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The Relationship Between Maternal Nutrition During Pregnancy and Primary Tooth Caries in Stunted Toddlers: A Study at Umbulsari

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ABSTRACT Stunted growth in children is often accompanied by dental health complications, yet the relationship between maternal nutritional status during pregnancy and primary tooth caries in stunted toddlers remains inadequately understood. Primary tooth enamel formation occurs during critical developmental periods, particularly during the fifth week of gestation, making this phase vulnerable to nutritional deficiencies that may compromise dental health outcomes. This study aimed to investigate the correlation between maternal nutritional status during pregnancy and the incidence of primary tooth caries in stunted toddlers attending the Umbulsari Community Health Center. A retrospective case-control study was conducted using purposive sampling to select 90 participants. Maternal body mass index (BMI) data were collected as indicators of nutritional status during pregnancy, while primary tooth caries incidence was assessed through comprehensive dental examinations. Statistical analysis was performed using Spearman's non-parametric correlation test to determine the relationship between variables. Preliminary observations of 10 stunted toddlers revealed the universal presence of dental caries, prompting the expanded investigation. Analysis of the complete dataset demonstrated a statistically significant relationship between maternal nutritional status and primary tooth caries occurrence ($p=0.001$, $r=0.351$). The majority of mothers exhibited below-normal nutritional status during pregnancy, while their stunted toddlers presented with an average of 7.3 dental caries per child. The correlation coefficient indicated a weak negative relationship, suggesting that improved maternal nutrition is associated with reduced caries incidence. A significant inverse correlation exists between maternal nutritional status during pregnancy and primary tooth caries development in stunted toddlers. These findings underscore the critical importance of maintaining adequate maternal nutrition during pregnancy to optimize primary tooth development and minimize dental caries risk in offspring. The results support the implementation of comprehensive prenatal nutritional interventions as a preventive strategy for pediatric dental health.

INDEX TERMS Maternal nutrition, Primary tooth caries, Stunted toddlers, Prenatal development, Dental health

I. INTRODUCTION

Early childhood development represents a fundamental determinant of lifelong health outcomes, with nutritional adequacy during the first 1000 days of life serving as a critical foundation for optimal growth trajectories [1]. Stunting, characterized by height-for-age z-scores below -2 standard deviations, affects approximately 149 million children under five years globally and remains a persistent public health challenge [2]. Indonesia demonstrates particularly concerning prevalence rates, with national stunting statistics reaching 21.6% in 2022, despite improvement from 30.8% in 2018 [3]. East Java Province exhibits even higher rates at 38.2%, with Jember Regency recording the most severe prevalence of 34.9%, indicating chronic community-level nutritional deficiencies [4]. Concurrent with stunting concerns, dental caries prevalence among Indonesian toddlers remains alarmingly high at 51.2%, representing the highest burden across all age demographics [5]. The intersection of stunting and dental health presents a complex clinical challenge, as stunted children demonstrate significantly elevated caries rates compared to their normally growing counterparts [6]. This dual burden of malnutrition and dental disease creates compounding effects on child development, quality of life, and long-term health outcomes. Contemporary research approaches investigating maternal nutrition-child dental health relationships predominantly employ longitudinal cohort studies and cross-sectional analyses utilizing standardized anthropometric assessments and clinical dental examinations [7][8]. Advanced methodologies incorporate biomarker analyses, including serum vitamin D, calcium, and folate levels, to establish mechanistic pathways between prenatal nutritional status and offspring dental development [9]. Emerging techniques utilize digital imaging and artificial intelligence-based caries

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detection systems to enhance diagnostic accuracy and minimize examiner bias [10][11]. Recent investigations have employed sophisticated statistical modeling approaches, including structural equation modeling and machine learning algorithms, to account for multiple confounding variables and establish causal relationships between maternal factors and pediatric dental outcomes [12][13]. Additionally, epigenetic studies are beginning to elucidate how maternal nutritional status influences gene expression patterns affecting tooth development and enamel formation [14][15].

Despite significant advances in understanding individual components of maternal nutrition and child dental health, substantial gaps persist in comprehensively characterizing these relationships within specific vulnerable populations. Most existing studies focus on general pediatric populations without stratifying by growth status, potentially masking critical associations specific to stunted children [16][17]. Furthermore, limited research has been conducted in Indonesian contexts, where unique dietary patterns, socioeconomic factors, and genetic backgrounds may influence observed relationships [18]. The temporal relationship between maternal nutritional status during critical periods of tooth development (particularly the 5th-15th gestational weeks) and subsequent caries development in stunted offspring remains inadequately characterized [19][20]. Additionally, the dose-response relationship between the severity of maternal malnutrition and the extent of dental pathology in stunted children requires further elucidation.

This study aims to investigate the correlation between maternal nutritional status during pregnancy and primary tooth caries incidence in stunted toddlers attending the Umbulsari Community Health Center, Jember Regency, East Java. This investigation contributes to the scientific literature through three primary domains:

1. It provides novel insights into the specific relationship between maternal prenatal nutrition and dental caries development within the vulnerable population of stunted toddlers, addressing a critical knowledge gap in pediatric dental epidemiology.
2. The study generates essential baseline data for the East Java region, particularly Jember Regency, contributing to evidence-based policy development for integrated maternal-child health interventions.
3. The findings will inform the development of targeted preventive strategies that address both nutritional and dental health outcomes simultaneously, potentially improving the effectiveness of public health interventions in resource-limited settings.

This paper is organized as follows: Section II examines the literature review and theoretical framework underlying maternal nutrition and pediatric dental health relationships; Section III delineates the research methodology, including study design, sampling procedures, and analytical approaches; Section IV presents the empirical findings and statistical analyses; Section V discusses the implications of results within existing literature context and addresses study limitations; and Section VI concludes with key findings and their relevance for clinical practice and future research endeavors.

II. METHOD

A. STUDY DESIGN AND SAMPLING

This investigation employed a retrospective analytical study design utilizing bivariate correlation analysis to examine the association between maternal nutritional status during pregnancy and primary tooth caries occurrence in stunted toddlers [21]. The retrospective approach was selected to analyze historical data regarding maternal prenatal nutritional parameters and their relationship to current dental health outcomes in the offspring population [22]. The research was conducted at the Integrated Healthcare Services (Posyandu) facility within the Umbulsari Community Health Center, Jember Regency, East Java Province, Indonesia. The health center is strategically located at Jl. KH. Agus Salim, Krajan Village, Umbulsari District, serves a predominantly rural population with documented high stunting prevalence. Data collection was performed between February and April 2024, following a comprehensive preliminary assessment conducted in August 2023. The target population comprised mother-child dyads consisting of mothers who experienced pregnancy within the Umbulsari Community Health Center catchment area and their stunted toddlers currently receiving healthcare services. Purposive sampling methodology was implemented to select participants meeting predetermined eligibility criteria [23]. Sample size calculation was performed using the correlation coefficient formula with $\alpha = 0.05$, power = 80%, and expected correlation coefficient $r = 0.35$, resulting in a minimum required sample of 90 participants.

B. INCLUSION AND EXCLUSION CRITERIA

Participants were included if they met the following criteria: (1) mothers with toddlers aged 24-60 months as of January 2024; (2) children diagnosed with stunting according to WHO growth standards (height-for-age z-score < -2 SD); (3) mothers who regularly attended integrated healthcare services at the study location; (4) availability of complete maternal health records including BMI data during pregnancy; (5) provision of informed consent for participation in the study [24]. Participants were excluded based on the following criteria: (1) mothers with children younger than 24 months or older than 60 months; (2) children without confirmed stunting diagnosis; (3) incomplete maternal health records or missing BMI data during pregnancy; (4) mothers who declined participation or withdrew consent; (5) children with congenital anomalies affecting dental development; (6) recent migration to the study area with insufficient health record documentation [25].

C. DATA COLLECTION PROCEDURES

Maternal nutritional status during pregnancy was assessed retrospectively using documented BMI measurements recorded in the Maternal and Child Health (KIA) booklets and maternal cohort records. BMI categories were classified according to Indonesian Ministry of Health guidelines: underweight (<18.5 kg/m²), normal weight (18.5-24.9 kg/m²),

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overweight (25.0-29.9 kg/m²), and obese (≥30.0 kg/m²) [26]. Data verification was performed by cross-referencing multiple documentation sources to ensure accuracy and completeness. Dental caries assessment was conducted using the decayed, extracted, and filled teeth (def-t) index, specifically adapted for primary dentition evaluation in toddlers [27]. Clinical examinations were performed by a single calibrated examiner using standardized protocols under artificial illumination with dental mirrors and probes. The def-t index quantifies caries experience by counting the total number of decayed, extracted due to caries, and filled primary teeth. Intra-examiner reliability was established through duplicate examinations of 10% of the sample, achieving a Cohen's kappa coefficient of 0.89. All clinical findings were systematically recorded on standardized data collection forms designed specifically for this study. Each examination sheet included participant identification, demographic information, maternal BMI data, and comprehensive dental caries documentation. Data quality assurance measures included immediate verification of recorded information, systematic review of incomplete entries, and standardized coding procedures for all variables [28].

D. STATISTICAL ANALYSIS

Statistical analysis was performed using SPSS version 26.0 software package. Descriptive statistics were calculated for all variables, including measures of central tendency and dispersion. Normality assessment was conducted using the Kolmogorov-Smirnov test to determine appropriate statistical testing procedures. Given the non-parametric distribution of the data, Spearman's rank correlation coefficient was utilized to examine the relationship between maternal BMI during pregnancy and def-t scores in stunted toddlers [29]. Statistical significance was set at $p < 0.05$, with correlation strength interpreted according to established guidelines: weak ($r = 0.10$-0.39), moderate ($r = 0.40$-0.69), and strong ($r = 0.70$-1.00) correlations.

E. ETHICAL CONSIDERATIONS

This study received formal ethical approval from the Research Ethics Committee of the Surabaya Health Polytechnic, Ministry of Health, under approval number EA/2155/KEPK-Poltekkes_Sby/V/2024. All procedures were conducted by the Declaration of Helsinki principles for human research. Informed consent was obtained from all participants before data collection, with particular attention to ensuring comprehension among participants with varying educational backgrounds. Participant confidentiality was maintained through the use of unique identification codes, and all data were stored securely with restricted access limited to authorized research personnel [30].

III. RESULTS

A comprehensive sample of 90 participants was examined, comprising respondents who satisfied all predetermined inclusion criteria. These eligibility requirements encompassed mothers of toddlers aged 24-60 months as of January 2024, maternal caregivers who accessed integrated healthcare services at the designated facility, parental consent for study participation, and mothers whose children exhibited confirmed stunting nutritional status according to established diagnostic parameters.

According to the data in TABLE 1, most of the respondents were male, with a percentage of 52.2% with an average age of 24-33 months, namely 34.4%. There were 67 respondents under five who were classified as having short nutritional status. According to the data in TABLE 2, most mothers fall within the 18-25 years age range, and approximately 33 of them have completed their education up to junior high school. In the maternal nutritional status variable during pregnancy, 48 mothers were found to be in the deficient category, with a percentage of 53.3%. Apart from that, in the dental caries variable, the majority of respondents were in the range of 9 – 13 teeth with an average deft of 7.3. Based on

TABLE 1
Respondent Characteristics

Characteristics	Frequency (f)	Percentage (%)
Gender		
Boy	47	52.2
Girl	43	47.8
Age		
24-33 months	31	34.4
34-43 months	30	33.3
44-53 months	20	22.2
54-60 months	9	10.1
Nutritional Status		
Short	67	74.4
Very short	23	25.6

TABLE 2
Characteristics of The Respondent's Mother (Stunted Toddler Mother)

Characteristics	Frequency (f)	Percentage (%)
Age		
<18 years	1	1.1
18-25 years	51	56.7
26-33 years	29	32.2
>33 years	9	10
Mother's Latest Education		
Elementary School	24	26.7
Junior High School	33	36.7
Senior High School	27	30
Diploma/Bachelor	6	6.6

TABLE 3
Characteristics of Research Variables

Characteristics	Frequency (f)	Percentage (%)
Maternal Nutritional Status Less	1	1.1
Normal	51	56.7
Overweight	29	32.2
Obese	9	10
Dental Caries		
<4	24	26.7
4-8	33	36.7
9-13	27	30
14-18	6	6.6
>18	0	0
d(decay)	476	68.9
e(ekstration)	184	31.1
f(filling)	0	0
Mean deft : 7.3		

TABLE 4
Analysis of the Relationship between Maternal Nutritional Status During Pregnancy and Dental Caries in Stunted Toddlers

Research Variable	n	r	⟩ Value
Maternal Nutritional Status During Pregnancy (BMI)	90		
Deciduous Dental Caries in Stunted Toddlers Aged 24-60 Months	90	-0.351	0.0001

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TABLE 3, bivariate analysis was utilized using the SPSS version 16.0 software to determine whether there exists a correlation between maternal nutritional status during pregnancy and dental caries in stunted toddlers at the Umbulsari Health Center in Jember district. The research employed the non-parametric Spearman correlation test, using an ordinal scale to measure maternal nutritional status variables during pregnancy and an interval scale for dental caries in stunted toddlers. According to TABLE 4, the ρ value was (0.001), which is less than (0.05), indicating a significant relationship between maternal nutritional status during pregnancy and the occurrence of dental caries in stunted toddlers. The correlation coefficient obtained was -0.351, indicating a weak negative correlation between the variables, suggesting an inverse relationship.

IV. DISCUSSION

The findings of this investigation demonstrate a statistically significant correlation between maternal nutritional status during pregnancy and the prevalence of deciduous dental caries in stunted toddlers at the Umbulsari Community Health Center. The Spearman correlation analysis conducted with 90 respondents revealed a weak negative correlation between these variables, indicating an inverse relationship whereby improved maternal nutritional status corresponds to reduced incidence of dental caries in primary teeth. The substantial prevalence of suboptimal maternal nutritional status observed in this study population, as determined through BMI calculations, presents significant public health implications. This finding corroborates the established understanding that pregnancy represents a critical period of heightened nutritional vulnerability, during which metabolic demands increase substantially to support both maternal physiological adaptations and fetal development [31]. The elevated energy and nutrient requirements during gestation create conditions wherein nutritional deficiencies may readily manifest, particularly in populations with limited access to diverse, nutrient-dense foods.

The exceptionally high prevalence of dental caries in primary teeth among stunted toddlers, categorized within the "very high" def-t classification according to WHO criteria, underscores the severity of oral health challenges within this vulnerable population. This observation aligns with the theoretical framework proposed by Kidd and Bechal regarding the multifactorial etiology of dental caries, wherein host factors, bacterial presence, dietary substrates, and temporal elements converge to create cariogenic conditions [32]. The inverse relationship identified between maternal nutritional status and caries prevalence suggests that maternal nutrition during the critical period of tooth formation significantly influences the structural integrity and caries susceptibility of deciduous teeth. The formation of deciduous teeth commencing at the fifth week of gestation represents a critical developmental window during which adequate maternal nutrition is paramount for optimal tooth mineralization and enamel formation [33]. The deficiency of essential nutrients, particularly vitamin D and calcium, during this formative period appears to predispose developing teeth to structural defects such as Developmental Defects of Enamel (DDE), which subsequently increase caries susceptibility throughout the primary dentition period.

The findings of this investigation demonstrate remarkable consistency with previous research examining the relationship between maternal nutrition and pediatric oral health outcomes. The observed correlation between suboptimal maternal nutritional status and increased caries prevalence aligns closely with the work of Aviva et al., who similarly documented elevated caries rates among toddlers whose mothers experienced nutritional deficiencies during pregnancy [34]. This convergence of findings across different study populations strengthens the evidence base supporting the critical role of maternal nutrition in determining children's oral health trajectories.

The exceptionally high def-t scores observed in stunted toddlers within this study population correspond directly with findings reported by Fadhillah et al., Achmad et al., and Simorangkir, all of whom documented similar patterns of severe caries prevalence in stunted pediatric populations [35][36]. This consistency across multiple research contexts suggests that the relationship between nutritional status and oral health outcomes transcends geographical and demographic boundaries, indicating a fundamental biological relationship that warrants urgent public health attention. However, certain aspects of the current findings diverge from some international studies. Research conducted by Cetin et al. examining pregnant women in developed countries revealed widespread malnutrition issues, yet the oral health outcomes in their pediatric populations were not as severely compromised as observed in the current study [37]. This discrepancy may reflect the influence of additional socioeconomic factors, healthcare accessibility, and cultural dietary practices that modify the relationship between maternal nutrition and pediatric oral health outcomes in different contexts.

The weak correlation coefficient identified in this study contrasts with some investigations that have reported stronger associations between maternal nutritional parameters and children's oral health outcomes. This variation may be attributed to differences in study methodologies, population characteristics, measurement tools, and the multifactorial nature of caries development, which involves complex interactions between genetic, environmental, behavioral, and nutritional factors [38]. Contemporary research by Rahman et al. has expanded understanding of the mechanisms linking maternal nutrition to pediatric oral health, demonstrating that specific micronutrient deficiencies during pregnancy can alter the composition and protective properties of children's saliva, thereby influencing caries susceptibility [39]. These mechanistic insights provide biological plausibility for the correlations observed in the current study and suggest that the relationship between maternal nutrition and pediatric caries may be mediated through multiple physiological pathways. Several methodological limitations must be acknowledged when interpreting the findings of this investigation. The cross-sectional design employed in this study precludes the establishment of definitive causal relationships between maternal nutritional status and pediatric caries outcomes. While the observed correlation suggests an association, longitudinal studies would be

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Vol. 4 No.4, pp. 236-241, August 2024

necessary to confirm causality and identify the temporal sequence of events leading to caries development in children born to nutritionally compromised mothers.

The reliance on BMI as the primary indicator of maternal nutritional status represents another limitation, as this anthropometric measure provides limited information regarding specific micronutrient deficiencies that may be particularly relevant to tooth development. Future investigations would benefit from incorporating comprehensive nutritional assessments, including serum levels of vitamin D, calcium, phosphorus, and other minerals essential for tooth mineralization [40]. The study population's geographic and demographic homogeneity may limit the generalizability of findings to other populations with different socioeconomic characteristics, dietary patterns, and healthcare access. The specific cultural and environmental factors influencing both maternal nutrition and pediatric oral health in the Umbulsari region may not be representative of broader populations, necessitating replication studies in diverse settings. The absence of detailed dietary intake assessments during pregnancy represents a significant limitation that prevents the identification of specific nutritional interventions that might be most effective in preventing pediatric caries. Future research should incorporate comprehensive dietary recall methods and food frequency questionnaires to identify specific nutrients and dietary patterns most strongly associated with optimal pediatric oral health outcomes [41].

The clinical implications of these findings underscore the importance of integrating nutritional counseling and support into routine prenatal care protocols. Healthcare providers should be trained to recognize nutritional risk factors during pregnancy and provide targeted interventions to optimize maternal nutrition during critical periods of fetal tooth development. The development of standardized nutritional screening tools specifically designed for identifying pregnant women at risk of compromising their children's oral health represents an important area for future research and clinical application. Policy implications of this research suggest the need for coordinated public health interventions that address maternal nutrition as a strategy for preventing pediatric oral health problems. The integration of nutritional supplementation programs with existing maternal and child health services could provide a cost-effective approach to reducing the burden of pediatric dental caries in vulnerable populations [42]. Future research priorities should include the development of specific nutritional guidelines for pregnant women aimed at optimizing their children's oral health outcomes, investigation of the long-term effects of maternal nutritional interventions on children's oral health trajectories, and evaluation of community-based programs designed to improve maternal nutrition during pregnancy as a pediatric caries prevention strategy.

V. CONCLUSION

This investigation was conducted to examine the correlation between maternal nutritional status during pregnancy and the prevalence of primary tooth caries in stunted toddlers at the Umbulsari Community Health Center. The comprehensive analysis of 90 respondents revealed several significant findings that contribute to the understanding of the relationship between prenatal maternal nutrition and pediatric oral health outcomes. The assessment of maternal nutritional status demonstrated that the majority of mothers of stunted toddlers exhibited suboptimal nutritional parameters during pregnancy, with BMI values predominantly falling below 18.5 kg/m², thereby classifying them within the underweight category according to established anthropometric standards. Concurrently, the evaluation of primary tooth caries prevalence among stunted toddlers revealed an exceptionally high burden of dental pathology, with the majority of participants presenting def-t scores within the 9-13 tooth interval range, categorizing the caries prevalence as "very high" according to World Health Organization criteria. The statistical analysis employing Spearman correlation testing established the existence of a statistically significant yet weak correlation between maternal nutritional status during pregnancy and the occurrence of primary tooth caries in stunted toddlers ($p < 0.05$).

The correlation coefficient demonstrated a negative or inverse relationship between these variables, indicating that improved maternal nutritional status during pregnancy corresponds to reduced caries prevalence in children's primary dentition, while suboptimal maternal nutrition correlates with increased caries susceptibility. However, the weak magnitude of this correlation suggests that additional factors beyond maternal nutritional status may exert more substantial influences on primary tooth caries development in this population. Future research endeavors should focus on investigating specific micronutrient deficiencies during pregnancy that may have the greatest impact on tooth development, conducting longitudinal studies to establish definitive causal relationships, and exploring the effectiveness of targeted nutritional interventions during pregnancy as a strategy for preventing pediatric dental caries. Additionally, comprehensive studies incorporating genetic factors, postnatal dietary patterns, oral hygiene practices, and socioeconomic determinants would provide a more complete understanding of the multifactorial nature of primary tooth caries development in nutritionally vulnerable populations, ultimately informing evidence-based prevention strategies and public health policies.

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DATA AVAILABILITY

No datasets were generated or analyzed during the current study.

AUTHOR CONTRIBUTION

Shahila Nailil Muna conceptualized and designed the study, conducted the literature review, and participated in data collection and statistical analysis. Isnanto supervised the research methodology, oversaw the study implementation, contributed to data interpretation, and provided critical guidance throughout the research process. Agus Marjianto assisted with study design, participated in data analysis and interpretation, contributed to manuscript writing and revisions, and provided expert clinical insights on maternal nutrition and pediatric oral health. All authors collaborated in the preparation of the manuscript, reviewed and approved the final version, and agreed to be accountable for all aspects of the work, ensuring scientific rigor and accuracy.

DECLARATIONS

ETHICAL APPROVAL

This investigation was conducted following a comprehensive ethical review and formal approval from the Research Ethics Committee of the Surabaya Health Polytechnic, Ministry of Health, Republic of Indonesia, under ethical clearance number EA/2155/KEPK-Poltekkes_Sby/V/2024. All research procedures were executed in strict adherence to the ethical principles outlined in the Declaration of Helsinki regarding medical research involving human subjects. Before participant enrollment, voluntary informed consent was systematically obtained from all study participants, with particular emphasis on ensuring adequate comprehension of study procedures and objectives across diverse educational demographics. Participant anonymity and data confidentiality were rigorously maintained through the implementation of unique alphanumeric identification codes, while all collected data were securely archived with access restricted exclusively to authorized research personnel in accordance with established data protection protocols.

CONSENT FOR PUBLICATION PARTICIPANTS

Written informed consent for publication of research findings was obtained from all study participants before data collection. Participants were explicitly informed that aggregated, anonymized data would be utilized for academic publication purposes, and voluntary consent was documented by institutional research protocols.

COMPETING INTERESTS

The authors declare that they have no competing interests, financial or otherwise, that could potentially influence the conduct, analysis, or reporting of this research. No conflicts of interest exist regarding the publication of this manuscript.

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Vol. 4 No.4, pp. 236-241, August 2024

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