

## ORIGINAL ARTICLE

# Glycaemic Control and Dental Caries Prevalence in Older Adults With *Diabetes mellitus* in Kuala Lumpur and Selangor

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## ABSTRACT

**Introduction:** As populations age, the prevalence of chronic diseases like *Diabetes mellitus* (DM) and associated oral health complications, such as dental caries, increases. This cross-sectional study aimed to assess the dental caries prevalence among older adults with DM in Kuala Lumpur and Selangor. **Materials and methods:** Participants aged  $\geq 60$  years with DM were recruited from government health clinics. Data on sociodemographic, HbA1c levels, oral hygiene practices, and other risk factors were collected through questionnaires and medical records. Oral examinations were conducted to determine the decayed, missing, and filled teeth (DMFT) index and plaque scores. Associations between variables and DMFT scores were analysed using independent t-tests and non-parametric tests. **Results:** A total of 111 participants were examined. Participants with uncontrolled diabetes had significantly higher DMFT scores (16.51) compared to those with controlled diabetes (13.19) ( $p=0.007$ ). Ageing was associated with higher DMFT scores, peaking at 22.00 for those aged  $\geq 75$  years ( $p=0.029$ ). Although not statistically significant, lower education levels and socioeconomic backgrounds tended to have higher DMFT means. Good oral hygiene practices, especially flossing, were associated with lower caries ( $p=0.001$ ), whereas alcohol consumption was linked to higher caries ( $p=0.037$ ). **Conclusion:** Poor glycaemic control, advancing age and alcohol use are significant risk factors for increased dental caries experience among older adults with DM. The findings highlight the importance of good oral hygiene and integrating medical and dental care. Emphasis should be placed on risk-stratified screening, targeted preventive interventions, and improving access to care for this vulnerable population.

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## INTRODUCTION

The global population is undergoing a significant demographic shift, characterised by the ageing of societies in both developed and developing countries. As of 2017, the number of individuals aged 60 years and above worldwide stood at 962 million. By 2050, this figure is expected to double, reaching almost 2.1 billion (1). As populations age, there is an increased demand for healthcare services, particularly in managing chronic diseases and age-related conditions. Malaysia has reached the status of an ageing population in 2020, and it is anticipated to transition into an aged

population country by 2030. During this period, the elderly population is projected to constitute 15% of the total population (2). With this demographic shift comes a host of challenges, including increased prevalence of chronic diseases, disability, and reduced quality of life among older adults. One such challenge is tooth mortality, which poses a significant challenge among the elderly population in Malaysia as 32.1% of this age group were reported to be edentulous and only 23.9% of those aged between 60 and 70 possess a minimum of 20 functional teeth (2).

Dental caries among the elderly is becoming increasingly common due various factors, including increased life expectancy and the emerging trend that old people are retaining their teeth for longer durations (3,4). The Malaysian National Oral Health Plan (NOHP), in the year 2000, documented alarmingly high caries prevalence

rates of 95.4% and 95% for individuals aged 60 and 65 years, respectively (2). Among individuals aged 60 years and older, the mean decayed, missing, and filled teeth (DMFT) scores were 22.3, while for those aged 65 years and older, the scores were 23.5 (2). Several risk factors contribute to caries development in older adults, including periodontal attachment loss, previous caries experience, high cariogenic bacterial load, low socioeconomic status, lack of awareness, dietary habits, reduced salivary flow, elevated salivary glucose, and existing medical conditions and medications (3,5). Additionally, the presence of chronic diseases such as *Diabetes mellitus* (DM) further exacerbates the risk of dental caries among older adults.

DM is a chronic non-communicable disease that poses a significant healthcare burden globally. It is caused by a combination of insulin production and action deficiencies, which results in hyperglycaemia and other metabolic abnormalities (6). In Malaysia, the elderly population (aged 60 and above) constitutes 11.1% of the total population, amounting to 3.6 million individuals (7). Over five years, the prevalence of diabetes in Malaysia increased by 31%, with Type 2 DM (T2DM) dominating, particularly in the 70-74 age group (39.1%) (8). The complex aetiology of DM involves irreversible factors such as age, genetics, and race, as well as reversible factors including diet, physical activity, and smoking (9). Dietary habits contribute significantly to the rising DM incidence in developing countries like Malaysia, where traditional diets are being replaced by more Westernised, high-sugar diets (10).

The relationship between DM and periodontal disease has been extensively studied, with evidence suggesting that individuals with diabetes are at increased risk of periodontal complications, particularly if glycaemic control is poor (11). Moreover, diabetic individuals face an increased risk of root caries, highlighting the intricate interplay between oral health and systemic health in this population (12). Given the bidirectional relationship between diabetes and oral health, improving oral hygiene, and addressing dental caries among older adults with diabetes may have beneficial effects on glycaemic control and overall health outcomes (13). However, despite the growing body of evidence linking DM and dental caries among the elderly, there remains a lack of research focusing specifically on this relationship in the Malaysian context. Therefore, this study aimed to address this gap by assessing the prevalence of dental caries among older adults with DM in Kuala Lumpur and Selangor. By understanding the burden of dental caries in this vulnerable population, interventions can be developed to improve oral health outcomes and overall quality of life for older adults with diabetes in Malaysia.

## MATERIALS AND METHODS

This health clinic-based cross-sectional study was conducted from January 2023 to May 2024 among registered patients at government health clinics in Kuala Lumpur and Selangor. The study adhered to the guidelines outlined in the STROBE statement for reporting observational studies, ensuring transparency and consistency in reporting (14). Ethical approval was obtained from both the UiTM Research Ethics Committee (REC/09/2022 (PG/FB/21)) and the Malaysian Medical Research & Ethics Committee (NMRR ID-22-02572-1PD (IIR)). Clinics were randomly selected to cover urban and rural areas using an online Research Randomiser (<https://www.randomizer.org>). Individual informed and written consent was obtained prior inclusion of the participants into the study.

The sample size was calculated to be 112 using G\*Power version 3.1, considering a power of 95%, an alpha level of 0.05, and an effect size of 0.7548256, derived from a previous study by Malvania et al. (2017). Additionally, a drop-out rate of 20% was factored into the calculation. Those participants included in this study were aged 60 years and above, diagnosed with DM for at least 1 year by a government medical practitioner, and had routine glycosylated haemoglobin (HbA1c) measurements done within the last six months. They also had at least 10 remaining natural teeth, with three or more teeth with gingival recession. Exclusion criteria were established to exclude individuals with severe co-morbidities requiring hospitalisation, severe physical limitations, dementia, or mental illness, which could confound the study outcomes.

Data collection involved a comprehensive assessment, including structured questionnaires and oral health examinations. The questionnaire, validated for accuracy and reliability, encompassed sociodemographic and socioeconomic factors, as well as oral hygiene practices (15,16). As recommended by the Malaysian Clinical Practice Guidelines (CPG), glycaemic control status was defined according to the HbA1c target of <6.5%. Therefore, participants with HbA1c levels of  $\leq 6.5\%$  were categorised as having controlled DM, whereas those with levels  $>6.5\%$  were grouped as uncontrolled DM. These patients were identified through the available records from the health clinics. The questionnaire was administered via printed paper and Google Form platform.

Oral examinations were conducted by trained dental clinicians at health clinics. Prior to the study, the examiners were calibrated and demonstrated an excellent intra- and inter-reliability assessment with the Kappa scores ranging from 0.8 to 0.9. The number

of decayed, missing, and filled teeth (DMFT) and plaque score for each participant were determined. All teeth, including the third molars, were included in the caries assessment. Any plaque or calculus that hindered charting was removed using hand instruments. The dental examination was conducted in a well-lit operatory with direct visual inspection and tactile sensation with a dental explorer, periodontal probe, and mouth mirror. No radiographs were taken or obtained during the investigation, emphasising reliance on direct visual inspection and tactile sensation.

Data analysis was conducted using IBM SPSS software version 29.0. A range of statistical tests were employed to explore associations and relationships between variables. Non-parametric tests, including the Mann-Whitney U and Kruskal-Wallis tests, were used to compare mean DMFT values across various factors such as gender, age group, socioeconomic status, plaque scores, oral hygiene practices, and other risk factors for dental caries. Additionally, independent t-tests were utilised to compare mean DMFT scores between controlled and uncontrolled diabetics, as well as between those who regularly flossed and those who did not. Statistical significance was determined at a p-value of  $\leq 0.05$ .

## RESULTS

A total of 111 elderly diabetic participants were included in this study. The DMFT scores varied, with a mean score of 15.41 with a standard deviation of 6.2 (Figure 1). Table I presents the descriptive statistics and the relationship between DMFT scores and sociodemographic profiles of the participants. The study included 43.2% males and 56.8% females, with no significant difference in DMFT scores ( $p=0.619$ ). The t-test analysis showed a significant difference in DMFT scores between participants with controlled and uncontrolled diabetes. Uncontrolled diabetics had a higher mean DMFT score (16.51) compared to controlled diabetics (13.19), with a mean difference of 3.32 ( $p=0.007$ ) and moderate effect size.

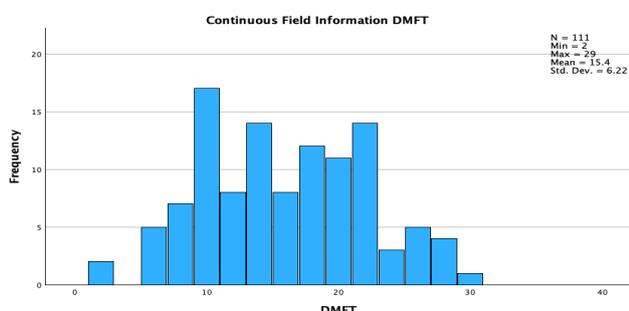


Figure 1: The frequency of DMFT scores (N = 111).

**Table I: Sociodemographic profiles of the participants and mean DMFT scores.**

Sociodemographic	N	Mean DMFT(±SD)	p-value
<b>Gender</b>			
Male	48	15.08(±7.1)	$p=0.619^a$
Female	63	15.65(±5.5)	
<b>DM status</b>			
Controlled	37	13.19(±5.5)	$p=0.007^b$
Uncontrolled	74	16.51(±6.3)	
<b>Age group</b>			
60 – 64	46	15.13(±6.2)	$p=0.029^c$
65 – 69	33	14.03(±5.5)	
70 – 74	25	15.88(±6.5)	
75 +	7	22.00(±5.2)	
<b>Education level</b>			
No formal education	10	16.70(±7.6)	$p=0.070^c$
Primary	21	16.05(±5.9)	
Secondary	73	15.62(±6.1)	
Tertiary	7	9.43(±4.4)	
<b>Occupation</b>			
Unemployed	11	17.09(±5.8)	$p=0.174^c$
Housewife	26	15.00(±6.7)	
Retiree	48	14.81(±5.9)	
Self-employment	5	22.00(±4.9)	
Full-time employment	21	14.81(±6.4)	
<b>Gross income (RM)</b>			
<1000	48	16.40(±5.9)	$p=0.151^c$
1000 – 3000	44	15.41(±6.2)	
3001 – 5000	13	13.38(±7.8)	
>5000	6	11.83(±4.0)	

SD – standard deviation, RM – Ringgit Malaysia  
<sup>a</sup>Mann Whitney U test, <sup>b</sup>Independent t-test, <sup>c</sup>Kruskal-Wallis H test

Age distribution showed that most participants were between 60-64 years (41.4%), followed by 65-69 years (29.7%), 70-74 years (22.5%), and 75 years and older (6.3%). A significant difference in mean DMFT scores across different age groups was observed ( $p=0.029$ ), with the oldest age group (75+) having the highest mean DMFT score of 22.00. Pairwise comparisons revealed significant differences between the oldest age group (75+) and the 60-64 and 70-74 age groups, although these differences were not significant after applying the Bonferroni correction.

Most participants had a moderate level of education (65.8%) and a large number of participants had low to moderate income levels, with 43.2% reporting the lowest income bracket. While differences in DMFT scores across education levels, occupation, and income were not statistically significant ( $p=0.070, 0.174, 0.151$ ), there was a trend suggesting that better socioeconomic status was associated with lower DMFT scores.

**Table II: Plaque score, oral hygiene practices and mean DMFT scores.**

Oral hygiene	N	Mean DMFT(±SD)	p-value
<b>Plaque score (%)</b>			
0	15	16.80(±6.3)	p=0.065 <sup>a</sup>
≤20	51	13.90(±6.0)	
>20	45	16.64(±6.2)	
<b>OH practice</b>			
Poor	20	16.80(±5.9)	p=0.009 <sup>a</sup>
Fair	60	16.48(±6.3)	
Good	31	12.42(±5.4)	
<b>Toothbrushing frequency</b>			
Rarely	1	18.00	p=0.644 <sup>a</sup>
Once daily	21	16.76(±6.6)	
Twice daily	77	14.88(±6.1)	
3x daily	12	16.17(±6.9)	
<b>Flossing habit</b>			
Yes	31	12.42(±5.4)	p=0.001 <sup>b</sup>
No	80	16.56(±6.2)	

OH – oral hygiene, SD – standard deviation  
<sup>a</sup>Kruskal-Wallis test, <sup>b</sup>independent t-test

Regarding oral hygiene practices, most participants brushed their teeth twice a day (69.4%), but only 27.9% flossed regularly. Table II details the association between oral hygiene, oral hygiene practices and mean DMFT scores. Although participants with more than 20% plaque score had higher DMFT scores compared to those with less than 20% plaque, the differences in DMFT across plaque scores were not statistically significant (p=0.065). Oral hygiene practices were categorised as follows:

- Good: Toothbrushing at least twice daily with regular flossing.
- Fair: Toothbrushing twice daily without flossing.
- Poor: Less than twice daily toothbrushing and no flossing.

The data revealed a significant difference in DMFT scores based on oral hygiene practices, with those practicing good oral hygiene having lower mean DMFT values compared to those with fair or poor practices. Further analysis indicated that toothbrushing frequency alone did not significantly affect DMFT outcomes, but regular flossing was associated with significantly lower DMFT scores (p<0.001). The effect sizes (Cohen’s d, Hedges’ correction, and Glass’s delta) from the t-test showed a moderate to large impact of flossing on DMFT scores.

Table III presents other risk factors for dental caries and their association with mean DMFT scores. The data initially suggest that higher daily sugar consumption is associated with higher mean DMFT scores. However, a decrease in mean DMFT was observed in the group consuming sugar four or more times daily compared to those with lower sugar intake. This finding is somewhat counterintuitive as one would generally expect higher sugar consumption to be associated with higher DMFT scores. Smokers had a higher mean DMFT score than non-smokers, but this difference was not statistically significant (p=0.284). Notably, participants who

consumed alcohol had a significantly higher mean DMFT score compared to those who did not consume alcohol (p=0.037).

**Table III: Other risk factors for dental caries and mean DMFT scores.**

Risks	N	Mean DMFT(±SD)	p-value
<b>Daily sugar consumption</b>			
None	21	14.95(±7.3)	p=0.314 <sup>a</sup>
Once	62	15.63(±5.5)	
2-3 times	19	16.63(±6.6)	
4 times or more	9	12.33(±5.9)	
<b>Smoking habits</b>			
Smoker	6	18.17(±6.5)	p=0.284 <sup>b</sup>
Non-smoker	105	15.25(±6.2)	
<b>Alcohol intake</b>			
Yes	4	21.50(±3.1)	p=0.037 <sup>b</sup>
No	107	15.18(±6.2)	

SD – standard deviation  
<sup>a</sup>Kruskal-Wallis test <sup>b</sup>Mann-Whitney U test

## DISCUSSION

The findings of this study highlight the sociodemographic factors, oral hygiene practices and other risk factors associated with dental caries experience among older adults with diabetes. The analysis found no significant difference in DMFT scores between males and females, suggesting that gender does not play a significant role in dental caries among the elderly diabetic population studied. Diabetic status emerged as a key determinant, with poor glycaemic control linked to significantly higher DMFT scores. The moderate effect size further emphasises the impact of diabetes control on dental caries. This aligns with previous studies on the detrimental impacts of hyperglycaemia on oral health and the proposed pathways involving salivary dysfunction and favourable environmental changes for cariogenic oral flora (17-19). Siudikiene et al. identified a significant association between greater caries prevalence in individuals with diabetes and variables including age, plaque score, and decreased unstimulated salivary flow rate (20). These changes create an environment favourable for bacterial growth, particularly the acidogenic and aciduric bacteria implicated in dental caries formation. However, optimal metabolic control serves to reduce detrimental alterations in saliva composition, such as elevated glucose levels and reduced pH (20).

Advancing age was another risk factor for greater caries experience, conforming to well-established trends of cumulative oral disease burden over time (21,22). The finding that older participants, particularly those aged 75 years and above, exhibited the highest mean DMFT scores points out the need for personalised dental caries preventive interventions targeting this age group. Education levels and other socioeconomic factors were also identified as important determinants of caries outcomes in this study. While participants without formal education and those who were self-employed exhibited higher mean DMFT scores, these differences were not statistically significant. However,

the trend observed suggests a potential association between lower educational attainment and higher dental caries prevalence, consistent with previous research highlighting the social determinants of oral health disparities (23,24).

In this study, although the frequency of toothbrushing alone did not significantly impact DMFT outcomes, regular flossing appeared as a significant factor in reducing DMFT scores among elderly diabetic individuals. The moderate to large effect sizes emphasise the substantial impact of flossing on caries. These findings further suggest that good oral hygiene practices are linked to lower DMFT scores. This correlates with results from the longitudinal German Oral Health Studies, which demonstrated that the use of powered toothbrushes and interdental cleaning aids had a pronounced positive impact on oral health, particularly in older adults, significantly contributing to an increase in caries-free surfaces (25). While oral hygiene is undoubtedly valuable for caries prevention, our findings hint that other risk factors like diabetic control and alcohol drinking may be more dominant drivers of caries experience at older ages after considerable accumulated disease burden (26).

In patients with poorly controlled diabetes, a diet with high rates of sugar-containing food and drinks might lead to unfavourable local and systemic effects. Systemically, a sugar or starch rich diet leads to increased blood glucose levels, which in turn leads to increased levels of glucose in saliva and in gingival crevicular fluid which both nurture the supragingival microbiome and trigger caries progression (27). The initial data of this study suggested that higher daily sugar consumption was associated with higher mean DMFT scores. However, the group consuming sugar four or more times daily had lower mean DMFT scores than those with lower sugar intake. This implausible result might be due to other confounding factors such as overall diet quality, or the timing of sugar consumption, which were not fully controlled for in the study. Adherence to a diabetic-appropriate diet characterised by high fibre content and low simple carbohydrate intake has the potential to decelerate plaque formation and inhibit the proliferation of acidogenic bacterial microflora, thereby contributing to caries prevention (12).

Another study that analysed the impact of smoking on both periodontal disease severity and caries prevalence, found that smoking is significantly associated with more severe periodontal disease and higher DMFT scores (28). Although our study similarly found smokers to have higher mean DMFT scores than non-smokers, this difference was not statistically significant. Instead, our study found alcohol consumption to be significantly associated with higher DMFT scores, suggesting that alcohol use may be a more relevant risk factor for caries in this elderly diabetic population.

Understanding the multifaceted factors in caries prevalence is crucial in developing effective and targeted preventive interventions to address the oral health needs of this population. This emphasises the importance of personalised dental care and preventive interventions for the elderly, especially those with DM, in order to mitigate the impact of ageing on caries burden. This study included the community-based sampling capturing a broad sociodemographic profile, which is considered one of its strengths. The limitations of this study involve the cross-sectional design precluding causal inferences and potential recall biases from self-reported data. Longitudinal investigations are warranted to delineate further the complex association between diabetes, sociodemographic factors, and dental caries risk factors in older adults. Future studies could include the impact of salivary dysfunction on caries risk by including assessments of salivary flow rate. Additionally, investigating dental caries preventive interventions aimed at improving dental caries incidence in this vulnerable population is also crucial. This shall involve collaborating with healthcare policymakers, multiple healthcare facilities or employing community outreach initiatives to reach a broader pool of patients. From this study, the authors conclude that it is imperative to improve health education, and awareness programmes specifically designed for older adults with diabetes, stressing the value of frequent dental check-up and glycaemic management.

## CONCLUSION

Within the limitations of this study, our findings emphasise a higher risk of dental caries among older adults with diabetes, particularly those with poor glycaemic control and from socioeconomically disadvantaged backgrounds. It stresses the importance of good oral hygiene practices, particularly flossing, in reducing caries risk. Advancing age, and alcohol consumption are also notable risk factors in this population highlighting the need for a comprehensive, multidisciplinary approach integrating medical and dental care, focusing on risk-stratified screening, targeted preventive interventions and improved care access. Tailored oral health promotion and facilitation of strict glycaemic management should be prioritised to address these challenges effectively.

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