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RESEARCH ARTICLE

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Do more pregnancies increase the risk of periodontal disease?

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Abstract

Background

Hormonal changes in pregnancy and their induced effect on periodontal health are well documented. The present study is aimed at the potential repercussions of multiple pregnancies on periodontal health.

Materials and methods

Our study utilized data from key sections of the NHANES. All the pertaining and relevant data for the study is collected. Our exposure variable was the number of pregnancies, and the outcome variable was periodontal disease. The number of pregnancies is classified as one, two, three, four, or more. Age, gender, race/ethnicity, education, poverty/income ratio, marital status, and other variables. Multiple logistic regression models were employed to assess the impact of multiple pregnancies on periodontal disease.

Result






The crude and multiple logistic regression analyses revealed that none of the variables were significantly associated with the prevalence of periodontitis. In univariate analysis, patients with one or two pregnancies had higher odds of experiencing periodontitis (OR 1.154, 95% CI 0.748-1.779), (OR 1.464, 95% CI 0.864-2.483) respectively. However, these associations did not reach statistical significance.

Conclusion

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version 1 16 Oct 2024	 view	 view	

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Any reports and responses or comments on the article can be found at the end of the article.

Within the limitation of the study, there is no significant relationship between parity and the prevalence of periodontitis, the longitudinal study may be warranted to delve deeper into any potential associations.

Keywords

Parity; Multiple Pregnancy; Periodontal Disease; NHANES

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REVISED Amendments from Version 1

The Introduction has been revised for better readability and to provide clearer context on the study's rationale.

Updates have been made to the Methods section to clarify the definition of the exposure variable, as suggested by the reviewers.

The Results section has been refined to improve clarity and presentation based on reviewer feedback.

The Discussion now includes additional limitations, specifically addressing the impact of categorizing pregnancy as a variable and the exclusion of edentulous participants.

Any further responses from the reviewers can be found at the end of the article

Introduction

Periodontal diseases are influenced by a variety of factors.¹ This prevalent oral condition is initiated by the accumulation of dental biofilm and is further exacerbated by various local and systemic elements.² Notably, hormonal factors play a significant role in impacting periodontal health.³ Fluctuations in progesterone and estrogen levels during different life stages, including puberty, pregnancy, and menopause, have been identified as contributors to adverse effects on periodontal health.⁴ The hormonal influence leads to gingival changes that worsen pre-existing dental biofilm-induced gingivitis. Moreover, the absence of estrogen, without the presence of dental biofilm, can result in desquamative changes in the gingiva, representing the other end of the hormonal spectrum.⁵

During the transitional phases between puberty and menopause, the nine-month duration of pregnancy introduces alterations to periodontal health, manifesting as both localized and generalized changes in the gingiva. Localized changes are characterized by the presence of a pregnancy tumor, while generalized changes manifest as an overall enlargement of the gingiva.⁶ This period is associated with heightened inflammation of the gingival tissues, commonly known as pregnancy gingivitis. Symptoms include redness, tenderness, and swelling of the gingiva, accompanied by spontaneous bleeding or bleeding during routine activities such as tooth brushing or eating.⁷ Typically commencing in the second month of pregnancy, these changes can peak in severity during the third trimester.⁸

The pathogenesis of altered periodontal health during pregnancy involves a combination of factors.⁴ Studying multiple pregnancies, as opposed to single pregnancies, is critical because cumulative gestational exposure to hormonal fluctuations and immune adaptations may exacerbate oral inflammatory responses, potentially amplifying periodontal vulnerability over successive pregnancies. A key aspect is the rise in levels of hormones such as oestradiol, oestriol, and notably, progesterone. These hormones play a central role in modifying the host immune-inflammatory response to oral bacteria. Specifically, *Prevotella intermedia*, a *Bacteroides* species thriving on estrogen and progesterone, experiences a significant increase during pregnancy, serving as a primary bacterial factor.⁹

Furthermore, these hormones exhibit specific receptors on gingival fibroblasts and epithelial cells, influencing gingival changes. Additionally, they act on endothelial cells, increasing vascular permeability and contributing to the overall alterations observed in the gingiva during pregnancy.¹⁰ This intricate interplay underscores the multifaceted nature of periodontal health dynamics in the context of pregnancy.

Progesterone emerges as the key hormone driving these changes, yet estrogen also plays a significant role in inducing vascular changes.¹¹ Simultaneously, deficiencies in host inflammatory cells, particularly in neutrophil chemotaxis, contribute to the adverse aspects of periodontal health. Significantly, vitamin D deficiency is a prevalent concern in the pregnant population, as highlighted in various publications.¹² The role of vitamin D in periodontitis is well-documented.

The susceptibility to oxidative stress increases during pregnancy due to heightened metabolic demands and increased tissue oxygen requirements, a factor strongly implicated in the inflammatory process.¹³ Additionally, the presence of gestational diabetes may further disrupt host defense mechanisms, altering the delicate balance between health and disease.¹⁴ The intricate interplay of these hormonal, nutritional, and metabolic factors underscores the complexity of periodontal health dynamics during pregnancy.

While numerous studies have delved into the connection between pregnancy and periodontal disease, there is a scarcity of research exploring the impact of multiple pregnancies on the increased risk of periodontal issues.^{15,16} Given the tissue changes occurring with each pregnancy and the cumulative effect of repeated exposure in subsequent pregnancies, there

is a hypothetical expectation of a deteriorating impact on periodontal health.⁴ Therefore, understanding the potential repercussions of multiple pregnancies on periodontal health holds significant importance for both expectant mothers and healthcare professionals.

By acknowledging this potential correlation, healthcare providers can underscore the importance of maintaining good oral hygiene practices and seeking appropriate dental care during pregnancy to mitigate any possible risks. In this context, an effort has been made to investigate the relationship between multiple pregnancies and periodontal health. This exploration aims to enhance our comprehension of potential risks and preventive measures associated with periodontal disease in individuals experiencing multiple pregnancies. Such knowledge can serve as a guide for healthcare professionals, enabling them to offer pertinent advice, facilitate early detection, and provide timely interventions to support optimal periodontal health outcomes in pregnant women. Existing evidence on parity and periodontal disease derives largely from high-income settings, with limited data from regions like [low-income countries], where higher fertility rates and disparities in oral healthcare access may uniquely shape risk trajectories. This study addresses this gap by examining the relationship in a population with demographics, offering insights critical to tailored prevention strategies.

Methods

Study design and population

The National Health and Nutrition Examination Survey (NHANES) is a comprehensive, cross-sectional survey conducted in the United States, aiming to provide a nationally representative overview of non-institutionalized individuals living in households. Participants in this survey undergo a series of assessments, including the completion of a questionnaire, medical and dental examinations, and various laboratory tests. The protocols for collecting oral health data in the NHANES 2011–2012 and NHANES 2013–2014 cycles were approved by the Centres for Disease Control and Prevention National Centre for Health Statistics Research Ethics Review Board. Written informed consent was secured from all survey participants.

Our study utilized data from key sections of the NHANES, including demographic information, examination results, questionnaire responses, and limited access data. The focus was on individuals aged 18 years and older who underwent a dental examination, with exclusion criteria in place to remove edentulous subjects from our analysis, we ensure a thorough and targeted evaluation of oral health within a diverse and nationally representative sample of the U.S. population. In this study, pregnancy exposure is operationalized as completed pregnancies (live births or stillbirths), excluding miscarriages or terminations, to align with parity metrics commonly used in population health research.

Variable of interest

Exposure variable

Number of pregnancies

Outcome variable

Periodontal disease

For this investigation, we used the NHANES complete periodontal examination data to calculate periodontal disease indices using Eke et al. definition of periodontal disease¹⁷). According to this definition, periodontal disease was classified as follows: Severe periodontitis: ≥ 2 interproximal sites with loss of attachment (LOA) ≥ 6 mm (not on the same tooth) and ≥ 1 interproximal site with probing depth (PD) ≥ 5 mm; Moderate periodontitis: ≥ 2 interproximal sites with LOA ≥ 4 mm (not on same tooth), or ≥ 2 interproximal sites with PD ≥ 5 mm (not on same tooth); Mild periodontitis: ≥ 2 interproximal sites with LOA ≥ 3 mm, and ≥ 2 interproximal sites with PD ≥ 4 mm (not on same tooth) or one site with PD ≥ 5 mm and finally, no periodontitis group whose has no evidence of mild, moderate, or severe periodontitis.¹⁸

Covariate variable

To ensure a comprehensive examination and control for any factors that might influence the outcome, our analysis includes a range of covariates. These covariates serve the crucial purpose of minimizing the impact of potential confounders, allowing us to scrutinize the relationship between the exposure and outcome with greater precision. The diverse set of covariates comprises age, gender, race/ethnicity, education, poverty/income ratio, marital status, occupation, alcohol consumption, dental insurance coverage, dental visit frequency, and body mass index (BMI). Age is categorized into six groups: (18-30), (31-40), (41-50), (51-60), and over 60 years. Gender is identified as either female or male. Race and ethnicity are classified as non-Hispanic White, non-Hispanic Black, Mexican American and other

Hispanic, and non-Hispanic Asian. Poverty indices are categorized into low, middle, and high. Marital status is delineated as yes or no. Occupation is categorized as working and non-working. Dental visits are categorized as regular and not regular. Dental insurance coverage is classified as yes or no. The number of pregnancies is classified as one, two, three, four, or more. Lastly, education level is categorized as less than high school, high school, and college graduate or above. By meticulously examining and accounting for these covariates, we aim to obtain results that are closer to the true relationship between the exposure and outcome, free from the confounding effects of other variables.

Statistical analysis

The data were obtained by consolidating demographic, health questionnaire, clinical examination, and limited access data from NHANES (2011–2012) with corresponding files from NHANES (2013–2014). To ensure unbiased point estimates and accurate variance estimation, considering the complex sampling design of NHANES, we applied proper sampling weights and utilized a licensed version of SAS survey procedures, following the recommendations of the National Centre for Health Statistics and the Centres for Disease Control and Prevention.

An analysis of the demographics and disease status of the study population was conducted using the Rao-Scott chi-squared test. Additionally, both simple and multiple logistic regression models were employed to assess the impact of multiple pregnancies on periodontal disease. The multiple regression model included age, sex, race, income, and education level as explanatory variables. The selection of these potential confounders was based on either current literature evidence or their association with insurance and dental care utilization variables observed in bivariate analysis. In SPSS, discrete missing values were assigned by designating '999' in the primary text box while leaving subsequent fields blank; once applied, this value was labeled to explicitly identify missing data entries in the dataset. The significance level was set at $p \leq 0.05$.

Results

Summary of the results

Table 1 presents the demographic characteristics of the study subjects, including weighted percentages. Among the 2128 subjects, more than one-quarter were aged over 60 years [insert specific age], 42.9% identified as non-Hispanic white, 34.6% had a high household level, and over half had either an associate or college degree. The majority of subjects had some form of health insurance and had visited the dentist within the 12 months preceding the survey.

Table 1. Demographic characteristics of the study subjects (n=2128).

	Total (n)	Percentage % ^a
Age		
18-30 years	482	22.7
31-40 years	327	15.4
41-50 years	347	16.3
51-60 years	357	16.8
More than 60 years	615	28.9
Race/ethnicity		
Mexican American	296	13.9
Other Hispanic	181	8.5
Non-Hispanic White	913	42.9
Non-Hispanic Black	426	20.0
Other Races Including Multi-Racial	312	14.7
Household income		
Below Poverty Line	644	30.3
Near Poverty	181	8.5
Low-Income	324	15.2
Middle-Income	242	11.4
High-Income	737	34.6

Table 1. *Continued*

	Total (n)	Percentage % ^a
Education level		
Less than High School	408	19.2
High School Level	450	21.1
AA or College Degree	1157	54.4
Weight status (Based on BMI)		
Underweight	595	28.0
Normal	564	26.5
Overweight	459	21.6
Obese	510	24.0
Alcohol consumption status		
Non-drinker	1363	64.1
Drinker	765	35.9
Diabetes		
Present	177	8.3
Not present	1951	91.7
Periodontal disease		
Severe	2	0.1
Moderate	45	2.1
Mild	172	8.1
Not present	1909	89.7
Time of most recent dental visit		
Less than 1 year	1333	62.6
1-2 years	388	18.2
More than 2 years	407	19.1
Insurance coverage		
Yes	1500	81.53
No	516	18.47
Pregnancy		
Not pregnant	827	38.9
One	161	7.6
Two	323	15.2
Three	295	13.9
Four	229	10.8
More than 4	293	13.8

^aWeighted row percentages.

Effect of sociodemographic factors on the prevalence of periodontitis

The subjects were categorized based on the severity of periodontitis, dividing them into groups of no, mild, moderate, and severe periodontitis (refer to [Tables 2](#) and [3](#)). The prevalence of periodontitis exhibited a significant difference primarily based on the subjects' age. Subjects in older age brackets were consistently more likely to have some form of periodontitis compared to their younger counterparts. Additionally, the prevalence of periodontitis on average was higher among pregnant subjects compared to those who were not pregnant.

Effect of health insurance, dental care utilization, and periodontal disease status on the prevalence of periodontics among study subjects

In [Table 4](#), approximately 9.4% of subjects with health insurance and 9.2% of subjects without health insurance exhibited some form of periodontitis. Analyzing periodontitis concerning the time elapsed since the last dental visit, we observed

Table 2. Subject demographics and demographic predictors of periodontics in study subjects (n=2128).

	Total (n)	No periodontitis %	Mild periodontitis %	Moderate periodontitis %	Severe periodontitis %	P-value
Age						
18-30	482	91.3%	0.4%	1.5%	6.8%	0.043*
31-40	327	90.5%	0.0%	1.8%	7.6%	
41-50	347	90.8%	0.0%	2.0%	7.2%	
51-60	357	86.0%	0.0%	1.7%	12.3%	
More than 60 years	615	89.6%	0.0%	3.1%	7.3%	
Race/ethnicity						
Mexican American	296	90.5%	0.0%	2.7%	6.8%	0.835
Other Hispanic	181	89.0%	0.6%	2.2%	8.3%	
Non-Hispanic White	913	89.5%	0.1%	2.1%	8.3%	
Non-Hispanic Black	426	89.0%	0.0%	2.1%	8.9%	
Other Races Including Multi-Racial	312	91.0%	0.0%	1.6%	7.4%	
Household income						
Below Poverty Line	644	87.9%	0.2%	2.0%	9.9%	0.830
Near Poverty	181	90.1%	0.0%	2.2%	7.7%	
Low-Income	324	91.4%	0.0%	2.5%	6.2%	
Middle-Income	242	89.7%	0.0%	2.9%	7.4%	
High-Income	737	90.5%	0.1%	1.8%	7.6%	
Education level						
Less than High School	408	90.9%	0.2%	1.7%	7.1%	0.842
High School Level	450	89.3%	0.0%	1.8%	8.9%	
AA or College Degree	1157	89.2%	0.1%	2.5%	8.2%	
Pregnancy						
Not Pregnant	827	90.7%	0.0%	1.5%	7.9%	0.392
One	161	87.0%	0.0%	3.1%	9.9%	
Two	323	89.5%	0.3%	1.9%	8.4%	
Three	295	90.8%	0.3%	2.0%	6.8%	
Four	229	88.6%	0.0%	4.4%	7.0%	
More than 4	293	88.4%	0.0%	2.0%	9.6%	

*Weighted row percentages.

*Statistically Significant at 0.05.

that 11% of subjects who had a dental visit within 12 months prior to the survey had periodontitis. For those with a dental visit more than 12 months but less than 24 months prior, 8.5% had periodontitis, and 9.8% of those with their most recent dental visit more than 2 years before the survey had periodontitis.

Table 3. Subject characteristics and health-related predictors of periodontitis among study subjects (n=2128).

	Total (n)	No periodontitis %	Mild periodontitis %	Moderate periodontitis %	Severe periodontitis %	P-value
Alcohol consumption status						
Non-drinker	1363	88.9%	0.1%	2.1%	9.0%	0.258
Drinker	765	91.1%	0.1%	2.2%	6.5%	
Weight status (Based on BMI)						
Underweight	595	88.6%	.2%	1.7%	9.6%	0.358
Normal	564	88.5%	0.0%	2.3%	9.2%	
Overweight	459	90.8%	0.0%	2.8%	6.3%	
Obese	510	91.4%	0.2%	1.8%	6.7%	
Diabetes						
Present	177	87.0%	0.0%	3.4%	9.6%	0.498
Not present	1951	90.0%	0.1%	2.0%	7.9%	
Education level						
Less than High School	408	90.9%	0.2%	1.7%	7.1%	0.842
High School Level	450	89.3%	0.0%	1.8%	8.9%	

^aWeighted row percentages.**Table 4. Distribution of periodontitis per dental visits, insurance coverage, occupation, and, marital status among study subjects.**

	Total (n=2128)	No periodontitis %	Mild periodontitis %	Moderate periodontitis %	Severe periodontitis %	P-value
Time of most recent dental visit						
Less than 1 year	1333	89.0%	0.2%	2.4%	8.4%	0.354
1-2 years	388	91.5%	0.0%	2.3%	6.2%	
More than 2 years	407	90.2%	0.0%	1.0%	8.8%	
Insurance						
Yes	1500	90.5%	0.0%	1.8%	7.6%	0.532
No	516	90.8%	0.0%	2.0%	7.2%	
Occupation						
Working	1134	90.2%	.1%	1.9%	7.8%	0.793
Not Working	994	89.1%	.1%	2.4%	8.4%	
Marital Status						
Married	1495	89.7%	0.0%	2.4%	7.9%	0.169
Not Married	520	89.2%	0.4%	1.5%	8.8%	

^aWeighted row percentages.

Both crude and multiple logistic regression analyses revealed that none of the variables were significantly associated with the prevalence of periodontitis. In univariate analysis, patients with one and two pregnancies had higher odds of experiencing periodontitis (OR 1.46, 95% CI 0.864-2.483), (OR 1.15, 95% CI 0.748-1.779) respectively. However, these associations did not reach statistical significance ($p > 0.05$). Patients with dental visits in the 1-2 year range had greater odds (OR 1.13, 95% CI 0.772-1.651) of having periodontitis, but this association was not statistically significant ($p > 0.05$) (see Table 5).

Table 5. Adjusted and Unadjusted Odds Ratio using Logistics Regression Analysis.

Variable	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Number of pregnancies		
Not Pregnant	Ref	Ref
One	0.78(0.51-1.199)	1.46(0.864-2.483)
Two	1.14(0.639-2.044)	1.15(0.748-1.779)
Three	0.90(0.541-1.484)	0.95(0.588-1.521)
Four	0.78(0.45-1.308)	1.08(0.652-1.78)
More than 4	0.98(0.567-1.679)	1.22(0.788-1.897)
Dental Visit		
Less than one year	Ref	Ref
1-2 years	0.76(0.509-1.123)	1.13(0.772-1.651)
More than 2 years	0.89(0.613-1.281)	0.91(0.558-1.489)
Insurance		
No	Ref	Ref
Yes	1.23(0.871-1.733)	1.21(0.859-1.713)

No Periodontitis=0 vs. Periodontitis (all three)=1.

Discussion

The primary aim of this study is to investigate the association between multiple pregnancies and the severity of periodontal disease/periodontitis. According to the study results, there was no discernible difference in the prevalence of periodontitis between individuals with single pregnancies and those with multiple pregnancies. However, it was noted that the prevalence of periodontitis was higher in pregnant individuals compared to non-pregnant ones. The study findings also indicated that patients with two pregnancies had higher odds of experiencing periodontitis than those with only one pregnancy, although this difference did not reach statistical significance. Both unadjusted and adjusted odds ratios for the number of pregnancies suggested higher odds of periodontitis during pregnancy.

The findings of the current study align with earlier reported research.^{19,20} Previous studies indicated higher gingival index and periodontal probing depth among women with prior pregnancies compared to primigravida. However, after adjusting for factors such as age, socio-economic status, education, and other associated risk factors, no correlation was identified. Nevertheless, some studies have demonstrated a significant association between increased gingival scores and periodontal probing depth in women with multiple pregnancies compared to those with a single pregnancy.²¹ Additionally, research has shown heightened gingival inflammation and increased periodontal probing depth during pregnancy.²²⁻²⁴

Piscoya et al. conducted a study exploring various factors, including the number of pregnancies and the prevalence of periodontitis. Their findings, organized in a hierarchy, revealed that schooling, family income, body mass index, and bacterial plaque were associated with the prevalence of periodontitis, but not with multiple pregnancies.²⁰ Another study concluded that, in addition to other factors, pregnant women with two or more previous births [multigravidae] exhibited significantly higher gingival index and periodontal probing depth scores compared to those with one previous birth. However, the increased gingival index and periodontal probing depth in multigravidae might be attributed to untreated gingival or periodontal disease from the first pregnancy persisting during subsequent pregnancies. Furthermore, factors such as low socio-economic status and lower educational levels could contribute to negligence of oral hygiene, leading to an increased prevalence of periodontitis.²¹

The variations in study findings may be attributed to several factors. Multiparous women typically tend to be older than prima gravida women, leading to a longer cumulative exposure to etiological agents of disease. Additionally, the absence of treatment during or between pregnancies results in untreated periodontal disease persisting into subsequent pregnancies.²¹ Multiparous women, especially those with young children, may prioritize other systemic health conditions, diverting attention, time, energy, and finances away from personal dental care. This tendency can result in neglected oral care, increased plaque accumulation, and a higher prevalence of gingival conditions.¹⁹

Therefore, the observed higher gingival index and probing depth in multiparous women may be more related to sociodemographic backgrounds than to a true association with parity. It is widely recognized that existing periodontal

disease is exacerbated during pregnancy, and pregnancy itself does not directly cause gingival or periodontal disease. Pregnancy-associated physiological changes can superimpose gingival inflammation on pre-existing dental plaque accumulation. If oral health is well-maintained with the absence of gingival inflammation before pregnancy, the condition of pregnancy itself may not induce gingivitis or periodontitis. Notably, existing studies have not taken into account pre-pregnancy gingival inflammation and treatment for the periodontal condition, which could influence the study outcomes.²⁰

Hormonal alterations during pregnancy contribute to an increase in specific periodontal pathogens, such as *Prevotella intermedia*, which utilizes elevated hormone levels as a nutrient. Physiological microvascular changes observed in pregnancy, coupled with exposure to altered dental biofilm, may exacerbate pre-existing gingival conditions. The surge in estrogen levels, particularly progesterone, reaches a 20-fold increase, leading to changes in vascular permeability that cause gingival swelling and elevated crevicular fluid levels.²⁵ The heightened production of prostaglandins, in addition to the vascular burden, may intensify gingival inflammation, result in the loss of keratinization of gingival epithelium, and foster fibroblast proliferation. Furthermore, the altered host response is characterized by decreased chemotaxis and phagocytic capacity of neutrophils, along with the down-regulation of IL-6 production. This exposes the gingival tissue to microbial attack, resulting in increased gingival inflammation.²⁶

Gestational diabetes compounds the detrimental effects on host immunity, fostering the proliferation of pathogenic microflora and increasing the risk of periodontal disease.²⁵ Repeated exposure to these events during multiple pregnancies is anticipated to lead to heightened periodontal destruction. However, it has been observed that postpartum, there is a substantial decrease in gingival inflammation, and gingival health is often restored to the pre-pregnancy state.²⁷ Furthermore, the experiences of gingival disease during previous pregnancies may prompt individuals to undergo periodontal treatment, contributing to the restoration of gingival health.²⁸ This could explain the absence of a significant difference in periodontitis among individuals with one pregnancy and those with multiple pregnancies in the present study.

There are several limitations to our study. Notably, the exacerbation of existing periodontal conditions during pregnancy is a well-known phenomenon. Unfortunately, our study lacked data on the status of gingival inflammation before pregnancy, which could have influenced the study outcomes. Additionally, being a retrospective cross-sectional study, our investigation relied on data from a study not specifically designed to address our hypothesis, potentially introducing clinical variations in the disease process. The utilization of dental care after the first pregnancy was not explored, and if a significant number of individuals underwent periodontal treatment after the initial pregnancy and before subsequent pregnancies, it might impact the outcomes. While a standardized protocol was followed for the diagnosis of periodontal disease, there remains a possibility of misclassification, albeit likely to be non-differential. Periodontal status was assessed only at the baseline survey, and changes over follow-up were not considered. It is conceivable that individuals initially free of periodontal disease might develop the condition later, potentially leading to an underestimation of the association for those groups. Another key limitation of using pregnancy as a categorical rather than a continuous variable is the potential loss of nuanced information regarding the incremental effects of each additional pregnancy on periodontal health. The exclusion of edentulous participants may have influenced our study findings, as individuals without teeth are unable to develop periodontitis and may represent a subgroup with a history of severe periodontal disease. To address these limitations, future studies should aim for larger longitudinal prospective designs to validate the findings from this initial study.

While the study did not identify a difference in the prevalence of periodontitis between single and multiple pregnancies, the findings hold significance on two fronts. Firstly, the data were obtained from a substantial sample size, highlighting increased gingival and periodontal changes during pregnancy. This underscores the need to educate all women about these findings, aiming to prevent periodontal changes during pregnancy that may impact their regular daily routines. Secondly, as periodontal disease is deemed a risk factor for pregnancy outcomes, its control assumes prime importance. Addressing and managing periodontal health becomes crucial in optimizing pregnancy outcomes.

Conclusion

In summary, this study has explored the relationship between parity and the prevalence of periodontitis, revealing no significant association between the prevalence of periodontitis and the number of pregnancies. However, a longitudinal study may be warranted to delve deeper into any potential associations.

Authors' contributions

Both Authors contributed equally from the idea to the preparing the draft and both authors reviewed and prepared the final draft of the study.

Ethics and consent

The protocols for collecting oral health data in the NHANES 2011–2012 and NHANES 2013–2014 cycles received approval from the Centres for Disease Control and Prevention National Centre for Health Statistics Research Ethics Review Board. All survey participants provided written informed consent before publishing their information.

<https://www.cdc.gov/nchs/nhanes/irba98.htm>

Data availability

Availability of data

Figshare: Do more pregnancies increase the risk of periodontal disease?, <https://doi.org/10.6084/m9.figshare.25662546>²⁹

The project contains the following underlying data:

- Demographical Characteristics (e.g., gender, income, BMI ...), Periodontal Disease status, Pregnancy status, and dental visits.

Data are available under the terms of the [Creative Commons Attribution 4.0 International license](#) (CC-BY 4.0).

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Open Peer Review

Current Peer Review Status:   

Version 2

Reviewer Report 10 March 2025

<https://doi.org/10.5256/f1000research.177715.r364984>

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Dr. Talal Shihayb

Boston University, Boston, Massachusetts, USA

I had a hard time tracking the changes and suggest an easier way of tracking the changes for reviewers.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Periodontitis-systemic diseases, oral epidemiology, advanced methods, meta-research in oral health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 27 February 2025

<https://doi.org/10.5256/f1000research.177715.r368196>

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Muhammad Anas 

Bacha Khan College of Dentistry, Mardan, Pakistan

Title: The Association Between Pregnancy and Periodontitis: A Cross-Sectional Study
Overall Assessment: This study investigates the relationship between pregnancy and periodontitis, providing valuable insights into the impact of pregnancy on gingival health. While the study has several strengths, including a substantial sample size and standardized protocol for diagnosing periodontal disease, it also has some limitations that affect the interpretation of the results.

Recommendations:

1. Future studies should aim for larger longitudinal prospective designs to validate the findings from this initial study.
2. Consider collecting data on the status of gingival inflammation before pregnancy to better understand the impact of pregnancy on periodontal health.
3. Explore the utilization of dental care after the first pregnancy and its potential impact on the outcomes.
4. Consider using more nuanced measures of pregnancy, such as a continuous variable, to capture the incremental effects of each additional pregnancy on periodontal health.

Conclusion:

In conclusion, while this study provides valuable insights into the relationship between pregnancy and periodontitis, it has several limitations that affect the interpretation of the results. Future studies should aim to address these limitations and provide more robust evidence on the impact of pregnancy on periodontal health.

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Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Dentistry, Oral Health, Oral and maxillofacial Surgery

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 12 February 2025

<https://doi.org/10.5256/f1000research.177715.r364985>

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Nancy Ajwa 

College of Dentistry, Riyadh Elem University, Riyadh, Saudi Arabia

Thank you Authors for revising the manuscript.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Public Health, Periodontology, Orthodontology, Dentistry

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Reviewer Report 26 December 2024

<https://doi.org/10.5256/f1000research.170283.r343703>

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Nancy Ajwa 

College of Dentistry, Riyadh Elm University, Riyadh, Saudi Arabia

The current structure provides a good foundation for the research paper. I have a few minor comments on the paper, which I am splitting in the headings so that authors can easily identify and improve the respective sections.

Introduction:

- Consider moving some of the detailed descriptions of the hormonal mechanism to later paragraphs for better flow.
- Add a brief sentence early in the introduction highlighting why studying multiple pregnancies (versus single pregnancy) is particularly important
- Consider mentioning any geographical or population-specific gaps in current knowledge that this study helps address

Methods:

- Clarify the definition of pregnancy exposure (whether it includes completed pregnancies only or all pregnancies)
- Add information about how missing data was handled in the analysis

Results:

- Round the odds ratios to 2 decimal places instead of 3 for better readability
- Include smoking status data in Table 1, as it's an important variable that was mentioned in the methods but not shown in the results

Discussion:

- Add a brief discussion of the limitations of using pregnancy as a categorical rather than continuous variable
- Include a short paragraph acknowledging the potential impact of excluding edentulous participants on the study findings

These modifications would improve the manuscript while maintaining its overall scientific merit and indexing. The core findings and conclusions remain sound, and these suggested changes are minor in nature.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Public Health, Periodontology, Orthodontology, Dentistry

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Author Response 30 Jan 2025

Eman Aljoghaiman

Dear Reviewer,

Thank you for your insightful review and valuable suggestions to enhance our manuscript. We have carefully revised the manuscript and highlighted the changes accordingly.

We sincerely appreciate your time and thoughtful feedback.

Best regards,

Competing Interests: No competing interests were disclosed.

Reviewer Report 04 November 2024

<https://doi.org/10.5256/f1000research.170283.r332865>

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Dr. Talal Shihayb

Boston University, Boston, Massachusetts, USA

The authors assessed the effects of number of pregnancies on periodontitis. Studying pregnancy outcomes in relation to oral health is crucial. However, I have some comments on the paper:

Introduction

No comments.

Methods

Can the authors explain why they only selected the 2011-2012 and 2013-2014 cycles of NHANES?

The authors excluded edentulous participants from their study. Dealing with edentulous patients is tricky and not straight forward. If the reason for being edentulous was due to periodontal disease, the perhaps edentulous participants may be considered as the most severe form of periodontitis (since the authors are studying prevalent periodontitis and not incident periodontitis). Given that the authors are studying the accumulated exposure of pregnancy on periodontal disease, the results could be different had edentulous participants due to periodontal disease been included in the analysis, I suggest the authors add edentulous as a separate category or at least justify/discuss excluding edentulous participants from the study in the methods/discussion section.

If by edentulous participants, the authors meant without any teeth, then any person with 1 tooth is automatically classified as mild periodontitis or no periodontitis and cannot be classified as moderate or severe. However, all included participants should have the chance to be in group of periodontitis, which is unfortunately prevented including participants with just 1 tooth. The authors perhaps may have already included those with at least 2 permanent teeth and if so, should make this clear. If not, then inclusion of participants with at least 2 teeth (if authors are still excluding edentulous participants) in the study or at least discussion of the impact of this aspect on the result is important.

The authors defined the exposure as the number of pregnancies. Did the authors include all pregnancies whether completed or not? Providing more details on this aspect would make the paper more clear. Furthermore, the authors used it as a categorical variable instead of a continuous exposure. Unfortunately, this results in loss of information. I suggest the authors add this to the discussion section.

The authors have defined the outcome of chronic periodontitis according to CDC/AAP. I suggest replacing the word periodontal disease with chronic periodontitis in the manuscript as the term periodontal disease is an umbrella term that includes multiple conditions.

I suggest adding more details on how smoking and alcohol were classified or at least cite their webpages if the authors classified them as NHANES originally did.

The authors wrote the following under statistical analysis: "To ensure unbiased point estimates and accurate variance estimation, considering the complex sampling design of NHANES, we applied proper sampling weights and utilized a licensed version of SAS survey procedures, following the recommendations of the National Centre for Health Statistics and the Centres for Disease Control and Prevention." I think using clustering variables to correctly estimate standard errors should be added as both sampling weights and clustering are need to correctly estimate point estimates and standard errors, respectively.

The authors have pointed out the covariates that they included in their study and mentioned the following under statistical analysis: "The multiple regression model included age, sex, race, income, and education level as explanatory variables. The selection of these potential confounders was based on either current literature evidence or their association with insurance and dental care utilization variables observed in bivariate analysis. The significance level was set at $p \leq 0.05$, ensuring a rigorous evaluation of the relationships within the study." Determining how the

confounding variables were selected is very crucial in order to estimate the causal effect of multiple pregnancies on chronic periodontitis. In this study, the authors rightly determined age, sex, race, income, and education level as confounding variables based on previous knowledge and literature. However, the following on insurance and dental visit was not clear: “their association with insurance and dental care utilization variables observed in bivariate analysis.” Furthermore, assessing associations or confounding variables based on p-values should be avoided (please check [1],[2])

As a point related to the one above and based on the criteria the authors went with for determining confounding variables, unfortunately, smoking and diabetes (well-known confounding variables) were left out of the multivariable logistic regression model. Therefore, residual confounding exists in the result. I suggest adding them to the model or at least discuss how the residual confounding of these would impact the odds ratio of number of pregnancies on periodontitis.

Results

The authors did not elaborate on any missing data. Authors should show the frequency and % of missing data for each variables. In addition, authors should describe how they dealt with any missing data in their analysis and discuss its implications on the results.

The authors mentioned that they have included the following covariates: “age, gender, race/ethnicity, education, poverty/income ratio, marital status, occupation, smoking habits, alcohol consumption, dental insurance coverage, dental visit frequency, and body mass index (BMI)” Although marital, status and occupation were mentioned in table 4, they along with smoking habits were not mentioned in table 1. Smoking habits was not even mentioned in any table. Authors should add these.

In table 5, patients wrote: “Patients with dental visits in the 1-2 year range had greater odds (OR 1.129, 95% CI 0.772-1.651) of having periodontitis, but this association was not statistically significant ($p > 0.05$) (see Table 5).” The odds ratios of the confounding variables are of no interest to the authors in the study as they are do not correctly estimate their causal effect. This phenomena is well-known as Table 2 fallacy (3). Kindly just report the odds ratios of main variable of interest (number of pregnancies) and remove the other from text or table.

Please round the odds of pregnancy on periodontitis to 2 digits as 3 digits adds nothing and just complicates reading the results.

I suggest removing displaying/discussing the results in text as significant or non-significant and instead focus on the point estimates as well as their precision (please check [1]and[2])

Discussion and conclusion

The authors wrote in the limitations: “Additionally, being a retrospective cross-sectional study, our investigation relied on data from a study not specifically designed to address our hypothesis, potentially introducing clinical variations in the disease process.” The word retrospective should be removed as this was a cross-sectional study.

Authors should further discuss the impact of no-temporality, pregnancy misclassification likelihood and effect, missing data, and leaving out important confounding variables.

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Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Periodontitis-systemic diseases, oral epidemiology, advanced methods, meta-research in oral health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 30 Jan 2025

Eman AlJoghaiman

Dear Reviewer,
Thank you for your insightful review and valuable suggestions to enhance our manuscript. We have carefully revised the manuscript and highlighted the changes accordingly. We sincerely appreciate your time and thoughtful feedback.
Best regards,

Competing Interests: No competing interests were disclosed.

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