54)	0.6180	
GI infections	0.58 (0.38-0.89)	0.0128*	8.39 (4.72 to 37.71)	1.86 (1.40-2.49)	0.0001	6.82 (2.53 to 4.69)	0.61 (0.40 to 0.94)	0.0268	9.12 (4.86 to 73.83)	0.81 (0.56 to 1.16)	0.2585	
Constipation	2.07 (1.38-3.11)	0.0004	6.65 (14.66 to 4.3)	0.34 (0.24-0.49)	0.0001	5.44 (4.12 to 7.99)	2.25 (1.48 to 3.43)	0.0001	5.89 (11.82 to 3.92)	1.38 (0.95 to 2.03)	0.0932	
Delayed milestones	0.87 (0.59-1.28)	0.4939		0.70 (0.53-0.93)	0.0157	11.52 (6.37 to 59.89)	0.84 (0.56 to 1.26)	0.4020		1.46 (1.03 to 2.08)	0.0336	10.68 (128.2 to 5.57)
Low BMI	0.76 (00.46-1.24)	0.2742		.10 (0.75-1.61)	0.6175		1.27 (0.71 to 2.27)	0.4125		0.81 (0.52 to 1.27)	0.3703	
High BMI	0.91 (0.52-1.60)	0.7550		0.68 (0.45-1.03)	0.0697		1.59 (0.80 to 3.15)	0.1849		1.58 (0.89 to 2.81)	0.1184	

Table 5: *Association between feeding types and multiple conditions (Caries and GHS).*

**: Significant.*

Bedtime bottle-feeding amplified the risk of S-ECC which was evident in the regression analysis (Table 6). Logistic regression analysis associating independent variables with caries reported that log likelihoods for the Null model and the Full model were 209.72 and 168.5 and were statistically significant ($p < 0.0001$) however, with small effect sizes as per the Cox and Snell R^2 0.12 and Nagelkerke R^2 0.25.

Variables	Log likelihoods			Effect Size	
	Null Model	Full Model	'p' Value	Snell R^2	Nagelkerke R^2
Independent variables with caries	209.12	168.50	P < 0.0001*	0.12	0.25
Bottle-fed with caries	65.08	0.0000000496	P < 0.0001*	0.69	1.00
Bottle-fed with sugar and Bedtime with caries	141.71	136.91	P = 0.0908	0.04	0.06

Table 6: *Logistic regression analysis.*

**: Significant.*

Hosmer and Lemeshow test (Table 7) reported that the fit of the model was good and the caries prediction was statistically significant ($p = 0.0329$).

Variables	Hosmer and Lemeshow test		AUROC probability	
	Fit of the model	'p' Value	AUROC	SE & CI
Independent variables with caries	Good	p = 0.0329*	0.81	0.04 (0.77 to 0.85)
Bottle-fed with sugar and Bedtime with caries	Good	p = 1.0000	0.62	0.06 (0.52 to 0.70)

Table 7: *Hosmer and Lemeshow test and The AUROC probability.*

**: Significant.*

The AUROC probability (Table 7) indicated that the model discriminated well [(AUROC) 0.81 Standard Error 0.04 (95% CI 0.77 to 0.85)].

The Wald statistic (Table 8) used to test the significance of individual coefficients in the model reported that exclusive bottle feeding and bedtime bottle-feeding were associated with caries. [Exclusive bottle feeding: Coefficient 1.13 Std. Error 0.43 Wald 6.91 (p = 0.0086) Odds ratio: 3.09 (95% CI 1.33 to 7.18); bedtime bottle-feeding: Coefficient 0.41 Std. Error P 0.87 Wald 4.38 p = 0.0363 Odds ratio: 2.38 (95% CI 1.06 to 5.39)].

	Coefficient	SE	Wald	p value	OR and CI
Bottle feeding with sugar	0.40	0.42	0.93	0.3337	1.50 (0.66 to 3.40)
Bedtime bottle feeding	0.85	0.42	4.10	0.0430*	2.33 (1.03 to 5.30)

Table 8: *Wald statistics for bottle feeding with sugar and bedtime bottle feeding.*

**: Significant.*

Discussion

Taking into consideration the scarcity of literature in Indian urban context on the ill-effects of bottle feeding on oral and general health, a need-based investigation was started in the department of Paediatric and Preventive Dentistry. The investigation assessed effects of bottle feeding on dental health (in terms of caries) and on GHS (in terms of anaemia, respiratory infections, GI infections, constipation, delayed milestones, high BMI and low BMI). Bottle feeding behaviour and its health can be studied through a psycho-socio-behavioural perspective, based on the Dahlgreen- Whitehead model [25].

Oral health, similar to general health, depends on the conditions in which people live and the choices they make [26]. Oral diseases and other chronic diseases have "common risk factors" [27]. It must be kept in mind that oral health is an integral aspect of systemic health and its isolation from the larger goal of achieving health can seldom meet success. Often oral health does not remain a priority of many health authorities, particularly of poor economies, as other health concerns need preferred attention [28]. Furthermore, health messages in isolation may involve unnecessary duplication of efforts and may even create conflicts [29]. The common risk factor approach identifies diet, addictions, physical activity and hygiene as the determinants of health; working on most of them is essential for oral health, too. Nevertheless, often the risk behaviours are clustered within the deprived communities and this could mean an opportunity to address various concerns together. This approach makes possible promotion of health with respect to those conditions that are perceived as higher threats (e.g. obesity, diabetes mellitus, coronary heart diseases) while also covering the promotional aspects related to those oral conditions usually regarded as lesser threats (such as dental caries) by people [27].

Bottle-feeding predisposes to a variety of health implications and can be regarded as a common risk factor. Research has demonstrated that prolonged bottle-feeding can affect the sleep cycle and led to ECC due to altered oral flora, affect oro-facial development and cause respiratory diseases such as otitis media, sinusitis, chronic cough and wheezing along with certain GI symptoms like regurgitation and vomiting, etc [20,21]. There exists a positive correlation between cow's milk consumption before 12 months of age and delayed developmental milestones in infants after the first year of age [22].

Thus, bottle-feeding predisposes children to many acute and chronic, dental and general conditions over a life course, compromising the quality of life [23]. There exists a need to discourage bottle-feeding practices in view of unnecessary excessive values of energy from carbohydrates and proteins while low fat content and macronutrient imbalance [17]. Moreover, shorter duration of breast feeding and early bottle-feeding with cow's milk may play a role in the development of constipation and anal fissures in infants and young children [18]. Also, severe IDA is associated with cow's milk consumption greater than 500ml/day in the day or at the bed time [19].

The prevalence of ECC and S-ECC in 1 - 2 year old children has been rarely reported globally and in India as well. The WHO index age for children being a minimum of 5 years and limited or difficult access to these populations are the reasons for the paucity of research in the 1 - 2 year old age group [30]. An investigation was thus justified to assess the prevalence of S-ECC, GHS and its association and also impact of various modifying factors like SES, presence of sugar in the bottle, bedtime bottle feeding, mother education status, presence of grandparents, etc.

Our study found out the caries prevalence in 1 - 2 year old age group to be 9.64% overall. 'Bottle fed' children were shown to have higher caries prevalence as compared to other children who were 'exclusively breast fed', 'breast fed and bottle fed' and 'fed by any other means' like glass or cup. It has been emphasized time and again that prevalence of caries is varied owing to differences in SES, dietary patterns, availability of preventive efforts [31]. Considering the age group of the population we studied and the fact that number of teeth present at this age is relatively less, the percentage of children affected by caries that we obtained is clinically significant. As the past caries experience is the predictor of future caries risk it is important to intervene at the earliest as bottle feeding is a common risk factor for development of not only caries but also other communicable and non-communicable diseases. Dental caries was measured in terms of dmft, the most commonly used measure for recording caries [32]. The threshold used was 'distinct visual change in enamel even when the surface was wet' based on ICDAS, the rating 2. Very few studies have assessed prevalence of dental caries in the age group that we considered. Our results were comparable to the results of a Brazilian study by Tiano., *et al*. (2009) on children up to 36 months of age attending day-care centers in the south-eastern region of Brazil; the cavitated carious lesion reported in this age group was 17.6% and ECC was 33.8% [33]. Likewise, study by Martinesa (2015), showed a trend for increasing prevalence and severity of ECC experience with increasing duration of bottle feeding to thirty-six months of age compared with not bottle feeding at all ($p = 0.006$ and $p < 0.001$ respectively) [34]. The caries prevalence in our study must have been mainly influenced by the protective effect offered by breast feeding as majority of the population (46.90%) was exclusively breast fed. These have a more therapeutic benefit in the view of preserving oral as well as overall

health. In our study bottle-fed children particularly at bedtime exhibited higher risk of caries as compared to those who were exclusively breast-fed, 'breast-fed and bottle-fed' and, feeding with any other practices. This was comparable to the results of the study reported by Detsomboonrat and Pisarnturakit (2015) where night time bottle feeding, frequency of drinking sweetened milk and falling asleep with a bottle in the mouth were important caries risk factors and the number of erupted teeth was a strong caries risk predictor. The study recommended that dentists should educate caregivers about these risk factors [35].

Children suffer from variety of communicable and non communicable diseases especially in the developing country like India where the living conditions and standards are subnormal [3]. Anaemia in children under two years of age is a common health problem due to the fact that their growth requires a high intake of iron which is usually not provided by their diet [36]. In our study, the presence of anaemia was determined not by the blood sample testing of the child, but using clinical measures (such as appetite, energy levels, pica, skin and nail changes) were recorded for the same. The odds of having anaemia in non-exclusive breast feeding were 1.57 times compared to children who were exclusively breast fed. Our results are in agreement with other studies in India. The studies demonstrated that the children most affected by anaemia are in the age-group of 6 to 23 months. Beyond this age a decreasing trend is observed up to the age of 48 to 59 months [37,38]. The results were in accordance with the study by Milankov., *et al*. (2014) wherein, it was observed that children breastfed for the longest period developed mild form of anaemia, while the children who were breastfed for the shortest period had severe anaemia. In addition, the highest percentage of anaemic children was additionally fed with cow's milk in both studies [39]. Another study in USA by Culhane (2001) reports that the bottle feeding practices contributed to the high rate of iron-deficiency anaemia [40]. Anaemia is usually caused by several associated factors, rather than individual ones. As reported by Chellan and Paul (2007) anaemia is attributed to dietary inadequacy due to poor purchasing power, illiteracy, ignorance regarding nutritional value of available cheap food, cultural taboos, superstition, large families etc [41]. The important factors could have contributed are the impact of environment, socio-economic factors, habits in the family, especially the ones related to the mother, certain individual characteristics (gender, time and way of delivery, birth weight and associated diseases) as well as the child's diet. The level of nutrition is certainly correlated with different quality of alimentary deficit. In infancy, the overall mental and physical development depends primarily on the diet, and the diet relies almost entirely on the attitude, perception, cultural and health education of the mother.

The results of our study demonstrated that the bottle-fed children exhibited a higher prevalence of GI infections as compared to other children who were exclusively breast fed, 'breast fed and bottle fed' and fed by any other means like glass or cup. Our study also suggested that bottle-fed children had a higher risk of having multiple conditions (dental and GHS) together such as, caries with anaemia, caries with GI infections, caries with respiratory infections and caries with delayed milestones; the odds being statistically significant. Bottle feeding can be considered as a common risk factor for development of not only caries but also other general health conditions. Infectious disease transmission occurs mainly due to the lack of a properly developed immune system in very young children. The microbial contamination that occurs in the bottles is plays a major role in causing GI infections in infants. Of concern is intrinsic bacterial contamination of the formula as well as extrinsic contamination from inappropriate handling or ineffective disinfection [42]. Confounding factors such as young age, low socio-economic status, being formula fed, hygiene, bathroom facilities, fomites, playing and eating behaviour have been reported to be important factors when it comes to the disease burden. Comparable results were obtained in a study Stuebe (2009) by which assessed the protective effect of breast feeding during the first 13 weeks and development of GI illness. It was observed that the prevalence of GI infections in bottle-fed babies was three times more that that of breast fed babies [43].

In case of constipation, our study also reported that the exclusively 'bottle-fed' children exhibited a lower prevalence as compared to other fed children. Andiran (2003) reported suggested that cow's milk had an eightfold risk of developing constipation and anal fissure; likewise, bottle-fed children with shorter duration of breast feeding had a fivefold risk [18].

In our study, we observed some protective benefits of HBM consumption. Our study demonstrated that exclusive breast feeding had protective benefits against caries, anaemia, GI infections, constipation and delayed milestones which were statistically significant. A re-

cent systematic review by Cui., *et al*. (2017) reported findings in concordance to our results. The overall analysis showed children ever breastfed had a reduced risk of ECC compared with those never breastfed. Conversely the study also stated that breast feeding duration ≥ 12 months is associated with higher ECC risk as compared to those who were breast fed > 12 months [44]. Correspondingly, Peres., *et al*. (2017) assessed the association between duration of breast feeding and dental caries in the primary dentition and reported that that prolonged breast feeding beyond 24 months increases the risk of having dental caries [45]. This can be explained on the basis of the acquisition of Mutans Streptococci soon after the teeth eruption. It is the sucrose that is readily utilized by the pathogenic bacteria in oral cavity to produce acid; whereas "cariogenic bacteria may not be able to utilize lactose as an energy source as readily as sucrose". Furthermore, once sucrose is fermented, pathogenic bacteria can utilize any other available sugar (including lactose which is present in HBM); thus, HBM is not cariogenic in an *in vitro* model, unless another carbohydrate source is available for bacterial fermentation [46]. Owing to the presence of sucrose in the weaning foods, it can be said that 'HBM is not cariogenic but improper feeding practices can be [47]. The protective nature of HBM can be affirmed by the studies showing that IgA and IgG present in HBM and both have potential for inhibition of streptococcal accumulation [48]. In accordance to a Cochrane review by Kramer and Kakuma (2009), majority of the literature on the health effects of breast feeding has been based on observational studies, with well-recognized sources of potential bias. Some of the biases tend to favour exclusively breastfed infants, while others favour those who receive earlier complementary feeding [49]. Sauls (1979) suggests that reverse causality is an important potential source of bias. Infants who continue to be exclusively breastfed tend to be those who remain healthy and on a consistent growth trajectory; significant illness or growth faltering can lead to interruption of breast feeding or supplementation with infant formula or solid foods [50]. Bauchner (1986) explains the reverse causality and how feeding practices act as a common risk factor for the development of variety of infections. Infants who develop a clinically important infection are likely to become anorectic and to reduce their HBM intake, which can in turn lead to reduction in milk production and even weaning. The temporal sequence of the early signs of infection and weaning may not be adequately appreciated; infection may be blamed on the weaning, rather than the reverse [51]. Poorly-growing infants (especially those in developing countries like India) are likely to receive complementary feedings earlier because of their slower growth. This may result in crying and poor sleeping, supplementation with formula or solid foods, or both, reduced suckling, and a vicious cycle leading to earlier weaning (i.e., discontinuation of breast feeding).

Children who were 'bottle-fed' exhibited higher odds of GHS parameters like GI infections, anaemia and constipation as compared to those who were 'exclusively breast-fed', 'breast-fed and bottle-fed' and 'fed by any other means'. Odds of GHS parameters like respiratory infections, delayed milestones and nutritional status; however were statistically non-significant. These results were in contradiction to the findings obtained by a few other studies. Kim., *et al*. (2011) reported that there exists a correlation between respiratory symptoms including nocturnal cough, otitis media, sinusitis, chronic cough, etc. along with certain GI symptoms like regurgitation and vomiting, etc. with prolonged bottle-feeding practices in infants [21]. Bennet., *et al*. (2014) reported a positive correlation between cow's milk consumption before 12 months of age and delayed developmental milestones in infants after the first year of age [22]. We did not find any association between the bottle feeding practice and alteration in the BMI status (high or low BMI). Our findings are in disagreement with that reported by Lakshman (2009) in a systematic review that bottle-feeds may contribute to overfeeding, rapid infancy weight gain and later, obesity. The study also reported that bottle-feeding gave the parents more control and the infant less self-regulation, thereby potentially superseding infant satiation clues [16]. It is indicative that due to bottle feeding there may be unnecessary excessive consumption of calories by carbohydrates and proteins whereas low intake fat content and hence macronutrient imbalance [17]. In our study the sample mainly consisted of children from low SES and that could have led to the overall poor nutritional status.

This study identifies bottle feeding as common risk and establishes an opportunity for a paediatric dentist to become a counsellor for the behaviour change. However, a larger sample and multi-centric investigation may substantiate our claims.

Conclusion

Based on the results of the study, following conclusions can be drawn with respect to the study objectives:

1. The prevalence of S-ECC in 1 - 2 year old children was found to be 9.64%.
2. Children who were bottle-fed exhibited higher odds caries and of GHS parameters like GI infections as compared to those who were 'exclusively breast-fed', 'breast-fed and bottle-fed' and, 'fed by any other means'. Odds of GHS parameters like anaemia, respiratory infections, delayed milestones and nutritional status; however were statistically non-significant.
3. Bottle-fed children compared to those who were 'exclusively breast-fed', 'breast-fed and bottle-fed' and, 'fed by any other means' exhibited higher risk of caries; with bedtime bottle feeding amplifying the risk of developing caries.
4. Bottle-fed children had a higher risk of having multiple conditions (dental and GHS) together such as, caries with anaemia, caries with GI infections, caries with respiratory infections and caries with delayed milestones; the odds being statistically significant.
5. Children having caries had higher risk of developing anaemia, GI infections and constipation; the odds being statistically significant.
6. Exclusive breast feeding had protective benefits against caries, anaemia, GI infections, constipation and delayed milestones which were statistically significant.

Based on the results of the study, following are our recommendations:

1. Identifying caries early marks the risk of other health related conditions that may affect an individual over a life-course.
2. Integration oral health promotion and prevention programs with general health program based on the common risk factor approach (w.r.t. bottle feeding) is much needed.

Conflict of Interest

Authors declare no conflict of interest.

Source of Funding

This was a self-funded study.

Acknowledgement

This study won the Japanese Society of Pediatric Dentistry Travel Award at the IAPD Global Summit on Early Childhood Caries in Bangkok (November 2018).

Bibliography

1. Petersen PE. "The World Oral Health Report 2003: Continous improvement of the oral health in the 21st century – the approach of the WHO Global Oral Health Programme". *Community Dentistry and Oral Epidemiology* 31.1 (2003): 3-24.
2. Casamassimo PS., *et al*. "Beyond the dmft: the human and economic cost of early childhood caries". *The Journal of the American Dental Association* 140.6 (2009): 650-657.
3. India Ministry of Health and Family Affairs, Govt. of India". *National Oral Health Survey and Fluoride Mapping* (2002 -03) (2004).

4. Olatosi OO and Sote EO. "Causes and pattern of tooth loss in children and adolescents in a Nigerian Tertiary Hospital". *Nigerian Quarterly Journal of Hospital Medicine* 22.4 (2012): 258-262.

5. Casamassimo P. "Hooked, Editorial". *Paediatric Dentistry* 19.1 (1997): 6.

6. Hallett KB and O'Rourke PK. "Social and behavioural determinants of early childhood caries". *Australian Dental Journal* 48.1 (2003): 27-33.

7. Freedman MR and Alvarez KP. "Early childhood feeding: assessing knowledge, attitude, and practices of multi-ethnic child-care providers". *Journal of the American Dietetic Association* 110.3 (2010): 447-451.

8. Ole Fejerskov., *et al*. "Dental Caries: The Disease and its clinical Management". 3rd Edn.

9. Sheiham A and James WP. "Diet and dental caries: the pivotal role of free sugars reemphasized". *Journal of Dental Research* 94.10 (2015): 1341-1347.

10. Bolling K. "Infant Feeding Survey". *The Information Centre* (2005).

11. WHO recommendations on postnatal care of the mother and newborn". 1. Postnatal care – standards. 2. Maternal welfare. 3. Infant, Newborn. 4. Guideline. I. World Health Organization. ISBN 978 92 4 150664 9 (NLM classification: WQ 500) (2013).

12. Lumeng J. "What Can We Do to Prevent Childhood Obesity?" *Zero to Three* 25.3 (2005): 13-19.

13. Fisher JO., *et al*. "Parental influences on young girls' fruit and vegetable, micronutrient, and fat intakes". *Journal of the American Dietetic Association* 1 (2002): 58-64.

14. Ministry of human resource development, Department of women and child development (Food and nutrition board), Govt. of India". *National Guidelines on Infant and Young Child Feeding* (2004).

15. Renfrew MJ., *et al*. "Formula feed preparation: helping reduce the risks; a systematic review". *Archives of Disease in Childhood* 88.10 (2003): 855-858.

16. Lakshman R., *et al*. "Mothers' experiences of bottle-feeding: a systematic review of qualitative and quantitative studies". *Archives of Disease in Childhood* 94.8 (2009): 596-601.

17. Carvalho MF., *et al*. "Home-made feeding bottles have inadequacies in their nutritional composition regardless of socioeconomic class". *Journal of Tropical Pediatrics* 59.4 (2013): 286-291.

18. Andıran F., *et al*. "Cows milk consumption in constipation and anal fissure in infants and young children". *Journal of Paediatrics and Child Health* 39.5 (2003): 329-331.

19. Parkin PC., *et al*. "Severe iron-deficiency anaemia and feeding practices in young children". *Public Health Nutrition* 19.4 (2016): 716-722.

20. Gaffney KF., *et al*. "Prolonged baby bottle feeding: a health risk factor". *Pediatric Nursing* 30.3 (2004): 242-246.

21. Kim HY., *et al*. "Prolonged bedtime bottle-feeding and respiratory symptoms in infants". *Asia Pacific Allergy* 1.1 (2011): 30-35.

22. Bennett WE., *et al*. "Early cow's milk introduction is associated with failed personal–social milestones after 1 year of age". *European Journal of Pediatrics* 173.7 (2014): 887-892.

23. Filstrup SL., *et al*. "Early childhood caries and quality of life: child and parent perspectives". *Pediatric Dentistry* 25.5 (2003): 431-440.

24. OberoiSS. UpdatingIncomeRanges for Kuppuswamy's Socio-Economic Status Scale for the Year (2014).

25. Whitehead M., *et al*. "Developing the policy response to inequities in Health: a global perspective. ill;.- Challenging inequities in health care: from ethics to action". New York: Oxford University Press (2001): 309-322.

26. Petersen PE. "The World Oral Health Report 2003: continuous improvement of oral health in the 21st century–the approach of the WHO Global Oral Health Programme". *Community Dentistry and Oral Epidemiology* 31.1 (2003): 3-24.

27. Sheiham A and Watt RG. "The common risk factor approach: a rational basis for promoting oral health". *Community Dentistry and Oral Epidemiology* 28.6 (2000): 399-406.

28. Kathmandu RY. "The burden of restorative dental treatment for children in Third World countries". *International Dental Journal* 52.1 (2002): 1-9.

29. Watt RG. "Strategies and approaches in oral disease prevention and health promotion". *Bulletin of the World Health Organization* 83.9 (2005): 711-718.

30. World Health Organisation. Oral Health Surveys: Basic Methods". 5th Edition. France: World Health Organisation (2013).

31. Bagramian RA., *et al*. "The global increase in dental caries. A pending public health crisis". *American Journal of Dentistry* 22.1 (2009): 3-8.

32. International Caries Detection and Assessment System Coordinating Committee". Rationale and Evidence for the International Caries Detection and Assessment System (ICDAS II) (2016).

33. Tiano AV., *et al*. "Dental caries prevalence in children up to 36 months of age attending daycarecenters in municipalities with different water fluoride content". *Journal of Applied Oral Science* 17.1 (2009): 39-44.

34. Martinesa F., *et al*. "Factors influencing the development of otitis media among Sicilian children affected by upper respiratory tract infections". *Brazilian Journal of Otorhinolaryngology* 159 (2015): 1-8.

35. Detsomboonrat P and Pisarnturakit PP. "Dental caries and related oral health factors among 9 to 18 month old thai children". *The Southeast Asian Journal of Tropical Medicine and Public Health* 46.4 (2015): 786-797.

36. World Health Organization. The world health report 2002: reducing risks, promoting healthy life". Geneva: WHO (2002).

37. Singh RK and Patra S. "Extent of anaemia among preschool children in EAG States, India: a challenge to policy makers". *Anemia* (2014).

38. Bharati S., *et al*. "Socioeconomic determinants of iron-deficiency anemia among children aged 6 to 59 months in India". *Asia Pacific Journal of Public Health* 27.2 (2015): 1432-1443.

39. Milankov O., *et al*. "What kind of milk can prevent infant's sideropenicanemia: Comparative study". *Medicinskipregled* 67.5-6 (2014): 167-171.

40. Culhane-Pera KA., *et al*. "Cultural feeding practices and child-raising philosophy contribute to iron-deficiency anemia in refugee Hmong children". *Ethnicity and Disease* 12.2 (2001): 199-205.

41. Chellan R and Paul L. "Prevalence of iron-deficiency anaemia in India: results from a large nationwide survey". *Journal of Population and Social Studies [JPSS]* 19.1 (2010): 59-80.

42. Redmond EC., *et al*. "Contamination of bottles used for feeding reconstituted powdered infant formula and implications for public health". *Perspectives in Public Health* 129.2 (2009): 85-94.

43. Stuebe A. "The risks of not breast feeding for mothers and infants". *Reviews in Obstetrics and Gynecology* 2.4 (2009): 222.

44. Cui LL., *et al*. "Breastfeeding and early childhood caries in children: an update meta-analysis of observational studies". *Asia Pacific Journal of Clinical Nutrition* (2016).

45. Peres KG., *et al*. "Impact of Prolonged Breast feeding on Dental Caries: A Population-Based Birth Cohort Study". *Paediatrics* 140.1 (2017): e20162943.

46. Rugg-Gunn AJ., *et al*. "Effect of human milk on plaque pH in situ and enamel dissolution in vitro compared with bovine milk, lactose, and sucrose". *Caries Research* 19.4 (1985): 327-334.

47. Erickson PR and Mazhari E. "Investigation of the role of human breast milk in caries development". *Pediatric Dentistry* 21 (1999): 86-90.

48. Irwin Mandel. "Caries Prevention: Current Strategies, New 50 Directions". *Journal of the American Dental Association* 127 (1996): 1477-1488.

49. Kramer MS and Kakuma R. "Optimal duration of exclusive breast feeding". *The Cochrane Database of Systematic Reviews* 8.8 (2012): CD003517.

50. Sauls HS. "Potential effect of demographic and other variables in studies comparing morbidity of breast-fed and bottle-fed infants". *Pediatrics* 64.4 (1979): 523-527.

51. Bauchner H., *et al*. "Studies of breast-feeding and infections: how good is the evidence?". *The Journal of the American Medical Association* 256.7 (1986): 887-892.

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