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ORAL HEALTH STATUS AMONG OLDER ADULTS LIVING IN A LIMESTONE MINING AREA

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ABSTRACT
Older adults in limestone mining areas face heightened oral morbidity risks from airborne dust exposure, restricted access to dental care, and physiological aging. Objective: To evaluate oral hygiene status (OHI-S), dental caries experience and risk (DMFT, CAMBRA), and periodontal status with treatment needs (CPITN) among older adults in Ungasan Village, Bali. This descriptive observational cross-sectional study involved 50 older adults aged ≥60 years in Ungasan Village, Jimbaran, Bali. Clinical examinations were performed according to World Health Organization (WHO) standards. Most participants were male (56.0%) and aged 60–69 years (78.0%). The mean DMFT index was high (6.48), with 86.0% categorized as high caries risk (CAMBRA). Oral hygiene was predominantly moderate (70.0%) or poor (22.0%). All participants had periodontal problems, including calculus (78.0%) and 4–5 mm pockets (22.0%). Treatment needs were dominated by oral hygiene instruction with scaling (74.0%) and complex care (24.0%). The 60–69 age group showed the highest clinical vulnerability due to higher tooth retention, fine motor decline, and polypharmacy-induced hyposalivation. Older adults in the limestone mining area of Ungasan Village have poor oral health, characterized by high caries and periodontal disease burdens. The 60–69 age group requires prioritized community-based preventive scaling and structured education.

Keywords: dental caries; geriatric oral health; limestone mining area; periodontitis; ungasan village

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INTRODUCTION

Older adults are an age group that is highly vulnerable to various systemic and organ-specific health problems, including oral health issues. The cumulative decline in physiological function, the presence of comorbidities, and physical and economic barriers to accessing dental care make the geriatric population a top priority in disease prevention efforts (Kementerian Kesehatan Republik Indonesia, 2021). his oral health situation becomes even more complex when older adults live in environments with exposure to specific industries, such as the limestone mining area in Ungasan Village, South Kuta District, Badung, Bali (Aghilinejad et al., 2016).

The continuous mining, cutting, and processing of limestone generate microscopic particulate dust that becomes suspended in the air of residential areas. This alkaline and abrasive limestone dust can be inhaled and deposited in the oral cavity, which in turn can disrupt oral homeostasis through changes in saliva pH, mechanical erosion of the enamel surface, and chronic irritation of the soft

tissues and oral mucosa (Pichardo et al., 2022). The effects of this environmental exposure exacerbate clinical conditions in older adults who naturally experience degenerative changes (Clark et al., 2021), such as salivary gland atrophy (xerostomia), gingival recession, and a decline in local immune function (Wahyukundari et al., 2024). In addition to environmental risk factors, older adults in Ungasan Village face fundamental challenges in the form of limited access to routine dental care and low awareness of the importance of preventive checkups (Supriyanto et al., 2020). Oral health problems are often neglected until they reach an advanced stage, accompanied by severe pain, destructive tissue damage, or tooth mobility that requires invasive treatment (Sijabat et al., 2020). Furthermore, knowledge and practice of self-administered oral hygiene among the elderly remain minimal, particularly regarding effective toothbrushing techniques for gum recession or the use of dentures (Pili et al., 2020).

Therefore, clinical baseline mapping of oral health in older adults—including oral hygiene (OHI-S), caries experience (DMFT), caries risk (CAMBRA), as well as periodontal status and treatment needs (CPITN)—is of critical importance (Nomura et al., 2016). The evidence-based scientific data from this study serve as a critical foundation for formulating integrated promotive and preventive intervention strategies aimed at improving the quality of life for older adults in the limestone mining area of Ungasan Village (WHO, 2011). The purpose of this study is to determine the oral hygiene status of older adults based on the Oral Hygiene Index-Simplified (OHI-s), to determine the prevalence of dental caries among the elderly based on the DMFT (Decayed, Missing, and Filled Teeth) index (Aisyah et al., 2024); to identify the level of caries risk among the elderly using the CAMBRA (Caries Management by Risk Assessment) method; and to determine the periodontal status and periodontal treatment needs among the elderly based on the CPITN (Community Periodontal Index of Treatment Needs) index (Ghaffari et al., 2021).

METHOD

This study employed a descriptive observational design using a cross-sectional approach, conducted in August 2026 at Balai Banjar Kelod, Ungasan Village, Jimbaran, South Kuta, Badung, Bali (Adiatman et al., 2019). The target population consisted of elderly members of the Ungasan Village Senior Citizens Association (Karang Lansia). The study subjects consisted of 50 older adults aged ≥60 years who were selected using purposive sampling based on the following inclusion criteria: residing in the vicinity of the Ungasan limestone mine, able to communicate effectively, and willing to undergo all clinical examination procedures, as evidenced by signing an informed consent form (WHO, 2025).

Data collection was conducted in two stages: structured questionnaire interviews to record demographic data (gender and age), and direct clinical examinations of the oral cavity guided by a team of specialist dentists and dental students who had undergone calibration. The clinical examination procedure followed standard infection prevention and control principles (universal precautions) using sterile diagnostic sets (mouth mirrors, probes, forceps) and WHO periodontal probes. The clinical indicators evaluated included: the Oral Hygiene Index—Simplified (OHI-S), the Decayed, Missing, Filled Teeth (DMFT) Index, Caries Management by Risk Assessment (CAMBRA), and the Community Periodontal Index of Treatment Needs (CPITN). The clinical data obtained were tabulated and analyzed descriptively using SPSS version 24. The analysis included frequency distributions, percentages, means, and cross-tabulations between clinical variables and demographic variables (gender and age group) (Adiatman et al., 2026).

RESULT

The results of a descriptive analysis of 50 elderly respondents in Ungasan Village showed that the majority of the subjects were male (56.0%) and were in the 60–69 age group (78.0%). A complete overview of the demographic characteristics and clinical status is presented in Table 1.

Table 1.
Demographic Characteristics and Clinical Indicators Among Older Adults (n=50)

Variable	Category	f	%
Gender	Male	28	56.0
	Female	22	44.0
Age (Years)	60–69	39	78.0
	70–79	9	18.0
	80–100	2	4.0
Caries Risk (CAMBRA)	Moderate	7	14.0
	High	43	86.0
Oral Hygiene (OHI-s)	Good	4	8.0
	Moderate	35	70.0
	Poor	11	22.0
Periodontal Status (CPITN)	Calculus on Probing	39	78.0
	Pocket 4–5 mm	11	22.0
Periodontal Treatment Needs	OH Instruction (Code 1.00)	1	2.0
	OH + Scaling	37	74.0
	Complex Treatment	12	24.0

Table 2.
DMFT Index Among the Elderly

Total DMF	Number of Subjects (n)	Mean DMFT Index	Severity Category (WHO)
324	50	6,48	High

The predominance of the 60–69 age group (78.0%) reflects the "young-old" transition phase, in which individuals begin to experience an accumulation of chronic dental diseases starting in their productive years (Clark et al., 2021). The caries assessment revealed alarming caries rates, with an average DMFT index of 6.48 (high category) and a total of 324 teeth affected by caries, missing, or filled. Consistent with this, the CAMBRA evaluation found that 86.0% of older adults were in the high caries risk category (Wulandari et al., 2022). This condition is triggered by postmenopausal or age-related physiological changes, such as a decrease in salivary flow rate (xerostomia), mucosal atrophy, and gingival retraction that exposes the cementum and root dentin, thereby increasing susceptibility to root caries (Peres et al., 2019). The high risk of caries is closely associated with moderate (70.0%) and poor (22.0%) oral hygiene, reflecting suboptimal daily mechanical plaque control. (7,10) The accumulation of plaque biofilm that binds particulate limestone dust and is exposed to salivary calcium accelerates the formation of hard calculus (Wahyukundari et al., 2024). This explains why all respondents experienced periodontal problems, consisting of subgingival calculus accumulation (78.0%) and the formation of 4–5 mm periodontal pockets (22.0%) (Tolera, 2026). The implications of these findings are reflected in treatment needs, with 74.0% of the elderly requiring a combination of oral hygiene education and scaling, and 24.0% requiring complex treatment interventions (Pili et al., 2019). To gain a deeper understanding of patterns of clinical vulnerability, a cross-tabulation analysis was conducted between clinical variables and demographic characteristics (Table 3).

Table 3.
Cross-Tabulation of Clinical Variables by Gender and Age Group

Clinical Variables	Category	Total (n=50)	Gender		Age Group (Years)		
			Male (n=28)	Female (n=22)	60–69 (n=39)	70–79 (n=9)	80–100 (n=2)
Caries Risk (CAMBRA)	Moderate	7	3	4	4	2	1
	High	43	25	18	35	7	1
Oral Hygiene (OHI-s)	Good	4	3	1	2	2	0
	Moderate	35	19	16	26	7	2
	Poor	11	6	5	11	0	0
Periodontal Status (CPITN)	Calculus on Probing	39	23	16	28	9	2
	Pocket 4–5 mm	11	5	6	11	0	0
Periodontal Treatment Needs	OH + Scaling	38	22	16	27	9	2
	Complex Treatment	12	6	6	12	0	0

Based on table 3. regarding the association between caries risk and gender and age, elderly men showed a slightly higher proportion of high caries risk (25 out of 28 individuals, or 89.3%) compared to women (18 out of 22 individuals, or 81.8%). Epidemiologically, this is associated with cumulative behavioral factors such as smoking and lower frequency of dental care utilization among men (Adiatman et al., 2019). By age group, the high-risk category for dental caries was dominated by the 60–69 age group (35 individuals). In this early stage of old age, the onset of systemic comorbidities (such as hypertension or diabetes) begins to trigger long-term medication use (polypharmacy), which has side effects that impair saliva secretion (xerostomia), thereby eliminating saliva's natural buffering function (Barbe, A. 2018).

DISCUSSION

The relationship between oral hygiene (OHI-S) and age shows that cases of poor oral hygiene (11 individuals) were specifically concentrated in the 60–69 age group (11 individuals), while all older adults over 70 years of age fell into the moderate and good categories. This phenomenon is related to the high retention of natural teeth in the early elderly group compared to the older age group (≥70 years), who tend to have experienced edentulism or the loss of many teeth (Peres et al., 2019). The presence of a full set of natural teeth, not balanced by adequate toothbrushing ability—due to the early onset of declining fine motor function or joint stiffness—leads to massive plaque accumulation (Delwel et al., 2018).

The observed relationship between oral hygiene status and age warrants careful interpretation. In this study, all 11 participants classified as having poor oral hygiene were aged 60–69 years. One possible explanation is that individuals in this age group may retain more natural teeth than those in older age groups, resulting in a greater number of tooth surfaces susceptible to plaque accumulation. When toothbrushing effectiveness is compromised by reduced manual dexterity, joint stiffness, visual impairment, or inadequate oral hygiene practices, plaque control may become less effective. However, because the number of remaining natural teeth, functional ability, and oral hygiene practices were not directly reported as measured variables, these mechanisms should be considered plausible explanations rather than confirmed causes. Furthermore, better OHI-S scores among adults aged ≥70 years should not necessarily be interpreted as better overall oral health, as tooth loss and edentulism may influence the number and type of surfaces available for examination (Paris et al., 2020).

Beyond physiological aging, environmental and occupational factors in the limestone mining area of Ungasan Village likely contribute to the observed oral health degradation. Inhalation and airborne deposition of fine limestone particulate dust (calcium carbonate) can directly impact the oral microenvironment (Aghilinejad et al., 2016). Continuous exposure to abrasive alkaline particles disrupts normal salivary pH buffering capacity, promotes oral mucosal dryness, and exacerbates mechanical tooth wear (Pichardo et al., 2022). In older adults, whose salivary flow rates are already compromised by age-related acinar atrophy or polypharmacy, airborne dust accumulation can impair natural self-cleansing mechanisms (Barbe, 2018). The synergy between environmental particulate deposition and reduced salivary flow accelerates dental plaque calcification, explaining the exceptionally high prevalence of subgingival calculus (78.0%) observed in this cohort (Wahyukundari et al., 2024).

The alarming severity of caries experience (mean DMFT index of 6.48) and the overwhelming proportion of high caries risk individuals (86.0% via CAMBRA) highlight a critical public health challenge among older adults in Ungasan Village. In geriatric populations, gingival recession frequently exposes vulnerable root dentin and cementum, which have a higher critical pH threshold for demineralization than enamel (Peres et al., 2019). When combined with particulate environmental exposure, compromised oral hygiene, and hyposalivation, root caries progression can occur rapidly and silently. The absence of routine restorative interventions in this population, driven by low baseline

oral health literacy and financial or geographic access barriers, allows active lesions to progress to gross crown destruction or tooth loss (Sijabat et al., 2020; Supriyanto et al., 2020).

Based on the relationship between periodontal status and treatment needs, all cases of 4–5 mm periodontal pockets (11 individuals) and complex treatment needs (12 individuals) were concentrated among older adults aged 60–69 years. Periodontal tissue damage in the elderly is cumulative over a lifetime (lifetime cumulative damage) as a form of chronic inflammatory response to plaque biofilm and calculus (Papapanou et al., 2018). In terms of gender, elderly women showed a slightly higher prevalence of periodontal pockets (6 individuals) compared to men (5 individuals). This is related to postmenopausal endocrine mechanisms, in which a decrease in estrogen levels triggers a reduction in bone mineral density (osteoporosis), which systemically accelerates the rate of alveolar bone resorption when local inflammation occurs due to subgingival calculus (Penoni et al., 2017).

The concentration of periodontal pockets measuring 4–5 mm and complex periodontal treatment needs among participants aged 60–69 years may reflect the cumulative effects of long-term exposure to dental plaque biofilm and calculus, together with individual differences in susceptibility to periodontal tissue destruction. Periodontitis is a chronic inflammatory disease in which dysregulated host responses to the subgingival biofilm contribute to connective tissue breakdown and alveolar bone loss (Tonetti et al., 2020). Nevertheless, chronological age alone does not establish disease severity or progression. The observed distribution may also be influenced by differences in tooth retention, previous dental treatment, oral hygiene practices, systemic conditions, and access to dental care (Papapanou et al., 2018). Therefore, the findings support prioritizing periodontal assessment in the 60–69-year age group within this study population, but they do not establish that this age group has a higher risk of disease progression than older participants. Comprehensive treatment (root planing/curettage) is critically important for older adults aged 60–69 years. The management of chronic periodontal infection is not only aimed at preventing edentulism but is also important for reducing the systemic inflammatory burden, which can exacerbate complications of cardiovascular disease and type 2 diabetes in older adults (Heningtyas et al., 2026).

Regarding sex, periodontal pockets were observed in six women and five men. Although the number was slightly higher among women, this difference is insufficient to establish a sex-related disparity without considering the total number of male and female participants, the proportion affected within each group, and appropriate statistical analysis. Postmenopausal estrogen decline may contribute to changes in bone metabolism and bone mineral density; however, systemic osteoporosis and periodontal alveolar bone loss are distinct conditions with a multifactorial relationship. Local plaque-induced inflammation remains a central factor in periodontal disease pathogenesis. Consequently, hormonal changes may be discussed as a potential biological consideration, but the present descriptive findings cannot demonstrate that menopause or estrogen deficiency caused the observed periodontal pockets (Tonetti et al., 2020)

The high prevalence of periodontal problems and the substantial need for scaling and more complex care highlight the importance of accessible, age-appropriate periodontal services in the study area. Initial management should include individualized oral hygiene instruction, professional supra- and subgingival instrumentation according to clinical indications, assessment of periodontal pocket depth and clinical attachment loss, and subsequent reevaluation (Aguirre Escobar et al., 2022). Root planing or periodontal surgery should not be recommended solely on the basis of age or a screening index; treatment decisions should be guided by a comprehensive periodontal examination, disease severity, tooth prognosis, medical history, and patient preferences. Where manual dexterity is limited, adapted toothbrush handles, powered toothbrushes, caregiver-assisted oral hygiene, and regular maintenance visits may be considered (Papapanou et al., 2018).

The potential systemic implications of periodontal inflammation also reinforce the importance of comprehensive oral healthcare for older adults. Periodontitis has been associated with several systemic conditions, including diabetes mellitus and cardiovascular disease. Nevertheless, this study did not evaluate systemic inflammatory biomarkers or establish causal relationships between periodontal status and systemic outcomes. Accordingly, periodontal treatment should be recommended primarily to control oral disease, preserve dentition where feasible, reduce symptoms, and maintain oral function and quality of life, while possible systemic benefits should be described cautiously (Papapanou et al., 2018). Overall, these findings indicate a substantial burden of oral disease among older adults in the limestone-mining area of Ungasan Village and support the need for community-based preventive and therapeutic services (Nurjazuli, 2019). Future studies should include larger samples, direct assessment of occupational dust exposure, number of remaining teeth, functional ability, medication use, systemic health, and access to dental care. Analytical studies would also help determine whether age, sex, occupational exposure, and other factors are independently associated with oral hygiene and periodontal outcomes (WHO, 2025).

CONCLUSION

Older adults in the limestone mining area of Ungasan Village have relatively poor oral health, characterized by a high prevalence of caries (mean DMFT of 6.48), a predominance of high caries risk (86.0%), and a high incidence of periodontal disease in the form of subgingival calculus (78.0%) and periodontal pockets of 4–5 mm (22.0%). The early elderly group (ages 60–69) was identified as the most vulnerable group with the highest need for complex periodontal care.

DECLARATIONS

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Ethical approval: Ethical clearance and administrative permission were granted for clinical examinations and survey procedures in Ungasan Village. Written informed consent was obtained from all participants prior to data collection.

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Declaration of the Use of Artificial Intelligence in Scientific Writing: During the preparation of this manuscript, the authors utilized Google Gemini solely as an artificial intelligence language assistant for English grammar refinement, phrasing optimization, and structural composition. The AI model was not used to collect data, perform statistical analyses, interpret clinical results, or

generate text verbatim. All scientific concepts, interpretations, and final text were thoroughly verified, edited, and approved by the authors, who accept full responsibility for the content of this publication.

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