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Prenatal Maternal Factors and their Association with Early Childhood Caries: A Case–Control Analysis

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Abstract **Original Research Article**

Introduction: Early childhood caries (ECC) is a multifactorial disease influenced by various maternal, prenatal, and perinatal factors. Understanding these associations is essential for developing effective preventive strategies, especially in rural populations. ***Material and methods:*** A case-control study was conducted with 386 mothers of preschool children (aged 36–72 months) from ten kindergarten schools in Kannur District, selected via systematic random sampling. The study group (n=193) included children with early childhood caries (ECC), and the control group (n=193) comprised caries-free children. Data on socio-demographic characteristics, prenatal, and perinatal history were collected using a structured questionnaire. Dental examinations followed WHO guidelines. Statistical analyses included Mann-Whitney U tests and multiple binary logistic regression, with significance set at $p<0.05$. ***Results:*** Children of mothers who experienced vomiting had significantly higher odds of ECC (odds ratio: 3.2) compared to those without vomiting with p value p=0.041 with 95% Confidence Interval of 1.05-9.78. Therefore, an association was found between maternal vomiting during pregnancy and ECC. Other prenatal factors (such as maternal age, diabetes, smoking) and perinatal factors (such as mode of delivery, birth weight) showed no statistically significant association with ECC. No significant differences were observed in prenatal conditions like allergies, oral hygiene practices, and snacking frequency between cases and controls ($p>0.05$). ***Conclusions:*** This study concluded that vomiting during pregnancy have been found to have an association in the development of ECC. Improving maternal knowledge and addressing the barriers can serve as an effective strategy to reduce ECC prevalence.

Keywords: ECC, Prenatal factors, Maternal factors.

INTRODUCTION

Early childhood caries (ECC) remains one of the most prevalent chronic conditions affecting children worldwide, with significant implications for general health, nutrition, and quality of life. [1] ECC is influenced by a complex interplay of biological, behavioral, and socio-environmental factors. Among these, maternal factors such as education level, oral health knowledge, dietary practices, and socioeconomic status play a critical role in shaping a child's oral health outcomes. [2]

The global literature provides robust evidence for these prenatal and perinatal associations. Maternal health during pregnancy plays a crucial role in shaping the immediate and long-term oral health outcomes of the child. Emerging evidence suggests that factors such as maternal nutrition, systemic health conditions, oral hygiene status, and prenatal care practices can influence a child's susceptibility to early childhood caries. Conditions such as gestational diabetes, poor maternal oral health, and inadequate prenatal care have been associated with an increased risk of ECC in offspring. While ECC is a multifactorial disease primarily influenced by diet, oral hygiene, and microbial activity, emerging research highlights that conditions and behaviors during pregnancy and the perinatal period can have both direct and indirect effects on a child's oral health. [3,4]

In India, where diverse socio-demographic conditions exist across regions, understanding risk factors is essential for developing effective preventive

strategies. [5] Studies conducted in various parts of Kerala, including Kannur, have reported varying prevalence rates of ECC, often ranging between 44% to 60% in preschool-aged children. [6] While most studies have focused on finding post-natal factors contributing to this high disease burden such as frequent consumption of sugary snacks, inadequate oral hygiene practices, and delayed or limited access to dental care, there is scarcity of research on finding the prenatal and perinatal factors for ECC. The Kannur district of Kerala presents a unique socio-cultural setting where maternal behaviors and awareness may significantly influence the prevalence of ECC. [7]

This study aims to explore the association between early childhood caries and maternal factors such as prenatal and perinatal factors. By identifying key maternal determinants, the research seeks to provide insights for public health interventions that target interventions to reduce the burden of ECC in the region

MATERIALS AND METHODS

A Case–control study was conducted by the department of Pediatric and Preventive Dentistry for a period of one year between June 2023 and June 2024. Before the start of the study the study design was comprehensively reviewed and approved by the Institutional Ethical Committee and Review Board of Dental College (IEC No: IECKDC/2023-01/013).

Sample size was calculated by reviewing the data from an existing literature on ECC by Peedikayil FC [6] which shows that prevalence of dental caries in children below 6 years ranges from 44% to 59.6% with an average of 53.58%. By deciding a 95% confidence Interval (Z =1.96) and precision of 0.05 by using the formula $n= Z^2pq/e^2$ The minimum sample size calculated was 366. Therefore, after adjusting it for the possible drop outs, a sample size of 386 was decided for the current study. So each group consists of 193 children at 1:1 ratio.

Children between the ages of 36 and 72 months of age was included in this study whereas physically, mentally, and medically compromised children without parental consent, children with enamel hypoplasia and children with congenital abnormalities were excluded.

The subjects for the study were school children from kindergarten sections in the Kannur district. For these, twenty schools were selected using a lottery method. The sample size was allocated proportionally based on the number of children in each selected school. A systematic random sampling technique was used to select the study participants into two groups; a study group (n = 193) including children who were diagnosed with ECC and a control group (n = 193) which includes caries-free children.

The examination was conducted during the Monthly Parents Meeting of the kindergarten schools. The study was explained to the parent in simple language and their consent was taken. A structured questionnaire, adapted and modified from a prior study,[8] was used to collect socio-demographic characteristics, prenatal and perinatal history of the child's mother. All data was entered in Excel sheet for analysis.

Dental examination was carried out for all selected children using World Health Organization dental caries diagnosis guideline (WHO 1993) under natural daylight. Principal investigator collected information through the face-to-face interview with the parent of the child.

In this study, 16 prenatal and 5 perinatal maternal factors were assessed using a structured questionnaire to explore their potential association with early childhood caries (ECC) in children.The prenatal maternal factors assessed were maternal age at delivery, presence of allergies during pregnancy, oral hygiene practices (frequency of tooth brushing), habits during pregnancy including alcohol consumption, smoking, and drug use , incidence and severity of vomiting and medications taken for it use of health supplements (e.g., folic acid, iron, vitamins, omega-3), use of alternative medicines (ayurvedic/homoeopathic), vaccination status and any post-vaccination reactions, history of bacterial/viral infections during pregnancy, occurrence of gestational diabetes, blood pressure variations during pregnancy, snacking frequency between meals. Post natal factors which were studied are type of delivery (normal or caesarean), birth weight of the baby, presence of complications during pregnancy and delivery, gestational age and duration of breastfeeding.

A standardized epidemiological tool dmft index was used to assess the dental caries experience in children. [9] It summarizes the number of decayed (d), missing due to caries (m), and filled (f) teeth.On clinical examination of the child , a tooth was considered decayed if there was visible evidence of cavitations , filled if the tooth was restored and extracted if extracted due to caries.The dmft score is the sum of these three components for an individual that is , dmft=d+m+f . Data from the questionnaire and child dmft was recorded in Excel sheet. The statistical analysis was conducted using SPSS software V 21, (IBM SPSS INC Chicago, IL, USA). Comparison of the prenatal conditions between cases and controls performed using the Mann-Whitney U test. Association between Prenatal and perinatal condition to Early childhood caries of cases and controls was performed using Multiple binary logistic regression. All statistical analyses were performed at a 95% confidence level. $p<0.05$ is considered significant.

RESULTS

The mean age of children with ECC is 3.7 years and in control group it is 3.27.

Table 1 shows comparison of the prenatal conditions between cases and controls. Most of the examined factors did not show a statistically significant association. This is indicated by the p-values for maternal age at delivery (p=0.901), history of allergies (p=0.156), frequency of teeth brushing (p=0.736), medication use for vomiting (p=0.489), intake of health supplements (p=0.712), use of Ayurvedic/Homeopathic medications (p=0.067), adherence to vaccinations (p=0.999), reactions after vaccination (p=0.059), occurrence of bacterial/viral infections (p=0.223), gestational diabetes (p=0.740), blood pressure variations (p=0.823), and the frequency of snacking between meals (p=0.059), all of which are above the conventional significance threshold of 0.05.

However, the frequency of vomiting during pregnancy demonstrated a statistically significant difference between the cases and controls groups, with a p-value of 0.041. This statistically significant finding suggests that there is a relationship between the occurrence and severity of vomiting during pregnancy and ECC.

Table 2 compares the perinatal conditions between cases and controls. The results did not yield statistically significant differences for any of the investigated factors. The type of delivery (p = 0.75), the baby's weight at birth (p = 0.621 across the weight categories), the occurrence of complications during pregnancy and delivery (p = 0.823), whether the baby was born at full-term (p = 0.082), and the duration of breastfeeding (p = 0.629 across the duration categories) all showed p-values greater than the conventional threshold of 0.05.

DISCUSSION

The present study, being a case control study helps to investigate a range of potential factors such as prenatal and perinatal factors of early childhood caries. Prenatal refer to maternal conditions, behaviors, and environmental exposures that occur during pregnancy and perinatal factors refers to the exposures around the time of birth. [10]

With regards to the prenatal factors in our study, vomiting during pregnancy period shows that a significant co-relation between ECC. Vomiting is a reflex controlled by the medulla, triggered by signals from the GI tract, CTZ, vestibular system, and brain. Key neurotransmitters include dopamine, serotonin, histamine, acetylcholine, and substance P. During pregnancy, high hCG and estrogen levels increase CTZ sensitivity, making vomiting more common in the first trimester. [11] Nausea and vomiting during pregnancy can cause extensive erosion of the tooth surface leading to deteriorating oral health status which has been associated with adverse pregnancy outcomes such as preterm births, development of pre-eclampsia and delivery of a "small-for-gestational-age" infant. Vomiting during pregnancy, especially in the first trimester, may increase the risk of early childhood caries (ECC) in infants due to the acidic environment in the mother's mouth and potential neglect of oral hygiene. After vomiting, the mother may not pay enough attention to oral care. If the teeth are not brushed sufficiently, an acidic environment will form in the mouth. In postpartum period, mothers can transmit cavity-causing bacteria to their babies, thereby increasing the risk of ECC. [12,13, 14] Vomiting also can lead to inadequate intake or loss of energy and nutrients which impacts positive health effects which may negatively affect the health of the mother and the development of the infant. [15,16]

Maternal behaviors such as smoking, alcohol consumption, and substance use during pregnancy are well-known to have adverse effects on the health of the fetus. [3] According to a Samani et al [17] cigarette smoke contains harmful chemicals that can affect the development of the fetus, including impairing tooth development. Smoking during pregnancy is associated with a higher incidence of low birth weight and preterm birth, both of which can indirectly contribute to oral health problems in children. [18,19] Children of smoking mothers may thus be at an elevated risk of early caries due to both intrauterine exposure and postnatal transmission of cariogenic bacteria. [20,21]

Prenatal alcohol exposure through maternal alcohol use can affect the enamel development of the child's teeth, making them more prone to caries. Furthermore, substance abuse can impair the mother's ability to care for her own oral health, which could increase the risk of transmitting harmful bacteria to the child. [22,23]

Our study could not find an association of health supplements and ECC. These supplements is essential for proper fetal development, including orofacial structures and dental tissues. Some studies show that deficiencies may predispose children to enamel hypoplasia, increasing the risk of ECC.[24]

The use of non-allopathic treatments during pregnancy may vary in their effectiveness or safety. There is no direct, valid scientific evidence from peer-reviewed studies proving a correlation between Ayurvedic or homeopathic medication use during pregnancy and ECC in children. Indirectly, Ayurvedic herbs like neem and homeopathic remedies like Kreosotum may reduce maternal cariogenic bacteria,[22] potentially lowering ECC risk via transmission, but this is speculative without prenatal data. Our study also didn't find any correlation.

Maternal infections during pregnancy may have systemic effects that could compromise the developing fetus's health, possibly leading to altered enamel formation or preterm birth, both known risk

factors for ECC. [23,24] No co-relation was found in our study. However, studies by Saddki *et al.,* [25] shows maternal periodontitis increases ECC risk via bacterial transmission causing enamel defects.

There is a plausible correlation between prenatal maternal gestational diabetes and ECC in children, supported by valid studies. Gestational diabetes mellitus increases the risk of enamel defects and ECC [26], whereas in our study there was no association with ECC.

Our study was not able to find any association between perinatal factors and ECC. Mode of delivery may affect the early colonization of the child's oral microbiota. Vaginal delivery exposes the infant to beneficial maternal microbiota, while C-section may lead to delayed colonization, potentially influencing caries risk. [27] The impact of cesarean-section delivery on ECC remains controversial. Xiang *et al.,* [28] conducted a systematic review and concluded that there is no significant association between mode of delivery and ECC risk. However, Xin Ge *et al.,* [29] suggested that cesarean-delivered children may be more susceptible to caries due to differences in oral microbial colonization. The study by Pattanaporn *et al.,* [30] found that cesarean section deliveries were associated with higher MS colonization, which in turn increased ECC risk.

Babies born with a weight less than 2500 grams may have compromised oral health, making them more susceptible to ECC. Nelson *et al.,* [31] demonstrated an increased risk of enamel hypoplasia in very low birth weight (VLBW) infants, which could predispose them to ECC. Castro *et al.,* [32] reported an association between LBW and delayed dental eruption, potentially influencing ECC risk.

One of the strengths of this study is its focus on a rural population, providing insight into a relatively understudied group with potentially unique risk profiles. The use of a case–control design enabled efficient identification of potential associations between early-life exposures and disease outcome. This study introduces vomiting during pregnancy as a possible independent risk factor for ECC, a topic not widely explored in prior research. While some may argue that vomiting is too common and multifactorial to isolate its effect on ECC, the statistically significant finding calls for further investigation. Additionally, the study's inability to detect associations with traditionally cited risk factors (e.g., low birth weight, C-section, maternal diabetes) may seem contradictory to other literature, possibly due to differences in study population or design. These discrepancies highlight the complex etiology of ECC and the need to consider local and contextual variables when assessing risk. Future research should explore the underlying mechanisms linking maternal vomiting and ECC, possibly through longitudinal cohort studies and multicentric studies involving diverse populations are needed to confirm the generalizability of these findings

However, the study is limited by its reliance on maternal self-reporting, which may be subject to recall bias, particularly for prenatal events several years prior. Social desirability bias may also have influenced responses related to smoking, alcohol use, or oral hygiene.

Table 1 - Comparison of the Prenatal Conditions Between Cases and Controls

Prenatal Factor	Odds Ratio (OR)	95% Confidence Interval	p-value
Maternal Age	1.008	0.92 – 1.10	.901
Allergy during pregnancy	1.12	0.95 – 1.32	.156
Brushing	1.315	0.28 – 6.20	.736
Maternal alcohol	-	-	No difference
Maternal smoking habit	-	-	No difference
Maternal drug habit	-	-	No difference
Vomiting	3.2	1.05-9.78	0.041*
Medication for vomiting	2.458	0.23 – 26.7	0.489
Health supplement use	1.543	0.20 – 11.6	0.712
Ayurvedic/Homeo meds	1.22	0.99 – 1.51	0.067
Vaccination status	1.01	0.73 – 1.39	0.999
Post-vaccination reactions	.070	0.004 – 1.17	.059
Infections during pregnancy	.207	0.01 – 4.12	.223
Diabetes	1.269	0.30 – 5.30	.740
Blood pressure variations	1.252	0.20 – 7.81	.823
Snacking habit	1.25	0.99 – 1.58	.059

$P<0.05$ = significant

Table 2 - Comparison of the Perinatal Conditions Between Cases and Controls

Perinatal Factor	Odds Ratio (OR)	95% Confidence Interval	p-value
Caesarean vs Vaginal Delivery	0.846	0.60 – 1.19	0.75
Birth Weight <2500g	1.557	0.85 – 2.85	0.621
Obstetric Complications	1.208	0.70 – 2.08	0.823
Preterm Birth	0.14	0.02 – 1.05	0.082
Breastfeeding <1 year	1.331	0.75 – 2.36	0.629

P<0.05 = significant

CONCLUSION

This study highlights the relationship between maternal factors and the prevalence of early childhood caries (ECC). Vomiting during pregnancy have been found to have an association in the development of ECC. Improving maternal knowledge through targeted educational interventions, supporting healthier dietary and oral hygiene practices, and addressing the barriers can serve as effective strategies to reduce ECC prevalence.

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