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Original Article

# Evaluation of Oral Health Status in Pregnant Women and its Correlation with Calcium and Phosphate Levels

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## Abstract

**Aim:** This study aimed to analyze the oral health conditions of pregnant women. The analysis involves evaluating two key indices: the decayed, missing, and filled teeth (DMFT) index and the basic erosive wear examination (BEWE) index. Furthermore, this study investigated potential correlations between calcium (Ca) and phosphate (P) levels within specific time intervals and the aforementioned oral health indices.

**Materials and methods:** This study included 66 women. The examination consisted of assessing the condition of the teeth by using the DMFT index. Additionally, the erosive decay of the teeth was evaluated according to the BEWE index. Salivary concentrations of Ca and P were determined using a colorimetric method. These measurements were performed during the first (T1) and third (T3) trimesters of pregnancy.

**Results:** The study results showed that the DMFT index value in T3 was significantly higher compared to that in T1. However, there were no significant differences in BEWE index values between the two time intervals. Furthermore, notable differences were observed in the levels of Ca and P between T1 and T3 ($Z=4.87$, $p=0.000$ and $Z=2.95$, $p=0.003$, respectively). Nevertheless, the analysis of the relationship between DMFT/BEWE indices and Ca and P levels found no significant correlation.

**Conclusions:** The results suggest that the third trimester poses a greater oral health burden. Additionally, there were notable fluctuations in the Ca and P levels during pregnancy. These findings shed light on the correlation between pregnancy phases and oral health indicators, emphasizing the significance of the salivary composition.

## Keywords

calcium, caries, erosion, phosphate, tooth

## INTRODUCTION

Oral health is a crucial aspect of the overall well-being and should be maintained during pregnancy and throughout a woman's lifetime. Maintaining proper oral hygiene can have a positive impact on the progression of general ailments such as cardiovascular diseases and diabetes.[1] Recent research indicates that 35% of American women have not undergone a dental check-up, while 56% have not visited the dentist at all during pregnancy.[2]

Hormonal and nutritional changes during pregnancy render pregnant women particularly vulnerable to tooth

decay, while dental hygiene also plays a significant role.[3] The oral cavity is frequently exposed to stomach acidity during pregnancy, which causes tooth enamel erosion. Additionally, acid reflux from the stomach caused or exacerbated by morning sickness in early pregnancy, a weakened esophageal sphincter, and pressure from the growing uterus can further contribute to dental erosion development.[4]

Various biochemical changes occur during pregnancy. Salivary calcium levels decrease during the third trimester, whereas salivary phosphate reduction begins in the second trimester, according to some studies. A decrease in phosphate concentration, which acts as a remineralizing agent, affects the remineralization process. Subsequently, the buffering capacity of saliva decreases from the first to the third trimester, resulting in an increase in the acidity of the oral environment.[5]

Numerous studies have examined the oral health status of pregnant women. Both Cordero et al. and Fakheran et al. discovered a substantial impact of oral health on the quality of life of pregnant women, with dental and gingival diseases hurting their self-perception and overall well-being.[6,7] However, Gambhir et al. pointed out a lack of knowledge and awareness about oral health among pregnant women, indicating the need for education and motivation.[8] Vamos et al. emphasized the significance of oral health promotion interventions during pregnancy, particularly those that address oral-related symptoms, hygiene behaviors, and potential oral-systemic implications.[9] The variables that contribute to this condition are complicated and interconnected, requiring a comprehensive understanding of the underlying factors.[10] However, advanced therapies hold promise for oral tissue regeneration, potentially providing a future solution for pregnant women with dental issues.[11,12]

Although various studies have been conducted[13], it is evident that there exist contradictory findings concerning the association between the decayed, missing, and filled teeth (DMFT) index and the basic erosive wear examination (BEWE) index among pregnant women. Additionally, the available literature lacks a connection between these indices and the levels of calcium and phosphorus despite the pivotal roles these minerals play in the development of tooth structure.

## AIM

This study aimed to assess the oral health of pregnant women during the first (T1) and third (T3) trimesters of pregnancy by employing two indices: DMFT and BEWE. Additionally, the study intended to investigate potential correlations between Ca and P levels and the aforementioned indices.

## MATERIALS AND METHODS

This cohort study was conducted at the Gynecology Clinic of the University Clinic Center of Kosovo between December 2019 and July 2020. The study was approved by the Ethics Committee of the Faculty of Medicine, University of Prishtina, Kosovo (reference number 4096/2019) and involved 66 pregnant women who provided consent and information following the Declaration of Helsinki. The patients were briefed on the research, willingly participated, and signed an informed consent form.

The inclusion criteria comprised pregnant women with good systemic and oral health mucosa during their first pregnancy. The exclusion criteria were as follows: diabetes, xerostomia, hypertension, preeclampsia, eclampsia, stomatitis aphthosis, viral infections, ulcerative changes in the oral cavity, dental fluorosis, use of chlorhexidine gluconate in the last three months, antibiotics, or other antibacterial agents.

A sample size of 66 individuals was determined in consultation with a statistical specialist, considering the number of women receiving initial pregnancy treatment at the Gynecology Clinic and the inclusion and exclusion criteria for the research. The sample size was calculated using the Cohran formula.[14] To prevent confounding effects during the study design and analysis phases, pregnant women in their first and third trimesters were selected for this study.

### Clinical examination for scoring of DMFT and BEWE indexes

The assessment of caries involved the application of the DMFT indices in accordance with the criteria laid out by the World Health Organization. The DMFT score is derived by tallying the number of permanent teeth affected by caries, with 'D' representing decayed, 'M' indicating missing teeth due to caries, and 'F' denoting filled teeth. The determination of DMFT scores for the samples relied on the findings of clinical examinations, in which the number of D, F, and M teeth resulting from caries was calculated. Capturing the necessary data involved the use of questionnaires and direct examination of the teeth in the samples.[15]

The BEWE index is a scoring system utilized to assess the most severely affected area within a sextant, providing practitioners with a cumulative score to aid in the management of this condition. It classifies the appearance and severity of tooth wear into four levels: 0 = indicates no damage to the enamel on the tooth surface; 1 = signifies only superficial loss of tooth enamel; 2 = indicates enamel loss and exposure of dentin on less than one third of the tooth surface; 3 = indicates enamel loss, exposed dentin, and loss of more than one third of the tooth surface without pulp exposure; 4 = represents a complete loss of enamel and exposed dentin.[16]

### Determination of calcium and phosphorus values in saliva

Ca and P values in saliva were determined by examining mineral excretion in unstimulated saliva. Saliva samples were immediately examined to avoid blood contamination, placed in a refrigerator at a temperature of 4°C (not more than a few hours), and then frozen at −20°C. The samples

were collected in high-quality thermopropylene vials that could withstand temperatures of −80°C. Saliva samples, totaling 2-3 milliliters, were collected from the pregnant women in the morning. Ca concentration was determined using the colorimetric method with Arsenazo III Randox, whereas the P concentration was determined using the UV photometric method with human molybdenum.[17]

## Statistical analysis

Data analysis was performed using SPSS Statistics for Windows (IBM, version 23.0, Armonk, NY, IBM Corp) and Excel 2016 (Microsoft Corporation, Redmond, WA, USA), and statistical significance was set at $p<0.05$. The results were presented in tabular and graphical formats. The Fisher Exact/Monte Carlo Sig test (two-sided, *p*-value) was used to compare the attribute-based series between the T1 and T3 trimesters. For numerical values such as BEWE, DMFT indices, Ca, and P, descriptive statistics were calculated, including mean, standard deviation (SD) with a 95% confidence interval (±95% CI), minimum, and maximum. Data distribution was evaluated using the Kolmogorov-Smirnov, Lilliefors, and Shapiro-Wilk tests (*p*). The variance in the parameter values analyzed in the T1 and T3 trimesters was examined using the Wilcoxon matched-pairs test (Z/p). Correlations between the index values and Ca and P levels were examined using Spearman's rank order R (R/p).

# RESULTS

The values associated with caries (D), missing (M), filled (F), and DMFT index during the first (T1) and third (T3) trimesters of pregnancy are shown in **Table 1**.

In the T3 trimester, the value of D for Z=3.14 and $p<0.01$ ($p=0.002$) was significantly higher than that of T1. However, for T=0.00 and $p>0.05$, there were no significant differences in the M ratio between T1 and T3. Furthermore, the values of F in T3 for Z=2.80 and $p<0.01$ ($p=0.005$) were significantly greater than those in T1. The DMFT index value as a whole in T3 for Z=4.37 and $p<0.001$ ($p=0.000$) was significantly greater than that in T1 **(Table 2)**.

During the T1 trimester of pregnancy, tooth erosion was not observed in 65 of 66 pregnancies (98.50%). Only one pregnancy (1.50%) during this stage showed significant enamel loss. In the T3 trimester, out of 66 pregnant women, 42 (63.60%) did not have any signs of erosive tooth wear. Among the remaining 24 women, 12 (18.20%) experienced tooth erosion, seven (10.60%) had pronounced enamel loss, and five (7.60%) experienced severe enamel loss **(Table 4)**.

The BEVE index values in relation to T1 and T3 were analyzed through cross-tabulation, yielding the following results: out of 66 pregnant women (100.00%) without recorded enamel damage at T1, 42 (64.60%) did not have any enamel damage on the tooth surface during T3. Additionally, in 12 (18.50%) pregnant women, only surface wear of the tooth enamel was observed, while in 6 (9.20%) pregnant women, enamel loss was less than one-third of the tooth surface with dentine exposure. Moreover, five (7.70%) pregnant women experienced enamel loss with dentine exposure, and another five (7.70%) had a loss of more than one-third of the tooth surface. One (100%) pregnancy that showed pronounced enamel loss during T1 also had complete enamel loss and pulp exposure during T3. The cross-tabulation for the BEVE index values during the first and third trimesters of pregnancy revealed no significant differences (Fisher's exact test =6.000 and $p>0.05$, respectively ($p=0.180$) / Monte Carlo Sig. / 0.170 – 0.190) **(Table 3)**.

**Table 1.** Descriptions of parameter values for the DMFT index in the first and third trimesters

| Trimester | Parameters | Number | Mean | Confidence −95% | Confidence +95% | Min. | Max. | SD |
|---|---|---|---|---|---|---|---|---|
| T1 | D | 66 | 3.29 | 2.7 | 3.88 | 0 | 8 | 2.41 |
| | M | 66 | 3.33 | 2.82 | 3.85 | 0 | 12 | 2.1 |
| | F | 66 | 2.12 | 1.42 | 2.82 | 0 | 14 | 2.84 |
| | DMFT | 66 | 8.76 | 7.95 | 9.56 | 2 | 18 | 3.27 |
| T3 | D | 66 | 3.74 | 3.17 | 4.31 | 0 | 9 | 2.32 |
| | M | 66 | 3.3 | 2.85 | 3.75 | 0 | 8 | 1.82 |
| | F | 66 | 2.48 | 1.78 | 3.19 | 0 | 14 | 2.87 |
| | DMFT | 66 | 9.53 | 8.65 | 10.41 | 2 | 20 | 3.57 |

T1: first trimester; T3: third trimester; D: decayed; M: missing; F: filled; SD: Standard deviation

**Table 2.** Comparison of DMFT index parameters between the two trimesters

| Parameters | Number | T | Z | *p*-level |
|---|---|---|---|---|
| D | 66 | 17 | 3.14 | 0.002 |
| M | 66 | 0 | | |
| F | 66 | 0 | 2.8 | 0.005 |
| DMFT | 66 | 0 | 4.37 | 0 |

D: decayed; M: missing; F: filled; T and Z: statistical variables

Statistical analysis revealed that calcium values in the T3 trimester of pregnancy exhibited a significant increase compared to those in the T1 trimester, with a Z-score of 4.87 and $p<0.001$ ($p=0.000$) **(Table 5)**. Similarly, phosphorus values in the T3 trimester of pregnancy also displayed a significant increase as compared to the T1 trimester, with a Z-score of 2.95 and $p<0.01$, respectively ($p=0.003$) **(Table 6)**.

Furthermore, **Fig. 1** shows the correlation between the DMF index and Ca values in the saliva of pregnant women during the T1 trimester of pregnancy. A Spearman rank order correlation coefficient (R) of −0.11 and $p>0.05$, establishes a small, negative, and non-significant correlation between the two variables. It was observed that with an increase in Ca values in the T1 trimester, the DMF index values tended to decrease.

**Table 3.** BEVE index values during the first and third trimesters

| | | | BEWE index / Third trimester | | | | Total |
|---|---|---|---|---|---|---|---|
| | | | No erosion | Initial erosion | Clear dentin loss | Hard enamel loss | |
| BEWE index First trimester | No erosion | Count | 42 | 12 | 6 | 5 | 65 |
| | | % | 64.60% | 18.50% | 9.20% | 7.70% | 100.00% |
| | Clear dentin loss | Count | 0 | 0 | 1 | 0 | 1 |
| | | % | 0.00% | 0.00% | 100.00% | 0.00% | 100.00% |
| Total | | Count | 42 | 12 | 7 | 5 | 66 |
| % | | 63.60% | 18.20% | 10.60% | 7.60% | 100.00% | |

**Table 4.** Descriptions of parameter values for the BEWE index in the first and third trimesters

| Trimester | Parameters | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| T1 | No erosion | 65 | 98.5 | 98.5 | 98.5 |
| | Clear dentin loss | 1 | 1.5 | 1.5 | 100 |
| | Total | 66 | 100 | 100 | |
| T3 | No erosion | 42 | 63.6 | 63.6 | 63.6 |
| | Initial erosion | 12 | 18.2 | 18.2 | 81.8 |
| | Clear dentin loss | 7 | 10.6 | 10.6 | 92.4 |
| | Hard dentin loss | 5 | 7.6 | 7.6 | 100 |
| | Total | 66 | 100 | 100 | |

**Table 5.** Descriptions of parameter values for calcium and phosphate in the first and third trimesters

| Trimester | Parameters | Number | Mean | Confidence −95% | Confidence +95% | Min. | Max. | SD |
|---|---|---|---|---|---|---|---|---|
| T1 | Ca | 66 | 2.22 | 2.2 | 2.24 | 2.01 | 2.55 | 0.09 |
| | P | 66 | 1.21 | 1.18 | 1.23 | 1.01 | 1.5 | 0.1 |
| T3 | Ca | 66 | 2.32 | 2.28 | 2.36 | 1.31 | 2.57 | 0.17 |
| | P | 66 | 1.29 | 1.23 | 1.34 | 0.79 | 2.2 | 0.23 |

T1: first trimester; T3: third trimester; Ca: calcium; P: phosphate; SD: standard deviation

**Table 6.** Comparison of Ca and P parameters between the two trimesters

| Parameters | Number | T | Z | *p*-level |
|---|---|---|---|---|
| Ca | 66 | 343.5 | 4.87 | 0 |
| P | 66 | 599 | 2.95 | 0.003 |

Ca: calcium; P: phosphate; T and Z: statistical variables

**Fig. 2** shows the correlation between the DMF index and Ca values in the saliva of pregnant women during the T3 trimester of pregnancy. The Spearman rank order correlation coefficient (R) of 0.05 and $p>0.05$ reveal a small, negative, and non-significant correlation between the two variables. However, with an increase in the Ca values in the saliva during the T3 trimester, the DMF index tended to increase.

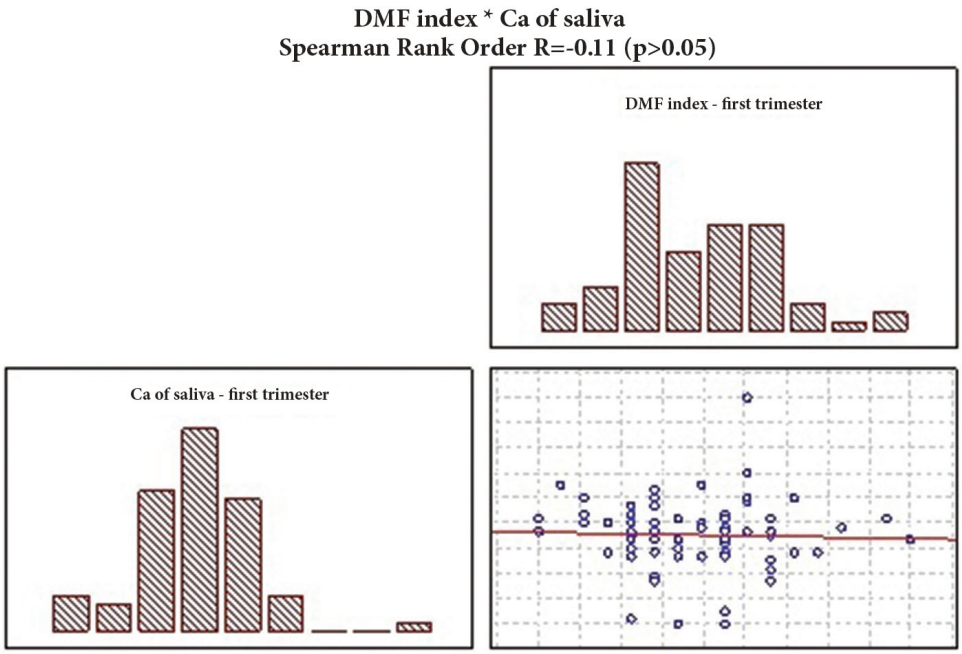


**Figure 1.** The relationship between DMF index and Ca values in the first trimester.

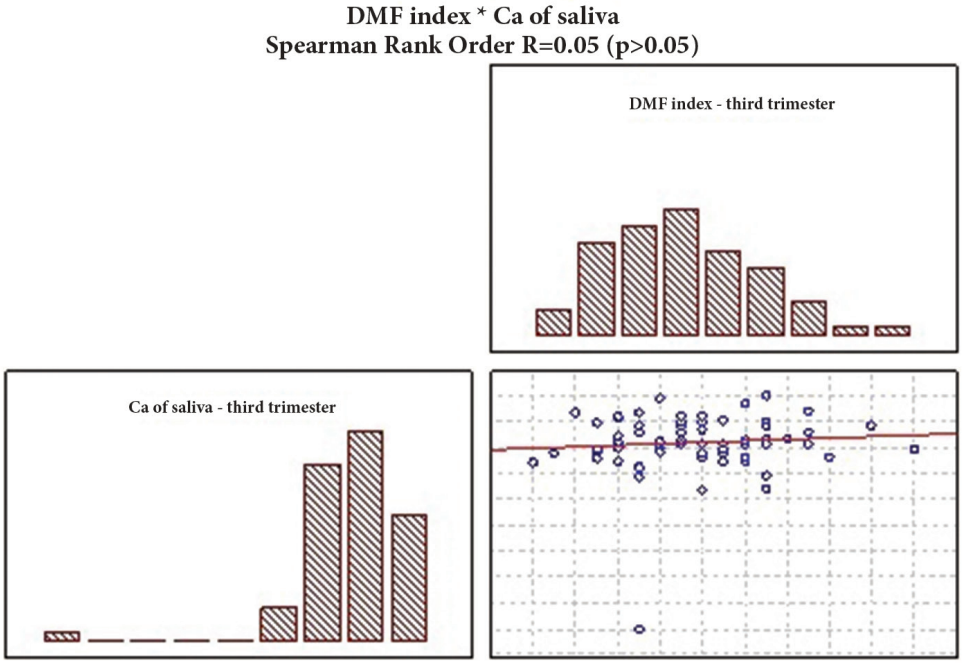


**Figure 2.** The relationship between the DMF index and Ca values in the third trimester.

**Fig. 3** shows the correlation between the BEWE index and Ca level in the saliva of pregnant women during the T1 trimester of pregnancy. A Spearman rank order correlation coefficient (R) of −0.04 and $p>0.05$, indicates a very low, negative, and non-significant correlation between the two variables. Nonetheless, an increase in the level of Ca in saliva leads to a decrease in the BEWE index values.

**Fig. 4** shows the correlation between the BEWE index and the level of Ca in the saliva of pregnant women during the T3 trimester of pregnancy. A Spearman rank order correlation coefficient (R) of −0.11 and $p>0.05$, suggests a slight, negative, and non-significant correlation between the two variables. However, an increase in the level of Ca in saliva during the T3 trimester led to a decrease in BEWE index values.

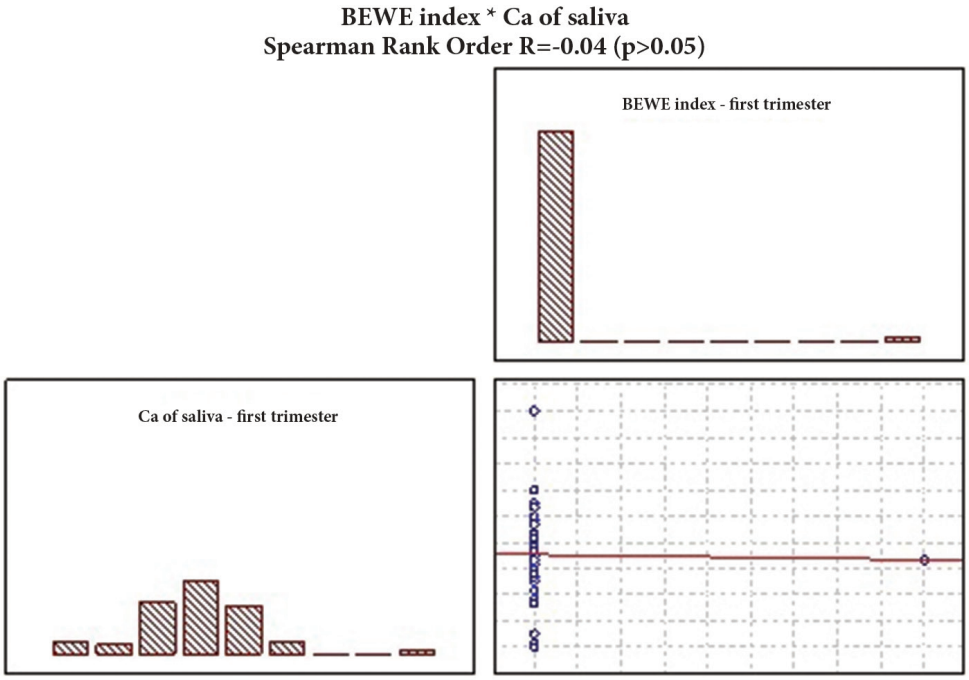


**Figure 3.** The relationship between the BEWE index and the level of Ca in the first trimester.

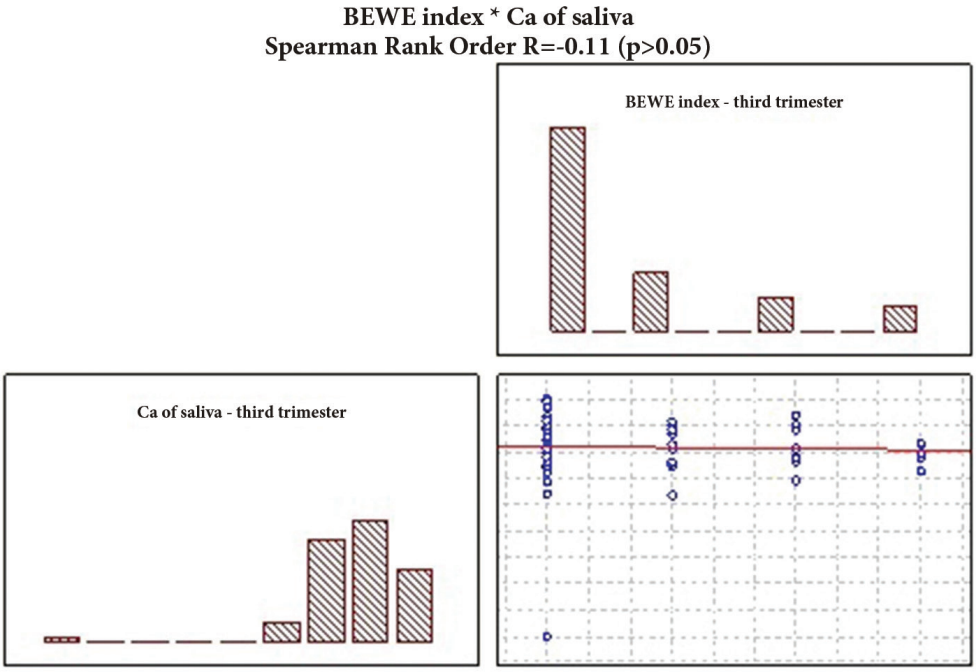


**Figure 4.** The relationship between the BEWE index and the level of Ca in the third trimester.

## DISCUSSION

The objective of the present study was to evaluate the oral health of pregnant women across various trimesters using the DMFT and BEWE indices. The study also aimed to establish a correlation between the levels of calcium and phosphorus in patients and these indices, given the role of these minerals in the remineralization process.

During the monitoring period, an increase in the DMFT index was observed in the T3 trimester of pregnancy. The increase in these values was not unexpected. Velosa-Porras et al. assessed the prevalence of caries in various stages of pregnancy and found that more than 50% of the participants developed new decay during pregnancy.[18] Furthermore, Yousef et al. discovered that during the T3 trimester, several salivary factors associated with caries undergo

changes, which can heighten the likelihood of future caries development.[19] Therefore, initiatives and assessments for caries prevention during pregnancy should commence in the initial or second trimesters.

The increase in DMFT index can also be attributed to the stress experienced during pregnancy. Existing literature suggests that stress during this period affects the growth of cortisol, leading to a decrease in immunoglobulin levels and saliva flow.[20] Consequently, these changes results in a decline in the oral immune system, dental plaque formation, and an increase in bacterial activity.

The participation of pregnant patients for the first time was also a significant factor that may have influenced the increase in DMFT values. Hom et al. discovered that first-time pregnant patients typically possess limited health knowledge, categorizing them as a vulnerable group of women.[21] This lack of awareness can contribute to various oral health issues, such as the development of tooth decay. Additionally, studies by Thomas et al. and Shamsi et al. revealed that over half of the pregnant women did not visit a dentist during their last pregnancy. On the other hand, healthcare providers often hesitate to provide dental services.[22,23] Da Costa et al. pointed out that general dentists, despite offering dental services to pregnant women, are often reluctant to perform this service because of concerns about fetal harm, patient entrapment, and potential legal issues.[24] These data indicate a poor oral health culture among pregnant women and underscores the need for appropriate action.

The elevated DMFT level during the monitoring period of this study is a cause for concern, especially considering that the participants were experiencing their first pregnancy. This is due to the fact that untreated caries contributes to an increased presence of bacteria in saliva, subsequently leading to potential transmission of these bacteria to infants and influencing the development of early childhood caries.[25] Hence, in order to mitigate this risk, it is recommended that pregnant women receive appropriate dental care, including the adoption of preventive measures such as reducing carbohydrate intake, regular dental plaque examinations performed by a dentist, as well as utilizing oral rinses that lower the acidity levels in saliva.[26]

The BEWE index was assessed in this study. Throughout the follow-up period, an upward trend in erosion values was noted, although no statistically significant differences were observed between T1 and T3. Al-Sultani evaluated the oral condition of soft and hard tissues during different trimesters of pregnancy. His findings indicated a significant relationship between dental erosion and the stage of pregnancy.[27] This correlation can be attributed to the specific periods of pregnancy when women experience more frequent episodes of vomiting, resulting in an increased risk of dental erosion due to repeated exposure to acidic stomach contents.[28] Additionally, studies have suggested that the elevated acidity in saliva during pregnancy may be caused by higher levels of progesterone and estrogen, which can impact the demineralization process and protective properties of tooth enamel.[29,30] Consequently, it is crucial for pregnant women to be aware of the potential risk of erosive teeth and to take proactive measures to maintain good oral hygiene.

Regarding the concentration of Ca and P ions, the study findings indicated an increase in the saliva of pregnant women during the T3 trimester compared to the T1 trimester. These results align with those of the recent studies conducted by Sultana et al. whereas other studies have reported conflicting outcomes.[31] Salvolini et al. discovered a decrease in the levels of Ca and P during pregnancy and attributed this decline to the increased demand for these minerals in fetal bone ossification.[32] Moreover, Breslau et al. found that elevated estrogen levels during pregnancy tended to reduce Ca levels.[33] The elevation in Ca and P concentrations observed in our study could be attributed to the possibility that some participants consumed food prior to saliva collection despite being advised not to do so. However, this aspect did not compromise the reliability and validity of our research.

Additionally, this study aimed to establish a correlation between DMFT and BEWE indices and the concentrations of Ca and P ions. Our findings are consistent with those of a recent study by Ghasemi et al., which revealed no significant relationship between DMFT and Ca and P.[34]

Lastly, it is important to note that the physiological and hormonal changes that occur during pregnancy can significantly affect a woman's health. Since the oral cavity is particularly vulnerable to these changes, it is important to take into account any potential pathological and physiological changes.[35] Consequently, maintaining a well-planned diet prior to conception, during pregnancy, and while breastfeeding is crucial in ensuring optimal health for both mother and child.[36]

## Limitations of the study

One limitation of the study pertained to the absence of data regarding oral hygiene performance, including the frequency of tooth brushing and regular visits to dental care professionals. These variables have the potential to influence DMFT and BEWE indices. Additionally, the study did not account for the current condition of the periodontium, the levels of estrogen and progesterone hormones in the participants, or the impact of the COVID-19 pandemic on the research. Recent studies have indicated that these factors can significantly affect the Ca and P levels, as well as the oral health of pregnant women.[37-39] Additionally, the small number of participants should be considered when interpreting our findings. Notwithstanding these constraints, our study provides compelling evidence of the correlation between oral health status and mineral levels in pregnant women over time.

## CONCLUSIONS

Considering the limitations of the present study, these findings indicate a progressive increase in DMFT values during

pregnancy. Notably, Ca and P levels significantly increased in the T3 trimester. No significant correlation was observed between the DMFT/BEWE indices and mineral levels.

In light of these results, it is recommended that preventive measures for caries be initiated as early as possible during pregnancy to ensure the oral health of both mother and child. These measures encompass maintaining proper oral hygiene, including regular brushing and flossing, attending dental check-ups, and adopting a balanced diet low in sugary foods. By adhering to these practices, the likelihood of developing tooth decay can be considerably reduced. Additionally, seeking advice from a healthcare professional specializing in dental care during pregnancy is advisable, as they can provide further guidance and support regarding preventive measures.

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## Competing Interests

The authors declare that they have no competing interests.

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# Оценка состояния здоровья полости рта у беременных и его корреляция с уровнем кальция и фосфата


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## Резюме

**Цель:** Целью данного исследования было проанализировать состояние полости рта беременных женщин. Анализ включает оценку двух ключевых индексов: индекса разрушенных, отсутствующих и запломбированных зубов (DMFT) и индекса основного эрозионного износа (BEWE - basic erosive wear examination). Кроме того, в этом исследовании изучались потенциальные корреляции между уровнями кальция (Ca) и фосфата (P) в течение определённых интервалов времени и вышеупомянутыми показателями здоровья полости рта.

**Материалы и методы:** В исследование были включены 66 женщин. Обследование заключалось в оценке состояния зубов по индексу DMFT. Дополнительно оценивали эрозивный кариес зубов по индексу BEWE. Концентрацию Ca и P в слюне определяли колориметрическим методом. Эти измерения проводились в течение первого (T1) и третьего (T3) триместров беременности.

**Результаты:** Результаты исследования показали, что значение индекса DMFT в T3 было достоверно выше по сравнению с таковым в T1. Однако существенных различий в значениях индекса BEWE между двумя временными интервалами не было. Кроме того, заметные различия наблюдались в уровнях Ca и P между T1 и T3 (Z=4.87, *p*=0.000 и Z=2.95, *p*=0.003 соответственно). Тем не менее, анализ взаимосвязи между индексами DMFT/BEWE и уровнями Ca и P не выявил значимой корреляции.

**Заключение:** Результаты показывают, что третий триместр представляет собой большую нагрузку на здоровье полости рта. Кроме того, во время беременности наблюдались заметные колебания уровней Ca и P. Эти результаты проливают свет на корреляцию между фазами беременности и показателями здоровья полости рта, подчёркивая важность состава слюны.

## Ключевые слова

кальций, кариес, эрозия, фосфат, зуб