



Differences in Salivary Calcium Levels and Oral Hygiene Status in Elderly Men and Women in Suka Maju Village, Deli Serdang Regency

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Abstract: Previous studies have examined salivary calcium and periodontal disease; however, evidence regarding sex-related differences in salivary calcium levels and oral hygiene status among elderly individuals with periodontitis, particularly in Indonesia, remains limited. This gap highlights the need for studies that can support more targeted oral health assessment and management in geriatric dentistry. This study aimed to analyze differences in salivary calcium levels and oral hygiene status between elderly men and women in Suka Maju Village, Deli Serdang Regency. This observational analytic study used a cross-sectional design. The subjects consisted of 88 elderly individuals. Oral hygiene was assessed using the calculus index, debris index, and Oral Hygiene Index (OHI), while salivary calcium levels were analyzed using spectrophotometry. The results showed that salivary calcium levels were higher in elderly men than in women. Most subjects in both groups had poor oral hygiene status. There was a significant difference in salivary calcium levels between elderly men and women ($p = 0.004$), while no significant difference was found in oral hygiene status between the two groups ($p = 0.950$). As the conclusion in elderly individuals with periodontitis, salivary calcium levels differ between females and males, with females having higher levels than males. The male OHI is higher than the female OHI, but there is no significant difference between the two.

Keywords: Elderly; Gender; Oral hygiene; Salivary calcium levels

Introduction

Indonesia is currently experiencing a demographic transition toward an aging society, with older adults (≥ 60 years) representing more than 11% of the national population in 2024, a proportion expected to rise steadily over the coming decades, reflecting a substantial demographic shift (Romadlona et al., 2025). This trend has important implications for healthcare systems, social welfare, and the quality of life among older adults, including oral health maintenance. As life expectancy increases, the growing elderly population requires increased attention not only to general health but also to oral health, which is increasingly recognized as an essential component of healthy aging because oral

diseases can impair mastication, nutrition, communication, social participation, and overall well-being among elderly individuals. Oral diseases such as periodontitis, dental caries, tooth loss, xerostomia, and impaired masticatory function are highly prevalent among older adults and can substantially affect overall quality of life (Kossioni et al., 2018; Peres et al., 2019; Petersen & Yamamoto, 2005). Poor oral health has also been associated with frailty, functional dependence, malnutrition, and reduced well-being among elderly individuals, highlighting its broader impact on systemic health and successful aging (Peres et al., 2019; Rouxel et al., 2016). Furthermore, the World Health Organization has emphasized that maintaining oral health throughout the life course is fundamental to preserving quality of

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life, social participation, and healthy longevity in older populations (WHO, 2022). As life expectancy continues to increase worldwide, identifying factors associated with oral health deterioration and developing effective preventive strategies for older adults have become important public health priorities (Bolukbasi & Dundar, 2024).

The physiological aging process causes various changes in the oral cavity, including decreased salivary flow rate, altered saliva composition, and declines in motor and cognitive abilities, which affect the capacity to maintain oral hygiene (Azzolino et al., 2019; Darwis et al., 2025). These conditions can increase the risk of periodontal disease, dental caries, and plaque and calculus accumulation in the elderly (Seo et al., 2024). Saliva plays a crucial role in maintaining the balance of the oral ecosystem by acting as a lubricant, buffer, and antimicrobial medium, and age-related alterations in salivary flow and composition have been shown to significantly increase susceptibility to oral diseases in older adults (Okuyama & Yanamoto, 2024). Recent studies emphasize that monitoring salivary parameters in elderly populations is essential for early detection of oral dysfunction and prevention of oral disease progression (Koskinas et al., 2026).

One component of saliva involved in the tooth remineralization process is calcium. High salivary calcium levels can have a protective effect against enamel demineralization; however, they can also increase calculus formation if not balanced by good oral hygiene (Enax et al., 2024). Research by Kaczor-Urbanowicz et al. (2017) and Pateel et al. (2017) supports the role of salivary calcium as a reliable biomarker associated with calculus accumulation, periodontal status, and oral hygiene performance in elderly individuals (Kaczor-Urbanowicz et al., 2017; Pateel et al., 2017).

Gender-related differences in calcium metabolism may become more pronounced with advancing age. In elderly women, particularly after menopause, estrogen deficiency accelerates bone resorption and alters calcium homeostasis, resulting in increased mobilization of calcium from skeletal tissues and potential changes in calcium concentrations in biological fluids, including saliva (Conforto et al., 2024). These alterations have been associated with reduced salivary flow rate, changes in salivary composition, and increased susceptibility to periodontal tissue breakdown and tooth loss (Vallabhan et al., 2020). In contrast, elderly men generally experience a more gradual decline in sex hormones, leading to different patterns of bone metabolism and mineral regulation (Coggins et al., 2025). Consequently, salivary calcium levels may reflect distinct physiological processes in men and women. Elevated salivary calcium concentrations in women may be associated with

postmenopausal bone turnover and increased mineral release, whereas in men, salivary calcium variations may be more strongly influenced by lifestyle factors, oral hygiene practices, and systemic health conditions (Mathangi et al., 2026). These differences may ultimately contribute to variations in dental calculus formation, periodontal health, and oral hygiene status between elderly men and women, highlighting the importance of sex-specific investigations of salivary calcium as a potential oral health biomarker.

Recent evidences indicate that postmenopausal women exhibit altered salivary composition, reduced salivary flow, and increased vulnerability to periodontal disease compared to age-matched men (Labunet et al., 2025). Meanwhile, in men, hormonal changes occur more gradually, but behavioral factors and oral hygiene habits often pose their own challenges (Lipsky et al., 2021). Studies published in the last five years also highlight that lifestyle factors such as smoking, oral hygiene behavior, and dental service utilization significantly contribute to gender-related disparities in oral health outcomes among the elderly (Han, 2026). These biological and behavioral differences form an important basis for comparing salivary calcium levels and oral hygiene between elderly men and women.

Social environment, education level, and awareness of the importance of dental and oral care also influence the oral hygiene status of the elderly (Bashirian et al., 2023). A recent community-based study by Hashim et al. (2025) in rural and underserved populations reports a higher prevalence of poor oral hygiene, untreated periodontal disease, and limited preventive care among older adults, emphasizing the importance of localized oral health research (Hashim et al., 2025; Sevik & Davas, 2025). Several studies indicate differences in salivary calcium levels and oral hygiene between men and women. However, research results remain varied and are influenced by population factors and research methods (Y. Chen et al., 2025).

Furthermore, most studies have evaluated salivary biomarkers or oral hygiene indicators separately and have predominantly involved clinical or urban populations, while evidence from community-dwelling elderly individuals in rural areas remains limited (Hashim et al., 2025; Sevik & Davas, 2025). Consequently, the relationship between salivary calcium levels and oral hygiene status among elderly men and women living in rural communities has not been adequately elucidated. Addressing this gap is important for improving the understanding of biological and behavioral determinants of oral health in aging populations and for developing targeted preventive strategies in resource-limited settings. This research was conducted in Suka Maju Village, Deli Serdang Regency, as it represents a rural community with limited access to

dental and oral healthcare services. Rural populations in Indonesia generally experience lower utilization of preventive dental care, reduced oral health literacy, and a higher burden of untreated oral diseases than urban populations. Older adults living in these settings are particularly vulnerable to poor oral hygiene and periodontal disease due to barriers in accessing regular dental services and age-related functional limitations. Therefore, this population provides an appropriate setting to investigate the relationship between salivary calcium levels and oral hygiene status among elderly individuals with periodontitis (Chen et al., 2026).

Method

This cross-sectional observational study was conducted among senior citizens living in Suka Maju Village, Sunggal District, Deli Serdang Regency, North Sumatra, Indonesia. The study protocol was approved by the Health Research Ethics Committee of the Faculty of Medicine, Universitas Sumatera Utara (No. 898/KEPK/USU/2025), and written informed consent was obtained from all participants prior to enrollment. A minimum sample size of 80 participants was calculated, and participants were recruited through purposive sampling. Eligible participants were adults aged ≥ 60 years diagnosed with periodontitis, having at least 10 natural teeth, residing in the study area, willing to participate, and former smokers who had ceased smoking for at least one year. Individuals who had received periodontal treatment within the previous three months or had systemic conditions that could affect periodontal status or salivary composition, including diabetes mellitus and hematological disorders, were excluded.

Prior to data collection, interexaminer training and calibration were performed to ensure consistency and reliability of clinical measurements. Demographic and medical information, including age, sex, smoking history, and systemic health status, were collected through structured interviews. Clinical oral examinations were subsequently conducted to assess periodontal status and oral hygiene.

Oral hygiene status was evaluated using the Oral Hygiene Index-Simplified (OHI-S) developed by Greene and Vermillion. The Debris Index-Simplified (DI-S) and Calculus Index-Simplified (CI-S) were assessed on six index tooth surfaces (16, 11, 26, 31, 36, and 46). The OHI-S score was calculated by summing the DI-S and CI-S scores and categorized as good (0.0–1.2), fair (1.3–3.0), or poor (3.1–6.0).

Unstimulated whole saliva samples were collected using the passive drooling method. Participants were instructed to refrain from eating, drinking, toothbrushing, smoking, or using mouthwash for at

least one hour before sample collection. Saliva was allowed to accumulate naturally in the floor of the mouth and was collected into sterile sputum containers over a 5-minute period while participants remained seated in a relaxed position. Samples were stored at -80°C in the Integrated Laboratory of the Faculty of Medicine, Universitas Sumatera Utara. Saliva samples were transferred into sterile microcentrifuge tubes and centrifuged at 3,000 rpm for 5 minutes at 4°C . The resulting supernatant was used for biochemical analysis.

Salivary calcium concentration was determined using a Calcium Arsenazo III assay kit according to the manufacturer's instructions. Calcium ions in the saliva reacted with Arsenazo III reagent to form a blue-colored complex, the intensity of which was proportional to calcium concentration. Absorbance was measured spectrophotometrically at 650 nm, and calcium concentrations were calculated using a standard calibration curve. The variables analyzed included salivary calcium levels and oral hygiene (OHI), with statistical analysis conducted using the Mann-Whitney test ($p < 0.05$).

Result and Discussion

The study investigated gender-related differences in salivary calcium levels and oral hygiene status among elderly individuals with periodontitis. As shown in Table 1, salivary calcium levels differed significantly between male and female participants ($p = 0.004$). Female subjects demonstrated significantly higher salivary calcium concentrations (4.372 ± 2.200) than male subjects (2.946 ± 1.348).

Table 1. The Differences of Salivary Calcium Levels between Male and Female Elderly Subjects with Periodontitis (n=88)

Gender	Salivary Calcium Level (Mean $\pm$ SD)	p-value
Female	4.372 $\pm$ 2.200	0.004*
Male	2.946 $\pm$ 1.348	

Mann-Whitney Test; significant $p < 0.050$

The significant difference in salivary calcium levels observed between elderly male and female subjects suggests that biological sex may influence calcium homeostasis in the oral environment. Saliva is a complex biological fluid whose composition is affected by numerous factors, including age, hormonal status, salivary gland function, systemic health, medication use, dietary intake, and mineral metabolism (Shah et al., 2025). Among elderly individuals, age-related physiological changes may alter salivary gland secretion and mineral composition, contributing to variability in salivary calcium concentrations (Xu et al., 2019).

One possible explanation for the higher salivary calcium levels observed among female participants is the hormonal alteration associated with menopause. Estrogen plays a critical role in maintaining calcium balance by regulating intestinal calcium absorption, renal calcium reabsorption, and bone remodeling. Following menopause, the decline in estrogen levels accelerates bone resorption and increases calcium mobilization from skeletal tissues (Kusiak et al., 2021; Wu et al., 2025). These changes may contribute to alterations in salivary calcium concentration. Previous studies have demonstrated that postmenopausal women exhibit significant changes in calcium metabolism and salivary biochemical composition, suggesting that hormonal changes influence salivary calcium levels in elderly females (Shetty et al., 2023; Singh et al., 2013). Studies provided by Agha-Hosseini et al. and Cydejko et al. showed similar results, confirming the higher concentration of calcium in the saliva of menopausal women compared to the controls (Agha-Hosseini et al., 2012; Cydejko et al., 2020).

The present findings are consistent with studies reporting associations among aging, hormonal changes, and alterations in salivary mineral content. Elevated salivary calcium concentrations have been reported in postmenopausal women and linked to increased mineral deposition in the oral cavity. Salivary calcium plays an important role in enamel remineralization and calculus formation. Therefore, increased salivary calcium levels may influence periodontal health by promoting the mineralization of dental plaque into calculus, which is a local contributing factor in periodontal disease progression (Mishra et al., 2021).

This finding indicates that gender, linked to biological and hormonal differences, influences salivary calcium metabolism in the elderly. This finding can be explained by the distinct biological and physiological characteristics between the two genders that affect saliva composition. Previous research shows that in elderly women, particularly after menopause, hormonal changes, such as decreased estrogen, can affect calcium metabolism and salivary secretion, thereby contributing to differences in salivary calcium levels compared with men (Dutt et al., 2013). The decline in estrogen levels in postmenopausal women is known to affect calcium metabolic balance, leading to decreased calcium levels both systemically and in saliva (Lin et al., 2026). Conversely, men do not experience drastic hormonal changes, so salivary calcium levels tend to be more stable in old age (Pataky et al., 2021). This finding confirms that the difference in salivary calcium levels between elderly men and women not only reflects gender differences but is also influenced by the interplay among hormonal, physiological, and environmental factors associated with aging (Tjahjajawati et al., 2021).

Interestingly, although female subjects exhibited significantly higher salivary calcium levels, oral hygiene status was comparable between males and females. In contrast, oral hygiene status did not differ significantly between genders ($p = 0.950$), with both groups exhibiting poor oral hygiene as reflected by high OHI-S scores (Table 2).

Table 2. The Differences of Oral Hygiene Index between Male and Female in Elderly Subjects with Periodontitis (n=88)

Gender	OHI (Mean±SD)	p-value
Females	3.142±1.580	0.950
Male	3.078±1.532	

Mann-Whitney Test; significant $p < 0.050$

This finding suggests that salivary calcium concentration alone may not directly determine oral hygiene status. Oral hygiene is a multifactorial condition influenced by behavioral, social, physical, and environmental factors. On the other hand, this study shows that the oral hygiene of the elderly, both male and female, is mostly in the poor category, with no significant difference by gender. This indicates that the oral hygiene of the elderly is more influenced by other factors, such as dental and oral health maintenance behaviors, physical limitations, level of knowledge, and systemic conditions associated with aging, than by gender (Desai & Nair, 2023). These findings are consistent with research by Bozdemir et al. (2016), which reported that most elderly individuals have poor oral hygiene, with no significant difference between males and females. This result suggests that, among the elderly population, oral hygiene status is not necessarily influenced by gender but is more closely related to other aging-related factors (Bozdemir et al., 2016). Daily oral hygiene practices, toothbrushing effectiveness, frequency of dental visits, educational background, socioeconomic status, manual dexterity, cognitive function, and access to dental care may have a greater influence on OHI-S scores than biological differences in salivary composition (Soofi et al., 2020).

The absence of a significant gender difference in oral hygiene status is in agreement with previous studies demonstrating that elderly populations commonly exhibit poor oral hygiene regardless of sex. Aging is frequently associated with reduced motor function, impaired vision, cognitive decline, chronic systemic diseases, and dependence on caregivers, all of which may negatively affect the ability to maintain adequate oral hygiene. Consequently, deterioration in oral hygiene among older adults may be more strongly related to aging-associated functional limitations than to gender itself (Müller et al., 2026). Furthermore, the high OHI-S scores observed in both groups indicate

substantial plaque and calculus accumulation among the study participants. Since all subjects were diagnosed with periodontitis, poor oral hygiene was expected and likely contributed to the persistence of periodontal inflammation. The findings emphasize the importance of maintaining effective plaque control measures in elderly populations, particularly among individuals with existing periodontal disease (Ibrahim et al., 2025). Daily physiological and behavioral conditions, such as stress levels, dietary patterns, and oral care habits, can influence the accumulation of plaque and debris, which form the basis of oral hygiene assessment (Al-Hassan et al., 2026).

The study provides valuable evidence regarding gender-related differences in salivary calcium levels among elderly individuals with periodontitis. The findings suggest that biological factors associated with aging and sex may influence salivary mineral composition, whereas oral hygiene status may be determined predominantly by behavioral and functional factors. Future longitudinal studies incorporating hormonal assessments, systemic health indicators, and additional salivary biomarkers are warranted to further clarify the mechanisms underlying these associations and their potential implications for periodontal disease progression in elderly populations. The limitation of this study is the small sample size, so the possibility of clinically significant subject-level variation was not fully addressed. Additionally, oral hygiene was measured only once, thereby not fully capturing potential variation in oral hygiene conditions over time.

Overall, this study affirms the importance of attention to dental and oral health in the elderly population, regardless of gender. Sustained promotive and preventive efforts, including dental and oral health education and improved access to dental health services, need to be enhanced to improve oral hygiene status and prevent dental and oral diseases among the elderly (Kementerian Kesehatan RI, 2018).

Conclusion

In elderly individuals with periodontitis, salivary calcium levels differ between females and males, with females having higher levels. The male OHI is higher than the female OHI, but the difference is not significant. The findings highlight the importance of regular oral health screening in elderly individuals, particularly women. Since female participants had higher salivary calcium levels than males, routine periodontal examinations and salivary biomarker assessments may help identify those at greater risk of periodontal disease. Early screening and timely treatment may improve oral health outcomes and quality of life in the elderly.

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Author Contributions

P.W. and J.M. contributed to methodological guidance, research supervision, and manuscript review. I.E. and A.S. contributed to critical review, scientific evaluation, and improvement of the manuscript. S.Y.A. contributed to the study design, data collection, data analysis, and manuscript preparation. All authors have read and approved the final version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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