Original Article

Impact of Menopausal Duration on Salivary Flow Rate, Tooth Loss, and Oral Health-related Quality of Life in Indian Communities

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Abstract

Background: Diminishing hormonal levels after menopause evoke physiological changes in a woman's body. Their effects on the oral cavity are noteworthy, considering symptoms of dry mouth, altered taste perceptions, and tooth loss that may be attributed to reduced salivary flow and alveolar density changes. **Aim:** The purpose of this study was to assess changes in salivary flow rate, tooth loss, and oral health-related quality of life (OHRQoL) as menopausal duration increased. **Materials and Methods:** A total of 327 women fulfilling the eligibility criteria were chosen from two villages in the Mysuru district, Karnataka. They were categorized into three groups based on menopausal durations. Salivary flow rates, number of teeth lost, and OHRQoL after menopause were assessed and compared at different menopausal durations. Sociodemographic characteristics and oral hygiene practices were recorded to identify potential confounders. **Results:** Multivariate analysis demonstrated a significant association between menopausal duration and salivary flow rates (adjusted odds ratio = 2.269). However, no such associations were observed with tooth loss and OHRQoL. **Conclusion:** Menopausal duration significantly affects salivary flow rate. Its influence on tooth loss and OHRQoL is, however, less evident. Although strong associations cannot be established, the inevitability of the menopausal state advocates consideration of other major yet modifiable factors to improve oral health.

Keywords: *Hypo salivation, India, post menopause, quality of life, tooth loss*

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Introduction

Women are subject to diverse physiological changes throughout life, beginning from menarche to pregnancy to menopause. These stages in a woman's life are attributed to variations in the levels of two major sex hormones, namely estrogen and progesterone. Menopause, commonly occurring during the fifth decade of life in women, is the termination of menstruation after ovaries have ceased to function for more than a year.[1,2] Women live with menopausal status for more than 20 years.[3] Throughout the course, due to alterations in sex hormone levels, they experience physiological changes ranging from cardiovascular to musculoskeletal that purportedly affect their psychological status and quality of life. An emphasis should also be made on the manifestation of oral symptoms due to reduced estrogen hormone production; the more common being xerostomia and burning sensation of the mouth and tongue.[1] Furthermore, according to some researchers, decreasing estrogen levels have been shown to increase the incidence of periodontitis and reduce alveolar bone density, which in turn may lead to tooth loss.[4,5] The oral health-related quality of life (OHRQoL), pertaining to various oral symptoms associated with menopause, may also be affected. As a result of reduced salivary flow, Xerostomia may cause physical discomfort and increased caries incidence, thereby having a negative

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impact on the quality of life. Tooth loss causes functional impairment with regard to chewing and also esthetic changes, which might physically and psychologically affect the quality of life.[6] The study aimed at assessing changes in salivary flow rate, tooth loss, and OHRQoL among the women of rural India as the menopausal duration increased.

Materials and Methods

The research was conducted in full accordance with the World Medical Association Declaration of Helsinki. The study protocol was approved by the institution's ethics committee.

Study participants

The study participants (postmenopausal women) were chosen from two villages located in the district of Mysuru, Karnataka, by a nonprobability sampling technique. The chosen villages were those adopted by the medical institution as an initiative by the State Government for the provision of quality health services in rural areas through Public Private Partnerships. The village health workers (Accredited Social Health Activists) were approached to identify postmenopausal women in the communities. A door-to-door survey was conducted by the principal investigator accompanied by the village health worker, and eligible participants were chosen until the desired sample size was achieved. The sample size was calculated to be ≃ 330, assuming a confidence level of 1.96, maximum allowable error of 5% (Type I error) and tooth loss prevalence of 28% as estimated from a pilot trial before the commencement of the study. Oversampling to about 5% was done to compensate for incomplete data recording. The study participants were chosen based on the following eligibility criteria. Inclusion criteria: (1) Postmenopausal women. (2) Not under Hormone Replacement Therapy. (3) Given written consent to participate in the study. Exclusion criteria: (1) Women with major salivary gland dysfunction or disorders. (2) Women with debilitating illnesses and psychological disorders. (3) Febrile at the time of data collection. A study of pro forma that included demographic details, information on general and oral health, lifestyle and oral hygiene habits of the individuals was filled by the investigator by interviewing the eligible participants.

Data collection

All clinical examinations were performed by a single examiner between 10 am and 12 pm The intra-examiner reliability was found to be 0.8. The clinical measures to be assessed were unstimulated salivary flow rate, number of teeth lost, tooth mobility, and caries status. The procedure for the collection of unstimulated saliva was adapted from the method suggested by Navazesh *et al*.[7] Participants refrained from taking food, beverages or smoking 1 h before saliva collection. They were seated comfortably on a chair and were advised to minimize any movements of the mouth during saliva collection. Sterile centrifuge tubes (Tarsons 15 ml graduated centrifuge tubes, PP, Cat. No: 546021) and plastic funnels were used to collect saliva. The participants were asked to swallow or empty their mouth and then lean their head over the test tube and funnel with mouth slightly open so that saliva passively drains into the tube. Saliva collection was done for 3 min. An oral examination was done under natural light using a mouth mirror and explorer to determine the number of teeth lost. Information on the time of tooth loss and the reason for tooth loss was also collected. The mouth was also examined for carious lesions (WHO criteria for diagnosis of caries)[8] and tooth mobility (Millers classification of tooth mobility, 1950).[9]

The oral health impact profile-14 (shorter version of OHIP-49 with the advantage of simplicity and easier computation)[10] was used to assess OHRQoL. The questionnaire was translated into the native language to maintain cross-cultural equivalence. The Cronbach's α for internal consistency was 0.82. The questionnaire was pilot tested before the commencement of the study. The correlation between the responses in English and the native language was found to be 0.8 ($P < 0.05$). For each of the questions, the participants were asked the frequency of the discomfort since menopause. They were asked to score 0 (never) or 1 (hardly ever) if the participants had experienced discomfort less than twice during the period. If otherwise, they were asked to score 2 (occasionally), 3 (fairly often), and 4 (very often), depending on the frequency of severity. The minimum score for a participant was 0 and the maximum score was 56. An increasing score indicated poorer OHRQoL.

Data analysis

The primary outcome variables of the study were changes in unstimulated salivary flow rate, tooth loss, and OHRQoL across different menopausal durations. Menopausal durations were categorized into three groups of ≤5 years, 6–14 years, and ≥15 years. Data were analyzed using SPSS (Version 22.0; SPSS Inc., Chicago, IL, USA). Statistical significance was fixed at $P \leq 0.05$. Cronbach's alpha was used to test the internal consistency. Test–retest reliability was assessed using kappa coefficients. Comparisons of mean salivary flow rates, tooth loss, and OHRQoL between different menopausal duration groups were made using Kruskal–Wallis test. Risk factors of reduced salivary flow rate, tooth loss, and poor OHRQoL were subjected to

univariate analysis to identify significant associations. Confounders to salivary flow rate changes were identified as age, medical history, and drug use while that of tooth loss were age, salivary flow rate, frequency of brushing, tooth mobility, and caries status. Binary logistic regression analysis was used to determine the association between menopausal duration and the primary outcome measures.

Results

A total of 327 women fulfilling the eligibility criteria participated in the study. The mean age of the participants was 54.88 years (standard deviation [SD] = ±10.67). The mean menopausal age was 42.78 years (SD = ±6.21). Fifty participants had undergone hysterectomy. A significantly higher proportion of participants (n = 208; 63.6%) fell under the lower socioeconomic status group. 110 participants (33.6%) presented with a history of some kind of systemic illnesses that included hypertension, diabetes, hyper/hypothyroidism, cardiac diseases, asthma, gastritis, hypercholesterolemia, osteoporosis, and migraine. Twenty participants (6.1%) reported of having deleterious habits such as smoking, tobacco chewing, and alcohol use. 59.9% and 28.1% of the participants had carious teeth and tooth mobility, respectively [Table 1].

The mean unstimulated salivary flow rate amongst participants was 0.26 (±0.23) ml/min. The mean values of unstimulated whole salivary flow rates for menopausal durations ≤5 years, 6–14 years, and ≥15 years were 0.28 (±0.23) ml/min, 0.27 (±0.26) ml/min, and 0.23 (±0.21) ml/min, respectively. It was observed that unstimulated salivary flow rates reduced as the menopausal duration increased and this was found to be statistically significant (P = 0.049) [Table 2]. Furthermore, menopausal duration was significantly associated with salivary flow rate changes with an adjusted odds ratio of 2.269 (adjusted for age, medical history, and drug use) among the group having menopausal duration ≤5 years in comparison with the group having menopausal durations ≥15 years (P = 0.05, Nagelkerke R^2 = 0.063) [Table 3].

The mean number of teeth lost among the participants was found to be 8.3 (±8.9). The mean number of teeth lost in menopausal duration groups ≤5 years, 6–14 years, and ≥15 years was 4.77 (±5.53), 8.44 (±9.02), and 10.73 (±9.95), respectively. There was an increase in the total number of teeth lost as the duration of menopause increased (P = 0.001) [Table 2]. It was observed that menopausal duration was significantly associated with tooth loss with an unadjusted odds ratio of 0.264 among the group having menopausal duration ≤5 years in comparison with the group having menopausal durations ≥15 years (P = 0.001, Nagelkerke R^2 = 0.075). However, when adjusted for confounders (age, salivary flow rate, frequency of brushing, tooth mobility, caries status), it had no significant effect (Adjusted odds ratio = 0.786, P = 0.634, Nagelkerke R^2 = 0.27) [Table 3].

Oral health-related quality of life scores increased as menopausal duration increased. However, the correlations were statistically insignificant [Table 4].

Table 1: Participant characteristics

Parameters	Frequency (%)
Menopausal duration (years)	
≤5	111 (33.9)
6–14	100 (30.6)
≥15	116 (35.5)
Socioeconomic status	
Upper	8 (2.4)
Upper middle	23 (7)
Lower middle	25 (7.6)
Upper lower	63 (19.3)
Lower	208 (63.6)
Significant medical history	
Present	110 (33.6)
Absent	217 (66.4)
Uses drugs that may reduce salivary flow	
Yes	91 (27.8)
No	236 (72.2)
Frequency of brushing	
Once	173 (52.9)
Twice	147 (45)
More than twice	7 (2.1)
Deleterious habits (smoking/tobacco chewing/alcohol use)	
Present	20 (6.1)
Absent	307 (93.9)
Carious lesions	
Present	196 (59.9)
Absent	131 (40.1)
Tooth mobility	
Present	92 (28.1)
Absent	235 (71.9)

Table 2: Salivary flow rate and tooth loss in relation to menopausal duration among participants

Menopausal duration	USFR (mL/min)		Tooth loss after menopause	
	n	Mean±SD	*n*	Mean±SD
≤5	110	0.28±0.23	73	4.77±5.53
6–14	96	0.27±0.26	73	8.44±9.02
≥15	115	0.23±0.21	102	10.73±9.95
Total	321	0.26±0.23	248	8.3±8.9
Statistical inference	χ^2 (2)=6.05 (Kruskal–Wallis test), P=0.049		χ^2 (2)=19.51 (Kruskal–Wallis test), P=0.001	

SD: Standard deviation, USFR: Unstimulated salivary flow rate

Table 3: Summary of binary logistic regression analysis on the association between menopausal duration and salivary flow rate and tooth loss

Menopausal duration	USFR				Tooth loss			
	OR	*P*	95% CI		OR	*P*	95% CI	
			Lower	Upper			Lower	Upper
Unadjusted								
≥15*		0.002				0.001		
≤5	2.866	0.001	1.578	5.203	0.264	0.001	0.133	0.522
6–14	1.433	0.211	0.816	2.517	0.371	0.006	0.182	0.756
Adjusted								
≥15*		0.097				0.887		
≤5	2.269†	0.050	1.000	5.150	0.787‡	0.634	0.294	2.109
6–14	1.224	0.573	0.606	2.469	0.823	0.669	0.337	2.011

*Reference group, †Adjusted for age, medical history, and drug use, ‡Adjusted for age, USFR, frequency of brushing, tooth mobility, and caries status. OR: Odds ratio, CI: Confidence interval, USFR: Unstimulated salivary flow rate

Table 4: Oral health related quality of life (mean oral health impact profile-14 score) in relation to menopausal duration among study participants

Menopausal duration	Frequency	OHIP scores, mean±SD
≤5	111	4.48±6.46
6–14	100	5.46±7.67
≥15	116	5.99±6.79
Total	327	5.31±6.97
Statistical inference	Kruskal–Wallis test χ^2 (2)=5.34, *P*=0.69	

OHIP: Oral health impact profile, SD: Standard deviation

Discussion

The most common age of natural menopause is between 45 and 55 years of age. In India, the mean age of menopause ranges between 41.9 and 49.4 years.[11] According to the 2011 census of India, there were about 96 million women aged 45 years and above.[11] Recent statistics also state that premature menopause is increasing in India.[11] Hence, an even greater number of women would have to spend more than 20 years of their lives in an estrogen deficient state, which would mean that they would have to cope with the deteriorative changes occurring as a result of a reduction in the hormone level.[12]

A rural setting was chosen as there has always been a scarcity of health resources and the nonavailability of facilities for dental treatments in the rural areas of the country, which would mean a lack of awareness about oral diseases. Hence, it was proposed that the study would give an overview of the oral health status of the elderly women of the population, their requirements and the steps that need to be taken by the health sector to evolve strategies to meet these requirements. Furthermore, this would be one among the few studies conducted on similar population groups (postmenopausal women) that have elicited oral changes occurring with increasing menopausal durations and the impact that they have had on the quality of life of the individuals.

There is sufficient evidence in literature stating that menopause, besides other factors, significantly affects the quality of life of women.[13-16] It is also noteworthy that fluctuating hormone levels have effects on the oral cavity.[17] The exact mechanism has not been clearly established. It has, however, been speculated that if the reduced hormonal levels can bring about changes in the body tissues, namely the skeletal, epithelial, etc., similar changes could be observed in the oral cavity. In this aspect, it has been suggested that reduction in estrogen has an effect on the salivary flow rate, alveolar bone formation, periodontal tissues, and oral mucosa, which may thereby affect the OHRQoL of women.

No cross-sectional observations to date have compared changes in salivary flow rates and tooth loss at different menopausal durations. However, studies have shown that salivary flow rates, compared to postmenopausal women, were higher in pre/perimenopausal females and those under hormone replacement therapy.[2,18-20] This corroborates the association found in the present research between salivary flow rate and menopausal duration, which could be mediated through variations in estrogen levels. However, the specific mechanism by which estrogens modulate human salivary gland function is poorly understood.[21,22]

Contradictory results were however obtained in a longitudinal study conducted by Ghezzi *et al*.[23] According to the study, there was no consistent change in salivary flow rates when postmenopausal women were followed up for 17 years. The major factors associated with salivary flow rate changes were age and the use of medications. Studies comparing salivary flow rates between pre/perimenopausal and postmenopausal women also gave contradictory results.[24,25] The

number of individuals under medication for systemic illnesses (proven to have an effect on salivary flow) was low, which may have failed to show an association in the present study. Besides, the other sociodemographic and sociocultural differences which determine food habits and nutritional status also could have contributed for the contradiction between the findings in our research with these studies. Age, when unadjusted for other confounders, showed a significant change in salivary flow, but there were other factors that had a greater influence, one of them being menopausal status. The model fitness was found to be low, indicating that salivary flow rates are subject to change from individual to individual and are also sensitive to various other exogenous and endogenous factors.

Menopausal duration, as an independent factor, significantly affected tooth loss. However, when controlled for other confounders, no significant association was observed. The significant factors associated with tooth loss in the model were age, tooth mobility, and caries status. A number of longitudinal studies had findings similar to that of our study. A prospective cohort study conducted by Bole *et al*.[26] enumerated the various risk factors for tooth loss among postmenopausal women, which included smoking status, diabetes, history of gum disease, plaque levels, and high body mass index. Payne *et al*. and Henriques and Pinto Neto.[27,28] found that bone mineral density was significantly associated with tooth loss rather than menopausal duration. It may be argued that estrogen levels may bring about changes in bone mineral density, but estrogen may not be the only factor associated with it. Tezal *et al*.[29] associated periodontal disease to bone mineral density which in turn may lead to tooth loss.

The results of a cross-sectional study conducted by Kim *et al*.[5] were in contrast to our results. Although variables, including age, income, educational level, osteoporosis, and duration of menopause, were significantly associated with tooth loss, the study failed to record the time of tooth loss (whether before or after menopause) as elicited in our research. In view of all these results, it may be concluded that although menopause does not significantly affect tooth loss status, it still proves to be one of the causes, and as it is inevitable, unlike other major factors, it is necessary that women especially after menopause be made aware of the various other causes of tooth loss and how they can be prevented.

Very few studies associated postmenopausal status with poor OHRQoL.[3,30] Literature search did not identify studies on OHRQoL of postmenopausal women in India. It is, however, subject to variation considering the awareness among the populations and their priorities. It should be emphasized that the study was done in a rural setting amongst a population of low socioeconomic status.

The menopausal duration was significantly associated with changes in salivary flow rate. It, however, was poorly associated with tooth loss and OHRQoL. With limited literature available in this discipline, we recommend cohort studies to precisely elicit the changes occurring in the oral cavity after menopause and relate it with salivary flow rate, tooth loss, and OHRQoL.

Strengths and limitations of the study

The results of our study are confined to the chosen population, restricting the generalization. Due to its cross-sectional nature, a causal relationship cannot be established. Assessment of the hormone levels at various menopausal durations would have corroborated our findings. Parameters, such as the age of tooth loss and the reason for tooth loss, were dependent solely on the participants recall and response. Hence, there were greater chances of recall bias. The study involved analysis of data from a distinct group of individuals (postmenopausal women) which may be considered a major strength of the study. We assessed the salivary flow rates and tooth loss status and their effects on OHRQoL at various menopausal durations among postmenopausal women. This was the first of its kind. Furthermore, the study was carried out in a rural set-up on a population of low socioeconomic status that had poor access to oral health services. It gives an overview of the oral health status of this vulnerable group and brings to attention the requirements that need to be fulfilled by the health-care sector for their advancement. However, a comparison with the urban population could better highlight the OHRQoL of postmenopausal women, and this provides scope for further research.

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Conflicts of interest

There are no conflicts of interest.

References

1. Dural S, Hatipoğlu MG, Çağirankaya LB. Evaluation of the effect of menopause on saliva and dental health. Hacet Dişhekim Fak Derg 2006;30:15-8.
2. Minicucci EM, Pires RB, Vieira RA, Miot HA, Sposto MR. Assessing the impact of menopause on salivary flow and xerostomia. Aust Dent J 2013;58:230-4.
3. Kim Y, Lee JH. Oral health-related quality of life of postmenopausal women. Adv Sci Technol Lett 2015;80:237-41.
4. Dutt P, Chaudhary S, Kumar P. Oral health and menopause: A comprehensive review on current knowledge and associated dental management. Ann Med Health Sci Res 2013;3:320-3.
5. Kim CS, Kim EK, Lee KS, Lee HK, Choi YH, Hwang TY, *et al.* Relationship between bone mineral density, its associated

physiological factors, and tooth loss in postmenopausal Korean women. BMC Womens Health 2015;15:65.
6. Gerritsen AE, Allen PF, Witter DJ, Bronkhorst EM, Creugers NH. Tooth loss and oral health-related quality of life: A systematic review and meta-analysis. Health Qual Life Outcomes 2010;8:126.
7. Navazesh M, Kumar SK, University of Southern California School of Dentistry. Measuring salivary flow: Challenges and opportunities. J Am Dent Assoc 2008;139 Suppl: 35S-40S.
8. World Health Organization. Oral Health Surveys: Basic Methods. 5th ed. Geneva: World Health Organization; 2013.
9. Miller SC. Textbook of Periodontia. 3rd ed. Philadelphia and Toronto: The Blakiston Co.; 1950.
10. Slade GD. Derivation and validation of a short-form oral health impact profile. Community Dent Oral Epidemiol 1997;25:284-90.
11. Pallikadavath S, Ogollah R, Singh A, Dean T, Dewey A, Stones W. Natural menopause among women below 50 years in India: A population-based study. Indian J Med Res 2016;144:366-77.
12. Padubidri V, Daftary S. Shaw's Textbook of Gynecology. India: Elsevier Health Sciences; 2014.
13. Blumel JE, Castelo-Branco C, Binfa L, Gramegna G, Tacla X, Aracena B, *et al.* Quality of life after the menopause: A population study. Maturitas 2000;34:17-23.
14. Norozi E, Mostafavi F, Hasanzadeh A, Moodi M, Sharifirad G. Factors affecting quality of life in postmenopausal women, Isfahan, 2011. J Educ Health Promot 2013;2:58.
15. Poomalar GK, Arounassalame B. The quality of life during and after menopause among rural women. J Clin Diagn Res 2013;7:135-9.
16. Mohammadalizadeh Charandabi S, Rezaei N, Hakimi S, Montazeri A, Taheri S, Taghinejad H, *et al.* Quality of life of postmenopausal women and their spouses: A community-based study. Iran Red Crescent Med J 2015;17:e21599.
17. Güncü GN, Tözüm TF, Cağlayan F. Effects of endogenous sex hormones on the periodontium – Review of literature. Aust Dent J 2005;50:138-45.
18. Laine M, Leimola-Virtanen R. Effect of hormone replacement therapy on salivary flow rate, buffer effect and pH in perimenopausal and postmenopausal women. Arch Oral Biol 1996;41:91-5.
19. Yalçin 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;6:10-7.
20. Kullander S, Sonesson B. Studies on saliva in menstruating, pregnant and post-menopausal women. Acta Endocrinol (Copenh) 1965;48:329-36.
21. Bjorling DE, Beckman M, Clayton MK, Wang ZY. Modulation of nerve growth factor in peripheral organs by estrogen and progesterone. Neuroscience 2002;110:155-67.
22. Välimaa H, Savolainen S, Soukka T, Silvoniemi P, Mäkelä S, Kujari H, *et al.* Estrogen receptor-beta is the predominant estrogen receptor subtype in human oral epithelium and salivary glands. J Endocrinol 2004;180:55-62.
23. Ghezzi EM, Wagner-Lange LA, Schork MA, Metter EJ, Baum BJ, Streckfus CF, *et al.* Longitudinal influence of age, menopause, hormone replacement therapy, and other medications on parotid flow rates in healthy women. J Gerontol A Biol Sci Med Sci 2000;55:M34-42.
24. Ship JA, Patton LL, Tylenda CA. An assessment of salivary function in healthy premenopausal and postmenopausal females. J Gerontol 1991;46:M11-5.
25. Streckfus CF, Baur U, Brown LJ, Bacal C, Metter J, Nick T. Effects of estrogen status and aging on salivary flow rates in healthy Caucasian women. Gerontology 1998;44:32-9.
26. Bole C, Wactawski-Wende J, Hovey KM, Genco RJ, Hausmann E. Clinical and community risk models of incident tooth loss in postmenopausal women from the Buffalo Osteo Perio Study. Community Dent Oral Epidemiol 2010;38:487-97.
27. Payne JB, Zachs NR, Reinhardt RA, Nummikoski PV, Patil K. The association between estrogen status and alveolar bone density changes in postmenopausal women with a history of periodontitis. J Periodontol 1997;68:24-31.
28. Henriques PS, Pinto Neto AM. Association between tooth loss and bone mineral density in Brazilian postmenopausal women. J Clin Med Res 2011;3:118-23.
29. Tezal M, Wactawski-Wende J, Grossi SG, Dmochowski J, Genco RJ. Periodontal disease and the incidence of tooth loss in postmenopausal women. J Periodontol 2005;76:1123-8.
30. Kim Y, Lee J. Menopause and depression and oral health-related quality of life of postmenopausal women. Int J Bio Sci Bio Technol 2015;7:203-10.