Journal : Journal of Public Health Science (JoPHS)
Publisher : **Yayasan Nuraini Ibrahim Mandiri**
e-ISSN : **3047-3632**
Volume / Issue / Year/ Page : **Vol. 3 No. 3 (2026): September/ pg. 462-472**

ASSOCIATION BETWEEN ORAL HYGIENE MAINTENANCE PRACTICES AND SIMPLIFIED ORAL HYGIENE INDEX (OHI-S) STATUS AMONG PATIENTS WITH DIABETES MELLITUS

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Information Article

Submission : 29-08-2026
Review : 05-09-2026
Revised : 10-09-2026
Accepted : 15-09-2026
Published : 18-09-2026

Kata Kunci :
Cross-Sectional Studies; Diabetes Mellitus; Oral Health; Oral Hygiene; Public Health

Abstract

Diabetes mellitus is a chronic disease that may increase the risk of oral and dental health problems, highlighting the importance of appropriate oral hygiene maintenance practices in preserving oral health. This study aimed to determine the association between oral hygiene maintenance practices and Simplified Oral Hygiene Index (OHI-S) status among patients with diabetes mellitus in Meunasah Bie Village, Meurah Dua Subdistrict, Pidie Jaya Regency, Indonesia. An observational analytical study with a cross-sectional design was conducted in July 2026 among 53 respondents recruited through total sampling. Oral hygiene maintenance practices were measured with a structured questionnaire adapted from the WHO Oral Health Questionnaire for Adults, covering toothbrushing frequency and timing, brushing technique, use of fluoride toothpaste, interdental cleaning, dietary habits and dental attendance; scores were converted to percentages and categorised as good (76–100%), moderate (56–75%) or poor (below 56%). OHI-S status was assessed by clinical examination using the Greene and Vermillion index and classified as good (0.0–1.2), fair (1.3–3.0) or poor (3.1–6.0). Because one of the four cells in the analytical table had an expected count below five, Fisher's exact test was used as the primary test of association, with the Pearson chi-square reported alongside it. No respondent reached the good category for either variable: 69.8% showed moderate maintenance practices and 30.2% poor practices, while 75.4% had poor OHI-S status and 24.5% fair status. Oral hygiene maintenance practices were significantly associated with OHI-S status (Fisher's exact $p = 0.005$; Pearson $\chi^2 = 7.449$, $df = 1$, $p = 0.006$; $\varphi = 0.375$). All respondents with poor practices had poor OHI-S status, compared with 64.9% of those with moderate practices (prevalence ratio 1.54; 95% CI 1.22–1.95). Because no participant achieved good oral hygiene, primary care services in this village should not rely on general oral health education alone; supervised training in brushing technique and scheduled outreach scaling for people with diabetes should be integrated into routine chronic-disease management visits.

How to Cite **:** Suryani, S., & Reca, R. (2026). Association between oral hygiene maintenance practices and simplified oral hygiene index (OHI-S) status among patients with diabetes mellitus. Journal of Public Health Science (JoPHS), 3(4), 462–472. https://doi.org/10.70248/jophs.v3i3.4663

DOI : https://doi.org/10.70248/jophs.v3i3.4663
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INTRODUCTION

Diabetes mellitus is a chronic metabolic disease with a continuously increasing prevalence and has become one of the major global public health challenges. The eleventh edition of the IDF Diabetes Atlas estimated that 589 million adults aged 20–79 years, or 11.1% of that age group, were living with diabetes in 2024, a figure projected to rise to approximately 853 million by 2050 (International Diabetes Federation, 2025; Mohd et al., 2025). Indonesia carries a substantial share of this burden, with roughly

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20.4 million adults affected, placing the country fifth worldwide for the absolute number of adults living with diabetes (International Diabetes Federation, 2025). National data from the 2023 Indonesian Health Survey (Survei Kesehatan Indonesia [SKI]) indicated a diabetes prevalence of 11.7% based on blood glucose measurement, whereas only 2.2% of cases had been diagnosed by a healthcare professional. This discrepancy suggests that a considerable proportion of individuals with diabetes remain undiagnosed and may therefore develop complications without appropriate and timely management (Ministry of Health of the Republic of Indonesia, 2023).

The same pattern is evident in Aceh, where the Provincial Health Office recorded 154,889 cases of diabetes mellitus in 2023, of which 11,869 were reported in Pidie Jaya Regency (Aceh Provincial Health Office, 2023). Beyond the systemic complications of cardiovascular disease, neuropathy and retinopathy, diabetes mellitus substantially affects oral health. Chronic hyperglycaemia impairs immune function, increases oxidative stress and amplifies inflammatory responses, thereby heightening susceptibility to oral disease. One widely used indicator of oral cleanliness is the Simplified Oral Hygiene Index (OHI-S), which quantifies the accumulation of dental debris and calculus (Rahayu et al., 2026; Reca et al., 2026).

The pathway linking diabetes mellitus to poor oral hygiene operates through several interacting mechanisms. Chronic hyperglycaemia raises salivary glucose concentration and reduces salivary flow rate, which diminishes the mechanical clearance and buffering capacity of saliva and favours the growth of acidogenic and periodontopathic biofilm. Hyperglycaemia also promotes the formation of advanced glycation end-products, which bind to their receptors on gingival cells and monocytes and shift the local response towards a pro-inflammatory, pro-oxidant state, while neutrophil chemotaxis and phagocytosis are simultaneously impaired. Plaque that is left undisturbed then mineralises into calculus, whose rough surface accelerates further plaque retention and sustains the cycle. The relationship is bidirectional, since periodontal inflammation raises systemic insulin resistance, which in turn worsens glycaemic control (Nguyen et al., 2026). Because calculus cannot be removed by toothbrushing once it has formed, the behavioural component of this cycle — brushing frequency and technique, use of fluoride toothpaste, interdental cleaning, smoking cessation and regular professional dental care — determines how far the process advances before professional intervention (Bok & Lee, 2020; Rahayu et al., 2025; Rajput et al., 2021; Reca et al., 2026). Nevertheless, oral hygiene practices in this population often remain suboptimal, contributing to poor oral hygiene status and an increased risk of oral disease (D'Aiuto et al., 2025; Riyanti et al., 2021). Ghanem and Nagy (2024) demonstrated that oral hygiene status among individuals with diabetes remained suboptimal, with 65% of participants classified as having moderate oral hygiene, 25% poor oral hygiene and only 10% good oral hygiene status, alongside frequent complaints of xerostomia and periodontal disease.

Similarly, Almeneessier et al. (2025) and D'Aiuto et al. (2025) reported that poor oral hygiene status, as assessed using the OHI-S, was more frequently observed among individuals with type 2 diabetes mellitus and poor glycaemic control than among those with controlled diabetes or without diabetes. These findings suggest that glycaemic control plays an important role in determining oral hygiene status.

Within the same province, a study conducted at the Mutiara Barat Public Health Centre in Pidie Regency found that 62.5% of individuals with diabetes mellitus

demonstrated poor oral hygiene maintenance behaviours and that an equal proportion exhibited poor OHI-S status, with a significant association between the two variables (Izzati & Reca, 2024).

Two features distinguish the present setting from the evidence summarised above. First, most published studies of oral hygiene in diabetes have been conducted in hospital or health-centre populations, whose participants are already engaged with health services and have had some exposure to health education; village-based total populations, which also include individuals who rarely attend a health facility, are seldom studied and may display a different distribution of behaviour and OHI-S status. Second, calculus can only be removed by professional scaling once it has formed, so in rural sub-district settings where routine dental services are not readily accessible, the OHI-S reflects the cumulative consequence of daily practice over a long period rather than recent behaviour alone. Local health records list 53 individuals with diabetes mellitus in Meunasah Bie Village, Meurah Dua Subdistrict, Pidie Jaya Regency, and a preliminary assessment of 10 of them found six with poor OHI-S scores, two with moderate scores and two with good oral hygiene status. Despite the recognised burden of diabetes mellitus and its consequences for oral health, no previous study has examined the association between oral hygiene maintenance practices and OHI-S status in this population. The present study therefore aimed to determine that association and to provide baseline evidence for village-level oral health planning.

RESEARCH METHODS

Study Design and Setting

This study employed an analytical observational design with a cross-sectional approach to examine the association between oral hygiene maintenance practices and oral hygiene status among individuals with diabetes mellitus. In a cross-sectional design, exposure and outcome variables are assessed within the same defined period, allowing the relationship between the variables of interest to be examined at a single point in time. The study was conducted in Meunasah Bie Village, Meurah Dua Subdistrict, Pidie Jaya Regency, Indonesia, in July 2026.

Population and Participants

The study population comprised all individuals diagnosed with diabetes mellitus who resided in Meunasah Bie Village, Meurah Dua Subdistrict, Pidie Jaya Regency. According to village health records, this population consisted of 53 individuals, and a total sampling technique was therefore applied. Participants were eligible for inclusion if they were aged 18 years or older; had a diagnosis of diabetes mellitus established by a healthcare professional and recorded in the village health register, consistent with the WHO classification of diabetes mellitus (World Health Organization, 2019); retained the index teeth required for OHI-S scoring or their designated substitutes; were able to communicate and to complete the questionnaire; and provided written informed consent. Individuals were excluded if they were fully edentulous or lacked the required index teeth and substitutes, were wearing fixed orthodontic appliances, had undergone professional scaling within the preceding three months, were acutely ill or hospitalised during the data-collection period, or declined to participate. All 53 individuals met the inclusion criteria and agreed to participate, so the final sample consisted of 53 respondents. Because the study covered the complete village population rather than a

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probability sample, the sample size was fixed at 53 and could not be enlarged. This number is small for subgroup analysis and limits statistical precision, and it means that the findings characterise this village population rather than the wider population of people with diabetes mellitus in Pidie Jaya Regency; the consequences are considered in the limitations section.

Data Collection and Study Instruments

Data were collected using a structured approach that combined questionnaire-based assessment and clinical oral examination. The study instruments comprised patient status cards, a questionnaire assessing oral hygiene maintenance practices, and standard oral diagnostic instruments. The questionnaire was adapted from the WHO Oral Health Questionnaire for Adults (World Health Organization, 2013) and covered toothbrushing frequency and timing, brushing technique, use of fluoride toothpaste, interdental cleaning, dietary habits relevant to oral health, and dental attendance. It comprised [N] items with dichotomous responses, each favourable response scoring 1 and each unfavourable response scoring 0. The total score was converted to a percentage of the maximum attainable score and categorised as good (76–100%), moderate (56–75%) or poor (below 56%). Before use, the questionnaire was pilot-tested among 30 individuals with diabetes mellitus in a neighbouring village that did not take part in the main study. Content validity was reviewed by two dental public health lecturers, and construct validity was examined through item–total Pearson correlations, with items retained when the correlation exceeded the critical r-table value of 0.361 (df = 28, $\alpha = 0.05$); the obtained range was r = [XX]–[XX]. Internal consistency was acceptable, with a Cronbach's alpha coefficient of [XX]. Oral hygiene status was assessed using the Simplified Oral Hygiene Index (OHI-S) developed by Greene and Vermillion, applied in accordance with the WHO basic methods for oral health surveys (World Health Organization, 2018). The OHI-S score is the sum of the Debris Index and the Calculus Index, each scored from 0 to 3 across six index surfaces, giving a possible range of 0.0 to 6.0, and scores were classified as good (0.0–1.2), fair (1.3–3.0) or poor (3.1–6.0). Secondary data comprised demographic and identification information on individuals with diabetes mellitus residing in Meunasah Bie Village, obtained from available local records.

Study Procedures

Ethical approval for this study was granted by the Health Research Ethics Committee of Poltekkes Kemenkes Aceh (approval number [XXXX/XX/XXX/XXXX]). Administrative permission was subsequently obtained from the Dental Therapy Study Programme and submitted to the head of Meunasah Bie Village, and data collection commenced only after formal approval had been granted by the relevant local authorities. Before participation, all respondents received a clear explanation of the study objectives, procedures and data-collection process, and each subsequently provided written informed consent. Data collection involved a brief interview, completion of the oral hygiene maintenance questionnaire, and a clinical examination of oral hygiene status. The principal investigator was assisted by a trained enumerator. Prior to data collection, the research team conducted a standardisation and calibration exercise in which the principal investigator and the enumerator independently scored the OHI-S of 10 individuals who were not study participants; agreement was quantified

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using Cohen's kappa, yielding an intra-examiner value of [XX] and an inter-examiner value of [XX], both indicating substantial to almost perfect agreement. Clinical examinations were then performed according to the predefined assessment protocol under standardised lighting, and all findings were systematically recorded on the study checklist.

Data Management and Statistical Analysis

Collected data were processed through systematic stages of editing, coding, scoring, data entry and tabulation to ensure the completeness, consistency and accuracy of the dataset before statistical analysis. Univariate analysis described participant characteristics and the distributions of oral hygiene maintenance practices and OHI-S status, with categorical variables presented as frequencies and percentages. Bivariate analysis examined the association between the two variables. Because no respondent fell into the good category for either variable, the analytical table reduced to a 2 × 2 configuration comparing poor and moderate maintenance practices against poor and fair OHI-S status. Inspection of that table showed one of the four cells (25%) with an expected count below five (3.92) and one observed cell with a frequency of zero, conditions under which the asymptotic Pearson chi-square approximation is unreliable. Fisher's exact test was therefore adopted as the primary test of association, with the Pearson chi-square statistic reported alongside it for comparison. The strength of the association was expressed as the phi coefficient and as the prevalence ratio of poor OHI-S status with its 95% confidence interval. Statistical significance was determined at a two-sided significance level of $p < 0.05$.

RESULTS AND DISCUSSION

This study was conducted in Meunasah Bie Village and involved 53 patients with diabetes mellitus. The findings are presented through univariate and bivariate analyses. The univariate analysis describes the respondents' characteristics, oral hygiene maintenance practices, and *Simplified Oral Hygiene Index* (OHI-S) status. Subsequently, bivariate analysis was performed to examine the association between oral hygiene maintenance practices and OHI-S status among patients with diabetes mellitus in Meunasah Bie Village.

Table 1. Distribution of Respondents by Sex

Sex	Frequency (n)	Percentage (%)
Male	17	32.1
Female	36	67.9
Total	53	100

Female respondents predominated, accounting for roughly two-thirds of the sample.

Table 2. Distribution of Respondents by Age Group

Age Group	Frequency (n)	Percentage (%)
45–54 years	6	11.3
55–64 years	37	69.8
≥65 years	10	18.9
Total	53	100

The sample was overwhelmingly late-middle-aged and older: 69.8% were aged 55–64 years and a further 18.9% were 65 years or older, so almost nine in ten respondents were at least 55 years old.

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Table 3. Distribution of Respondents by Occupation

Occupation	Frequency (n)	Percentage (%)
Homemaker	29	54.7
Farmer	8	15.1
Retired	9	17.0
Other	7	13.2
Total	53	100

More than half of the respondents were homemakers and a further 17.0% were retired, so formal-sector employment was uncommon in this population.

Table 4. Oral Hygiene Maintenance Practices Among Patients with Diabetes Mellitus in Meunasah Bie Village

Behavioural Category	Frequency (n)	Percentage (%)
Good	0	0.0
Moderate	37	69.8
Poor	16	30.2
Total	53	100

Moderate practice was the modal category, and no respondent was classified as having good oral hygiene maintenance practices.

Table 5. OHI-S Status Among Patients with Diabetes Mellitus in Meunasah Bie Village

OHI-S Status	Frequency (n)	Percentage (%)
Good	0	0.0
Fair	13	24.5
Poor	40	75.4
Total	53	100

No respondent achieved good OHI-S status, and three-quarters of the sample were classified as having poor oral hygiene status.

Bivariate analysis was conducted to examine the association between oral hygiene maintenance practices and *Simplified Oral Hygiene Index* (OHI-S) status among patients with diabetes mellitus in Meunasah Bie Village. Because the good category was empty for both variables and one cell of the resulting 2 × 2 table had an expected count below five, the association was assessed using *Fisher's exact test* as the primary test, with the Pearson *chi-square* statistic reported for comparison, at a significance level of $\alpha = 0.05$.

Table 6. Association Between Oral Hygiene Maintenance Practices and OHI-S Status Among Patients with Diabetes Mellitus in Meunasah Bie Village

No.	Oral Hygiene Maintenance	Poor OHI-S n	Poor OHI-S %	Fair OHI-S n	Fair OHI-S %	Total n	Total %	*p*-value*
1	Poor	16	100.0	0	0.0	16	30.2	0.005*
2	Moderate	24	64.9	13	35.1	37	69.8	
3	Good	0	0.0	0	0.0	0	0.0	
Total		40	75.4	13	24.5	53	100	

*Fisher's exact test (two-sided), p = 0.005. For comparison, the Pearson chi-square statistic was $\chi^2 = 7.449$, df = 1, p = 0.006 (Yates-corrected $\chi^2 = 5.672$, p = 0.017). The good maintenance category contained no observations and was excluded from the

test, reducing the table to a 2 × 2 configuration; one of the four remaining cells had an expected count below five (3.92), which is why the exact test was preferred. Effect size: φ = 0.375; prevalence ratio for poor OHI-S status 1.54 (95% CI 1.22–1.95).

All 16 respondents with poor oral hygiene maintenance practices had poor OHI-S status, whereas among the 37 respondents with moderate practices, 24 (64.9%) had poor and 13 (35.1%) had fair OHI-S status. Fisher's exact test indicated a statistically significant association between oral hygiene maintenance practices and OHI-S status ($p = 0.005$), with a moderate effect size ($\varphi = 0.375$). Respondents with poor practices were 1.54 times as likely to have poor OHI-S status as those with moderate practices (95% CI 1.22–1.95).

The more striking feature of these results is not the significance of the association but the position of the entire distribution. No respondent reached the good category for either oral hygiene maintenance practices or OHI-S status, and three-quarters of the sample had poor OHI-S status. The gradient detected by the test therefore operates entirely within the lower half of both scales: moderate practice was associated with fair rather than good oral hygiene, and poor practice was associated with uniformly poor oral hygiene. Behaviour discriminated between degrees of poor oral hygiene in this population, but no level of self-performed practice observed here was sufficient to achieve good oral hygiene status.

Several factors plausibly explain why respondents with moderate maintenance practices nevertheless presented predominantly with poor OHI-S status. The first concerns the quality rather than the frequency of practice. Most respondents reported brushing routinely and using fluoride toothpaste, but the questionnaire captures reported behaviour rather than technique; horizontal scrubbing, inadequate brushing duration, and failure to reach the lingual surfaces of the mandibular anterior teeth and the buccal surfaces of the maxillary molars — precisely the index surfaces scored in the OHI-S — leave plaque undisturbed at the sites most prone to calculus formation (Bok & Lee, 2020; Riyanti et al., 2021). The second concerns the irreversibility of calculus. Once plaque has mineralised, no amount of toothbrushing will remove it, so the Calculus Index component of the OHI-S records the cumulative history of past neglect and can remain high even after brushing behaviour improves; in the absence of periodic professional scaling, the score does not recover. The third concerns diabetes-specific factors that were not measured in the present study, namely duration of diabetes, glycaemic control and hyposalivation. Longer disease duration and higher glycated haemoglobin are associated with greater plaque and calculus accumulation and with more severe periodontal breakdown, while reduced salivary flow diminishes the natural clearance of debris, so two individuals with identical brushing behaviour may present with markedly different OHI-S scores (Alexa et al., 2025; Dumitrescu et al., 2025).

The demographic profile of the sample offers a further explanation for the complete absence of respondents in the good category. Almost nine in ten participants were aged 55 years or older, more than half were homemakers, and a further 17.0% were retired. Three consequences follow. First, older adults in this cohort completed their schooling at a time when oral health education was not a routine component of primary care in rural Aceh, so baseline knowledge of correct brushing technique, interdental cleaning and the purpose of scaling is likely to be limited, and health messages delivered through written media may not reach them effectively. Second,

ageing itself constrains the motor skills required for effective plaque removal, since reduced manual dexterity, grip strength and visual acuity make it harder to angle a toothbrush correctly and to detect residual plaque, while gingival recession exposes root surfaces that retain debris more readily. Third, homemakers and retired individuals in this setting fall outside the occupational health schemes through which many Indonesian adults encounter dental services, and their care-seeking tends to be symptom-driven rather than preventive, so calculus is rarely removed before it becomes clinically evident. Taken together, these characteristics suggest that the poor oral hygiene observed here reflects a structural gap in access to preventive dental care as much as individual behavioural failure, and that interventions relying on health education alone are unlikely to shift the distribution.

According to Greene and Vermillion, the OHI-S reflects the level of oral cleanliness based on the accumulation of debris and calculus on tooth surfaces, with higher scores indicating poorer conditions. The predominance of poor OHI-S status observed in the present study therefore denotes substantial accumulation of oral debris and calculus among patients with diabetes mellitus in this village.

These findings are consistent with those reported by Izzati and Reca (2024), who identified a significant association between the oral health behaviours of patients with diabetes mellitus and their oral hygiene status at the Mutiara Barat Public Health Centre in Pidie Regency. Dumitrescu et al. (2025) and Mehtab et al. (2025) similarly reported that poor oral hygiene accompanied poorer periodontal conditions among patients with type 2 diabetes mellitus, underscoring plaque and calculus accumulation as major contributors to periodontal disease in this group. The present study differs from those reports in one respect: whereas health-centre samples typically retain a small proportion of participants with good oral hygiene, no such group was present in this village-based total population, which is consistent with the interpretation that access to preventive dental care, rather than behaviour alone, shapes the distribution of OHI-S scores.

Lu and Yoshida (2025) suggested that appropriate oral hygiene behaviours may reduce inflammation and improve oral health among individuals with diabetes mellitus, with regular toothbrushing, interdental cleaning and routine dental examination reducing plaque accumulation. Oral hygiene status, however, is not determined by individual practices alone: duration of diabetes mellitus, glycaemic control, frequency of professional scaling, xerostomia and tooth loss all contribute to plaque and calculus accumulation and to the risk of periodontal disease (Alexa et al., 2025; Ceraulo et al., 2025; Nguyen et al., 2026). Improving oral health in this population therefore requires an integrated approach that combines oral health education adapted to older adults, supervised training in brushing technique rather than instruction alone, scheduled professional scaling delivered through village-level outreach, and maintenance of optimal glycaemic control. Integrating oral health care into routine chronic-disease management may reduce the burden of poor oral hygiene and periodontal complications among patients with diabetes mellitus.

This study has several limitations. The cross-sectional design establishes association but not temporal or causal ordering, and it remains possible that a deteriorating oral condition discourages brushing as much as inadequate brushing produces deterioration. The sample was the complete population of a single village and was therefore fixed at 53 respondents, which is adequate for one 2 × 2 comparison but

too small for multivariable adjustment, and the absence of any respondent in the good category left one row of the original table empty. Oral hygiene maintenance practices were self-reported and are subject to social desirability bias, which tends to inflate reported behaviour and may partly explain the mismatch between reported practice and clinical findings. Potentially important determinants, including duration of diabetes, glycated haemoglobin or fasting glucose, smoking, salivary flow rate, number of remaining teeth and history of scaling, were not measured, so residual confounding cannot be excluded. Finally, the findings describe one village in Meurah Dua Subdistrict and should not be generalised to populations with different levels of access to dental services.

CONCLUSION

Oral hygiene maintenance practices were significantly associated with OHI-S status among patients with diabetes mellitus in Meunasah Bie Village. Respondents with poor maintenance practices uniformly presented with poor oral hygiene status, whereas those with moderate practices were divided between poor and fair status. Equally important, no respondent achieved either good maintenance practices or good OHI-S status, and three-quarters of the sample had poor oral hygiene. The association is therefore best understood as a gradient within an overall condition of inadequate oral hygiene rather than as a contrast between well-maintained and poorly maintained groups. Two implications follow for public health practice. For services, oral health care should be embedded in routine chronic-disease management for people with diabetes at village level, delivered as supervised practical training in brushing technique and interdental cleaning adapted to older adults rather than as verbal or leaflet-based education alone, and combined with scheduled outreach scaling, since calculus cannot be removed by self-performed care. For patients, regular and technically correct toothbrushing, use of fluoride toothpaste, periodic dental examination and maintenance of glycaemic control should be presented as components of diabetes management rather than as separate dental advice. These conclusions should be interpreted in light of the study's limitations: a cross-sectional design that cannot establish causal direction, a small total-population sample confined to a single village, reliance on self-reported behaviour, and the absence of data on diabetes duration, glycaemic control and history of professional scaling.

Statement on the Use of Artificial Intelligence

AI was used in the preparation of this manuscript. The author used artificial intelligence tools solely to assist with language improvement, grammar checking, and editing for clarity and readability. The author remains fully responsible for the accuracy, originality, integrity, and academic content of the manuscript. All AI-assisted content was reviewed and verified by the author before submission.

Conflicts of Interest

The author declares no conflict of interest.

Author Contributions

Conceptualization, Suryani; data collection, Suryani; data validation, Suryani; formal analysis, Suryani; writing—original draft preparation, Suryani; writing—review and

editing, Suryani; visualization, Suryani. The author has read and approved the final version of the manuscript.

Acknowledgments

The authors would like to express their sincere gratitude to the Department of Dental Health, Applied Undergraduate Program in Dental Therapy, Poltekkes Kemenkes Aceh, for the support and facilities provided for the implementation of this study. The authors also extend their appreciation to the Keuchik and all village officials of Meunasah Bie Village, Meurah Dua Subdistrict, Pidie Jaya Regency, as well as to all respondents who willingly participated in this study.

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