Original Article

Comparison of Salivary pH, Flow Rate, and Oral Health During Pregnancy and Menopause

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Abstract

Background and Aim: The hormonal changes associated with puberty, menstruation, pregnancy, and menopause exert varying effects on the saliva and oral health of women. The aim of this study was to investigate the effect of pregnancy and menopause on saliva (pH and flow rate) and oral health utilizing saliva sampling and oral examination.

Materials and Methods: This case-control study was performed on 120 women in three groups of pregnant women, menopause and control group (each group = 40). Subjects were evaluated for any oral lesions and were examined for DMFT, gingival index (GI) and community periodontal index (CPI), and their salivary flow rate and pH were measured. Data analysis was performed using descriptive statistics, Analysis of Covarience, partial Spearman's correlation coefficient, adjusted logistic regression.

Results: According to the ANCOVA, there was a significant difference among groups based on the pH and salivary flow rate. The highest and lowest pH has been observed in menopausal (6.80±0.42) and pregnant (6.02±0.5) group, respectively. The mean salivary flow rate was highest in the pregnant group (2.91±0.92) and lowest in the menopausal group (2.12±0.85). There was no significant difference among the groups in terms of DMFT, CPI and GI after adjusting the effect of age as covariate. There was a significant difference between the three groups in terms of xerostomia and halitosis ($p < 0.05$).

Conclusion: Both pregnancy and menopause lead to alterations in oral health. In this investigation, the metrics of pH, xerostomia, and halitosis exhibited higher values in the menopausal group compared to the pregnant group.

Key Words: Pregnancy; Menopause; Flow rate; pH, Saliva

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Introduction

A female's life undergoes various stages, encompassing puberty, menstruation, pregnancy, and menopause, each of which exerts distinct impacts on oral health (1,2). It is imperative for physicians and dentists to possess a thorough awareness and understanding of the oral manifestations associated with pregnancy for effective

diagnosis and the formulation of appropriate treatment plans (3). The predominant oral alteration during this period is gingivitis (4), resulting from an augmented inflammatory response to local stimulations, elevated secretion of estrogen and progesterone, and alterations in the process of fibrinolysis.(3, 5-8). It is crucial to emphasize that pregnancy *per se* does not instigate gingivitis; rather, gingivitis is induced by inadequate oral hygiene and local stimulations. Pregnancy serves to intensify the gingival response to these local stimulations. (3). The prevalence of gingivitis has been reported to range from 50 to 98.25% in pregnant women (9). On the other hand, an increase in *Streptococcus mutans* and *Lactobacillus* rate has also been observed in late pregnancy and lactation (8). Periodontal disease seems to increase during pregnancy. In this regard, some researchers have noted a positive association between periodontal disease and adverse pregnancy complications (10). The rate of salivary flow and the composition of saliva are pivotal factors contributing to oral health (11, 12). There is a wide range of measurable biomarkers in saliva (13). The main changes in saliva in pregnancy include changes in flow, composition, pH and hormone levels (14, 15). Saliva pH decreases during pregnancy due to changes in ovarian hormone levels (3, 16). By decreasing in the pH of saliva, the oral cavity becomes a suitable environment for the growth and activity of microorganisms. Moreover, due to the disturbance of salivary balance, the function of leukocytes will be disrupted and the activity of oral microorganisms will increase (3). Many physiological changes in menopause occur due to decreased production of ovarian estrogen (17). These alterations suggest that estrogen has the potential to influence many oral tissues such as salivary glands, temporomandibular joint, oral mucosa and jawbones, taste bud function, and neural system (18-20). Saliva decreases during menopause (21) and decreased saliva, increases dental caries and may increase changes in oral sensation and taste changes (22, 23). In addition, some of the main problems for women after menopause are burning, dryness, mouth bad taste as well as periodontal problems (22). Therefore, the aim of this study was to evaluate and compare the effect of pregnancy and menopause on salivary pH and flow rate (FR) and oral health (health of the teeth, gums, and periodontal tissues) and oral lesions (ulcerated, vesiculobullous, white and red, pigmented and exophytic lesions) and disorders such as dry mouth, halitosis, taste disorder and burning mouth syndrome through history taking, oral examination and saliva sampling.

Materials and Methods

Study Design and Participant Selection

This case-control study, approved by the Ethics Committee of Qom University of Medical Sciences under the ethics code (IR.MUQ.REC.1398.017), involved 120 women with a mean age of 40.69 ± 14.41. The participants were recruited through an available sampling method in 2019 from individuals attending the Health Clinic and Forqani Hospital in Qom. The participants were distributed among three groups: the pregnant group comprised 40 individuals (11 in the first trimester, 6 in the second trimester, and 23 in the third trimester) with a mean age of 30.25 ± 5.74; the postmenopausal group consisted of 40 individuals with a mean age of 58.92 ± 5.79; and the control group comprised 40 individuals with a mean age of 32.9 ± 7.21. The inclusion criteria encompassed healthy pregnant women aged between 20 and 50 years, healthy postmenopausal women aged 50 years and above, who had been at least 2 years post-menopause, demonstrating an absence of systemic diseases and drug use. The control group comprised healthy women in their reproductive ages, not pregnant or menopausal, with regular menstruation, falling within the age range of 20 to 50 years. Exclusion criteria included the presence of any systemic debilitating disease in the study groups, use of drugs that change the secretion of saliva (cardiac and antihypertensive, sedatives, antibiotics, Painkillers, antihistamines, anticonvulsants, corticosteroids, and narcotics), complete edentulism, and smoking.

Data recording

After obtaining the consent form and filling in the demographic data form, the subjects were examined for evaluating the presence of oral lesions and record of DMFT (decayed, missing and filled teeth) index (24), (GI) gingival index for gingivitis (25) and community periodontal index (CPI) for periodontitis (26) using dental examination mirrors, periodontal probes and tongue blades. The patient was asked about dry mouth, halitosis, taste disorder, and burning mouth syndrome. Spitting method (27) was used to collect unstimulated saliva to measure pH and FR. Before collecting saliva, patients were asked to avoid eating and drinking, brushing and any oral irritation for an hour before. Saliva was collected at certain hours (3 to 5 pm) to avoid the influence of circadian changes. Unstimulated saliva of these subjects was collected for 5 minutes in clean and dry Falcon tubes, which was calculated in mL/ min. Tubes containing saliva were kept at -20 °C. The pH was measured and recorded by a pH meter (sentix 940, WTW, Germany)

Statistical analysis

Data analysis was performed using SPSS 20 and using descriptive statistics including mean and standard deviation and frequency percentage. Due to significant variety in age of three studied groups Analysis of Covarience (ANCOVA) with adjusting the effect of age was used to compare the mean of DMFT index, CPI, GI, pH and saliva FR in the three groups. In addition, partial Spearman's correlation coefficient was also used to investigate the correlation of DMFT index, CPI, GI, pH and saliva FR in the three groups and adjusted logistic regression was used to compare the rate of dry mouth, burning mouth, halitosis, dysgeusia, oral lesions and gingivitis in three groups. P values lower than 0.05 were considered as statistically significant.

Results

In this study, 120 people with a mean age of 40.69 ± 14.41 years were enrolled, including 40 pregnant women, 40 postmenopausal women and 40 women in the control group. The three groups were compared in terms of mean pH, salivary FR and DMFT (See table 1)).

As depicted in Table 1, significant differences were evident among the groups concerning salivary pH and flow rate (FR). Pregnant women exhibited the lowest salivary pH, and this discrepancy proved to be statistically significant. Meanwhile, the postmenopausal group displayed the lowest salivary FR. However, after adjusting for age as a covariate, no significant differences were observed among the three groups in terms of DMFT, CPI, and GI.

As per the findings in table 2 and following adjusted logistic regression for age, a significant difference was observed among the groups concerning occurrences of dry mouth and halitosis. ($p<0.05$). The highest rate of dry mouth and halitosis were reported in post-menopausal individuals. There was no significant difference among three groups in term of burning mouth, dysgeusia and presence of oral lesion ($p>0.05$).

As indicated in table 3, the partial Pearson correlation test revealed no statistically significant correlation between pH and DMFT, CPI, and GI across all three groups. Furthermore, no significant correlation was found between salivary FR and DMFT or CPI in the post-menopausal group. However, a significant positive correlation was identified between salivary FR and GI in both post-menopausal and control groups, indicating an increase in salivary FR with an increase in GI. Moreover, a significant inverse regression was noted between salivary FR and both CPI and GI in the control group. However, there was no significant correlation between salivary FR and DMFT in the control group.

Discussion

Pregnancy and menopause are two situations in which women are prone to salivary changes and oral health problems due to hormonal fluctuations. The oral mucosa is sensitive to changes in estrogen and progesterone levels

Table 1. comparison between three groups of study in terms of PH, flow rate(FR), DMFT, CPI, GI

Variables	Pregnant Mean±SD	Postmenopausal Mean±SD	Control Mean±SD	P value of age effect	P Value of group*
pH	6.02±0.5	6.80±0.42	6.73±0.49	0.189	0.001
FR	2.91±0.92	2.12±0.85	2.35±1.15	0.949	0.039
DMFT	9.60±4.57	9.43±3.25	11.53±3.46	0.004	0.162
CPI	1.63±1.07	1.33±1.07	1.61±1.47	0.120	0.857
GI	1.33±0.85	1.08±0.84	1.08±0.89	0.114	0.428

*based on Analysis of covariance (ANCOVA) and age considered as covariate.

Table2. Comparison the incidence of dry mouth, burning mouth, halitosis, dysgeusia and oral lesions among three groups in last month

	Control) (% n	Postmenopausal (%) n	Pregnant (%) n	P Value* (group effect)	P value (age effect)
Dry mouth	2(5)	10(25)	2(5)	0.831	0.003
burning mouth	0	1(2.5)	0	0.943	0.297
haliyosis	3(7.5)	10(25)	1(2.5)	0.483	0.027
dysgeusia	0	1(2.5)	2(5)	0.331	0.535
Oral lesions	1(2.5)	4(10)	3(7.5)	0.296	0.215

*according to binary logistic regression and including age as covariate

Table 3. evaluation the correlation between PH and saliva Flow Rate(FR) with variables of age, DMFT, CPI and GI in three groups

Groups	Variables	Saliva flow rate		pH	
		Correlation	P Value*	Correlation	P Value*
Pregnant	DMFT	-0.38	0.819	-0.196	0.232
	CPI	-0.089	0.590	0.046	0.783
	GI	-0.086	0.602	0.047	0.776
Postmenopausal	DMFT	-0.313	0.053	-0.063	0.703
	CPI	0.299	0.065	0.073	0.660
	GI	**0.367**	**0.021**	-0.140	0.395
Control	DMFT	0.215	0.189	0.002	0.989
	CPI	**-0.350**	**0.029**	-0.160	0.330
	GI	**-0.355**	**0.027**	-0.170	0.302

*P value estimated based on partioal pearson correlation after controlling the age effect

(28). Gingivitis and pyogenic granuloma are common entities due to elevated levels of estrogen during pregnancy. Research has indicated a connection between the reduction in estrogen levels during menopause and oral alterations (29). Moreover, aside from the decline in estrogen, psychological issues and nutritional deficiencies are also influential factors in the oral discomforts experienced during this period. Oral manifestations during menopause include dysgeusia, burning mouth syndrome, and reduced salivary flow (21,28).

This study aimed to compare the salivary pH, flow rate (FR), oral health, and oral lesions between pregnancy and menopause periods. The findings indicated a reduction in salivary flow rate in the menopausal group compared to the control group, aligning with outcomes reported in various studies (19, 21, 27, 30). Apart from the reduction in estrogen levels, the aging process, characterized by parenchymal atrophy of the salivary gland, can contribute to a decline in salivary FR (28). In the study of Aryeh et al. salivary FR in menopausal individuals did not change significantly compared to the control group (31). The reason for this discrepancy could be due to the difference in the mean age of the control group in the two studies. In the current investigation, an increased salivary FR was noted in the pregnant group compared to contro. This finding is consistent with the results reported by Kamate et al., who noted an elevation in salivary FR specifically during the second trimester of pregnancy (2). Similarly, Naveen *et al*. reported a significant increase in salivary FR among pregnant women compared to their non-pregnant counterparts (14), corroborating the current findings. However, studies conducted by Rockenbach *et al*. (32) and Ramadugu et al. (33) did not observe any significant difference in salivary FR between pregnant and non-pregnant women. This disparity in findings could be attributed to variations in sampling methods employed across different pregnancy trimesters.

In this study, the salivary pH in the pregnant group exhibited a significant reduction compared to the control group. In the investigations conducted by Naveen et al. (14), Migliario et al. (34), Jain et al. (35), and Bakhshi et al. (36), a decline in salivary pH was noted in pregnant women when compared to the control group, a trend consistent with our study. The reduction in salivary pH during pregnancy may be associated with the prevalence of vomiting and gastric reflux, which are common occurrences during this period. The variations in salivary pH and FR outcomes across different studies can be attributed to differences in the timing and methodology of sampling, as well as variations in the methods employed to measure pH (34).

In this study, no significant differences were observed among the three groups concerning the DMFT index. In studies by Rukmini and Yalcin, an elevation in DMFT was reported in postmenopausal women compared to the control group (21, 30). Conversely, the study by Foglio-Bonda indicated slightly higher DMFT in the control group than in the menopause group (27). Kamate et al. (2) and Jain et al. (35) observed an increase in the DMFT index in the pregnant group compared to the control group. The disparities in age among the study groups, sample sizes, dietary habits, and oral hygiene levels in various studies may account for these variations.

In this investigation, the pregnant group exhibited higher values for both CPI and GI compared to the menopausal and control groups; however, no significant associations were identified among the three groups. In a study by Jain et al., consistent with our findings, the pregnant group demonstrated increased values for both indices compared to the control group. The escalation in gingivitis and periodontitis during pregnancy is attributed to diminished oral health care and heightened levels of hormones such as progesterone, leading to localized inflammation in the gums (35). When comparing the three groups in terms of pH and saliva FR, the current investigation revealed that the pregnant group exhibited the lowest pH, while the menopausal group had the highest value. Furthermore, the post-menopausal group showed the lowest salivary FR, whereas the pregnant group had

the highest record. In Saluja et al.'s investigation, salivary FR increased from the menopausal group to the pregnant group and then the control group, but no statistically significant difference was observed between the groups. The lowest pH was observed in the post-menopausal group, followed by the pregnant and control groups, respectively (28). This finding diverged from our study, and the dissimilarity may be attributed to the significant disparity in age range within the control group and variations in pregnancy trimesters.

In the current study involving post-menopausal patients, oral complaints comprised of dry mouth, halitosis, oral lesions, dysgeusia, and burning mouth. A study conducted by Hashemipour et al. in Iran reported dry mouth as the most prevalent symptom in post-menopausal women, along with other oral symptoms such as dysgeusia, bleeding gums, and burning mouth, respectively (22), demonstrating some similarity with our findings. Conversely, in a study by Santosh et al., significant oral findings in post-menopausal women comprised mucosal pain, dry mouth, and dysgeusia (29), which contrasted with the current study. The disparity might be attributed to differences in sample size and the exclusion criteria related to systemic diseases in this investigation.

In pregnant women involved in the current investigation, the sequence of oral complaints included gingivitis, oral lesions, dry mouth, dysgeusia, and halitosis, respectively. Similarly, in Kia et al.'s study (3), gingivitis was identified as the most prevalent intraoral manifestation. The study by Patil revealed a higher prevalence of pyogenic granuloma, gingivitis, and dental caries in pregnant women. Additionally, among pregnant women with gingivitis, complaints of halitosis and gum bleeding were frequently reported.

Conclusion

Pregnancy and menopause both cause changes in oral health. In this study, the assessment of salivary pH, xerostomia, and halitosis showed elevated values in the menopausal group in comparison to the pregnant group.

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References

1. Suri V, Suri V. Menopause and oral health. Journal of mid-life health. 2014 Jul;5(3):115.
2. Kamate WI, Vibhute NA, Baad RK. Estimation of DMFT, salivary streptococcus mutans count, flow rate, pH, and salivary total calcium content in pregnant and non-pregnant women: a prospective study. Journal of clinical and diagnostic research: JCDR. 2017;11(4):ZC147.
3. Kia S, Vadiati Saberi B, Moonesan M, Madani A. Frequency of intra and extra oral manifestations of pregnant women in Rasht (2013). Journal of Inflammatory Disease. 2017; 20(6):18-2.
4. Naseem M, Khurshid Z, Khan HA, Niazi F, Zohaib S, Zafar MS. Oral health challenges in pregnant women: Recommendations for dental care professionals. The Saudi Journal for Dental Research. 2016;7(2):138-46.
5. Annan B, Nuamah K. Oral pathologies seen in pregnant and non-pregnant women. Ghana medical journal. 2005;39(1):24-7.
6. Corbella S, Taschieri S, Francetti L, De Siena F, Del Fabbro M. Periodontal disease as a risk factor for adverse pregnancy outcomes: a systematic review and meta-analysis of case–control studies. Odontology. 2012;100(2): 232-40.
7. Madianos PN, Bobetsis YA, Offenbacher S. Adverse pregnancy outcomes (APO s) and periodontal disease: pathogenic mechanisms. Journal of clinical periodontology. 2013; 40:S 170-S80.
8. Patil SR. Oral changes in pregnant and nonpregnant women: A case-control study. Journal of Orofacial Sciences. 2013;5(2):118.
9. Díaz-Guzmán LM, Castellanos-Suárez JL. Lesions of the oral mucosa and periodontal disease behavior in pregnant patients. Medicina oral, patologia oral y cirugia bucal. 2004; 9(5): 434-3.

10. Faezi M FS, Vakili A. . Correlation Between Periodontal Disease during Pregnancy and Low Birth Weight and Preterm Delivery. Armaghane danesh. 2012;17(2):139-48.
11. Malamud D. Saliva as a diagnostic fluid. Dental Clinics. 2011;55(1):159-78.
12. Razi MA, Qamar S, Singhal A, Mahajan A, Siddiqui S, Minz RSM. Role of natural salivary defenses in the maintenance of healthy oral microbiota in children and adolescents. Journal of Family Medicine and Primary Care. 2020; 9 (3):1603.
13. Koh DS-Q, Koh GC-H. The use of salivary biomarkers in occupational and environmental medicine. Occupational and environmental medicine. 2007;64(3):202-10.
14. Naveen S, Asha M, Shubha G, Bajoria A, Jose A. Salivary Flow rate, pH and buffering capacity in pregnant and non-pregnant women-A comparative study. JMED research. 2014; 2014: 1-8.
15. Lundström T, Lingström P, Wattle O, Carlén A, Birkhed D. Equine saliva components during mastication, and in vivo pH changes in the oral biofilm of sound and carious tooth surfaces after sucrose exposure. Acta Veterinaria Scandinavica. 2020;62:1-6.
16. Polyzos NP, Polyzos IP, Zavos A, Valachis A, Mauri D, Papanikolaou EG, et al. Obstetric outcomes after treatment of periodontal disease during pregnancy: systematic review and meta-analysis. Bmj. 2010;341.
17. Nair DB. Effect of Saliva in Oral Health of Post Menopausal Women. IOSR-JDMS. 2016; 15(8):118-20.
18. Paganini-Hill A. The benefits of estrogen replacement therapy on oral health: the Leisure World cohort. Archives of internal medicine. 1995;155(21):2325-9.
19. Mahesh D, Komali G, Jayanthi K, Dinesh D, Saikavitha T. Evaluation of salivary flow rate, pH and buffer in pre, post & post menopausal women on HRT. Journal of clinical and diagnostic research: JCDR. 2014;8(2):233.
20. Cydejko A, Kusiak A, Grzybowska ME, Kochańska B, Ochocińska J, Maj A, et al. Selected Physicochemical Properties of Saliva in Menopausal Women—A Pilot Study. International journal of environmental research and public health. 2020;17(7):2604.
21. Rukmini J, Sachan R, Sibi N, Meghana A, Malar CI. Effect of menopause on saliva and dental health. Journal of International Society of Preventive & Community Dentistry. 2018; 8(6): 529.
22. Hashemipour M, Sinaie N, Mehrabizadeh H, Borna R. Prevalence of oral manifestation in premenopausal and postmenopausal females referring to Kerman School of Dentistry. Journal of Isfahan Dental School. 2010:185-94.
23. Singh B KK, Narang R.S, Singh Sh, Kaur P. Oral Dryness in Post Menoapusal Women: Hormonal Impact. Journal of Gerontology & Geriatric Research 2016;5(4):73-78. 2016.
24. Chen C-F, Wang R-H, Cheng S-N, Chang Y-C. Assessment of chemotherapy-induced oral complications in children with cancer. Journal of Pediatric Oncology Nursing. 2004;21(1):33-9.
25. Demmer RT, Jacobs DR, Desvarieux M. Periodontal disease and incident type 2 diabetes: results from the First National Health and Nutrition Examination Survey and its epidemiologic follow-up study. Diabetes care. 2008;31(7):1373-9.
26. Pilot T, Miyazaki H. Global results: 15 years of CPITN epidemiology. International Dental Journal. 1994;44(5 Suppl 1):553-60.
27. Foglio-Bonda P, Rocchetti V, Nardella A, Fantinato M, Sandhu K, Foglio-Bonda A. Salivary pH and flow rate in menopausal women. European review for medical and pharmacological sciences. 2019;23(3):918-22.
28. Saluja P, Shetty V, Dave A, Arora M, Hans V, Madan A. Comparative evaluation of the effect of menstruation, pregnancy and menopause on salivary flow rate, pH and gustatory function. Journal of clinical and diagnostic research: JCDR. 2014;8(10):ZC81.
29. Santosh P, Nidhi S, Sumita K, Farzan R, Bharati D, Ashok K. Oral findings in postmenopausal women attending dental hospital in Western part of India. Journal of clinical and experimental dentistry. 2013;5(1): e8.
30. Yalcin F, Gurgan S, Gurgan T. The effect of menopause, hormone replacement therapy

(HRT), alendronate (ALN), and calcium supplements on saliva. J Contemp Dent Pract. 2005;6(2):10-7.
31. Aryeh HB, Gottlieb I, Ish-Shalom S, David A, Szargel H, Laufer D. Oral complaints related to menopause. Maturitas. 1996;24(3):185-9.
32. Rockenbach MI, Marinho SA, Veeck EB, Lindemann L, Shinkai RS. Salivary flow rate, pH, and concentrations of calcium, phosphate, and sIgA in Brazilian pregnant and non-pregnant women. Head & Face Medicine. 2006;2(1):1-5.
33. Ramadugu K, Blostein F, Bhaumik D, Jiang W, Davis E, Salzman E, et al. Co-occurrence of yeast, streptococci, dental decay, and gingivitis in the post-partum period: results of a longitudinal study. Journal of oral microbiology. 2020;12(1):1746494.
34. Migliario M, Bindi M, Surico D, De Pedrini A, Minsenti S, Pezzotti F, Mele B, Foglio Bonda P L. Changes in salivary flow rate and pH in pregnancy. European Review for Medical and Pharmacological Sciences. 2021;25(4):1804-1810.
35. Jain K, Kaur H. Prevalence of oral lesions and measurement of salivary pH in the different trimesters of pregnancy. Singapore medical journal. 2015;56(1):53.
36. Bakhshi M, Kavei D, Asayesh H, Mehdipour A. Evaluating the effect of pregnancy on streptococcus mutans, pH and buffering capacity of saliva. Studies in Medical Sciences. 2015;26(6):467-74.