

Determinants of Oral Complications Among Diabetes Mellitus Patients at Industri Health Center

Desak Ketut Mahayati Tri Puspani¹, Atik Setiawan Wahyuningsih¹, Reni Yuli Astutik¹  Check for updates

¹ Postgraduate in Public Health Program, Strada Indonesia University, Indonesia

Correspondence should be addressed to:
Desak Ketut Mahayati Tri Puspani
desaypuspa19@gmail.com

Abstract:

Diabetes mellitus (DM) increases patients' susceptibility to various oral complications, including dental caries, periodontal disease, xerostomia, and oral candidiasis. This study aimed to examine the influence of demographic, clinical, behavioral, and oral health knowledge factors on the occurrence of oral complications among patients with DM, and to assess the potential mediating role of the Oral Hygiene Index-Simplified (OHI-S). An analytical observational study with a cross-sectional design was conducted involving 90 patients with DM selected through purposive sampling. Data analysis included Chi-square tests to assess bivariate associations ($X \rightarrow Y$), Ordinary Least Squares (OLS) regression to evaluate the effects of independent variables on OHI-S scores ($X \rightarrow M$), multivariate logistic regression to examine the association between OHI-S and oral complications ($M \rightarrow Y$), and mediation analysis using OLS regression pathways. Most participants presented with moderate oral complications (54.44%), followed by mild (26.67%) and severe (18.89%) categories. Bivariate analysis revealed significant associations between oral health knowledge ($\chi^2 = 43.445$; $p < 0.001$) and type of DM ($\chi^2 = 7.282$; $p = 0.026$) with oral complications. OLS regression demonstrated that only oral health knowledge significantly influenced OHI-S scores ($\beta = -0.392$; $p < 0.001$). However, multivariate logistic regression indicated that OHI-S was not a significant predictor of oral complications ($\beta = 0.0139$; $p = 0.957$; OR = 1.014; 95% CI: 0.61–1.68). Furthermore, mediation analysis showed no significant indirect effects (all $p > 0.95$), indicating that OHI-S did not mediate the relationship between the studied determinants and oral complications. Oral complications among patients with DM in primary healthcare settings are multifactorial. While oral health knowledge and DM type were significant determinants at the bivariate level, OHI-S did not function as a significant predictor or mediator in the multivariate model.

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INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both (Jadon et al., 2024). Insulin, a hormone produced by the pancreas, plays a crucial role in regulating blood glucose levels by facilitating the uptake of glucose into cells for energy production (Regina & Tong, 2025). When this regulatory mechanism is impaired, prolonged hyperglycemia occurs, leading to systemic metabolic disturbances (Zhao et al., 2023).

DM represents a major global public health challenge due to its rapidly increasing prevalence and associated morbidity and mortality (Hossain et al., 2024). The condition is strongly linked to lifestyle-related factors, including unhealthy dietary patterns, physical inactivity, and rising obesity

rates (AlOmeir et al., 2025). Over time, uncontrolled DM can result in a wide range of complications, such as cardiovascular disease, nephropathy, retinopathy, and neuropathy, significantly reducing patients' quality of life and increasing healthcare burdens worldwide (Pradeepa & Mohan, 2024).

In addition to systemic complications, DM is closely associated with various oral health problems (Alqadi, 2024). These include dental caries, periodontal disease, xerostomia, and oral candidiasis (Grisi et al., 2022). However, the severity and progression of oral complications in individuals with DM are not uniform. They are influenced by multiple factors, including glycemic control, disease duration, oral hygiene practices, age, and dental care history (Bolchis et al., 2024). Poorly controlled DM has been consistently associated with more rapid progression and increased severity of oral diseases, particularly periodontal tissue destruction (Chung et al., 2024).

The pathophysiological mechanisms underlying oral complications in DM involve complex interactions between metabolic and local factors (Alfarisi & Saheb, 2026). Chronic hyperglycemia contributes to impaired immune responses and microvascular changes, such as diabetic angiopathy, which reduce oxygen supply to oral tissues and promote the growth of anaerobic bacteria (Păunică et al., 2022). In addition, elevated levels of fermentable carbohydrates in saliva create a favorable environment for acidogenic bacteria, leading to enamel demineralization and dental caries (Inchingolo et al., 2022). Poor oral hygiene further exacerbates these conditions, accelerating disease progression (Luo et al., 2022).

Given the multifactorial nature of oral complications in patients with DM, it is essential to identify the key determinants of their occurrence. Understanding the roles of demographic, clinical, behavioral, and knowledge-related factors will provide a more comprehensive basis for prevention and management strategies (Alsaidan et al., 2024). Therefore, this study aims to analyze the determinants of oral complications among patients with DM, to inform targeted interventions to improve oral health outcomes and overall quality of life in this population.

METHOD

Research Design

This study employed an analytical observational design with a cross-sectional approach using quantitative methods. The design was selected to examine the relationships among determinants and the occurrence of oral complications among patients with diabetes mellitus (DM), as well as to explore the potential mediating role of the Oral Hygiene Index-Simplified (OHI-S).

Participants

The study involved 90 patients with diabetes mellitus who were recruited from the Industri Health Center in Gresik. Participants were selected using a purposive sampling technique based on predefined inclusion criteria, including a confirmed diagnosis of DM and willingness to participate in the study.

Data Collection

Data were collected using structured instruments that assessed demographic characteristics, clinical conditions, oral health behaviors, and levels of oral health knowledge. Clinical oral examinations were conducted to assess oral complications and oral hygiene status using the OHI-S index.

Data Analysis

Data analysis was performed using IBM SPSS version 23. Bivariate analysis was conducted using the Chi-square test to assess associations between independent variables and oral complications ($X \rightarrow Y$). Ordinary Least Squares (OLS) regression was applied to evaluate the effects of determinants on OHI-S scores ($X \rightarrow M$). Multivariate logistic regression analysis was used to examine the relationship between OHI-S and the occurrence of oral complications ($M \rightarrow Y$). Mediation analysis was further conducted using OLS regression to assess the indirect effects of independent variables through OHI-S ($X \rightarrow M \rightarrow Y$ pathway).

Ethical Clearance

Ethical approval for this study was obtained from the Public Health Program, Universitas Strada Indonesia. All participants provided informed consent prior to data collection, and confidentiality of participant information was strictly maintained throughout the study.

RESULT

Table 1. Influence of Demographic Factors on Oral Complications in DM Patients

Variable	Statistical Test	p-value	Significance	Interpretation
Age	Chi-Square	0.007	Significant	Age is associated with the incidence of oral complications
Gender	Chi-Square	>0.05	Not significant	No association with oral complications
Economic Status	Chi-Square	>0.05	Not significant	No association with oral complications
Glycemic Control	Chi-Square	>0.05	Not significant	No association with oral complications
Oral Hygiene Behavior	Chi-Square	>0.05	Not significant	No association with oral complications
Smoking Habits	Chi-Square	>0.05	Not significant	No association with oral complications
Oral Health Knowledge Level	Chi-Square	>0.05	Not significant	No association with oral complications
Type of Diabetes Mellitus	Chi-Square	>0.05	Not significant	No association with oral complications
Duration of Diabetes Mellitus	Chi-Square	>0.05	Not significant	No association with oral complications
Genetic Factors	Chi-Square	>0.05	Not significant	No association with oral complications

The analysis shows that age is the only factor significantly associated with oral complications in DM patients ($p = 0.007$), indicating that older patients have a higher risk. Other variables were not statistically significant ($p > 0.05$), suggesting that oral complications are influenced by multiple complex factors rather than individual characteristics alone.

Table 2. Effect of Glycemic Control, Smoking Habits, Oral Health Knowledge Level, Type of Diabetes Mellitus, DM Duration, and Genetic Factors on Oral Complications in DM Patients

Variable	Statistical Test	p-value	Significance	Interpretation
Glycemic Control	Chi-Square	0.365	Not significant	No association with oral complications
Smoking Habits	Chi-Square	0.515	Not significant	No association with oral complications
Oral Health Knowledge Level	Chi-Square	>0.05	Not significant	No association with oral complications
Type of Diabetes Mellitus	Chi-Square	0.268	Not significant	No association with oral complications
DM Duration	Chi-Square	>0.05	Not significant	No association with oral complications
Genetic Factors	Chi-Square	0.704	Not significant	No association with oral complications

Glycemic control was not significantly associated with oral complications in DM patients ($p = 0.365$). This suggests that oral complications are likely influenced by multiple factors rather than glycemic control alone. Smoking habits were not significantly associated with oral complications in DM patients ($p = 0.515$), indicating no meaningful difference in complication rates between smokers and non-smokers in this study. Oral health knowledge level was not significantly associated with oral complications in DM patients ($p > 0.05$), indicating that differences in knowledge did not directly affect the incidence of oral complications in this study. The type of diabetes mellitus was not significantly associated with oral complications in DM patients ($p = 0.268$), indicating no meaningful difference in complication incidence between DM types in this study. Diabetes mellitus duration was not significantly associated with oral complications ($p > 0.05$), suggesting that differences in disease duration did not affect the incidence of oral complications in this study. Genetic factors were not significantly associated with oral complications in DM patients ($p = 0.704$), indicating that family history did not influence the incidence of oral complications in this study.

Table 3. Influence of Demographic Factors on OHI-S

Variable	Statistical Test	p-value	Significance	Interpretation
Age	OLS Regression	>0.05	Not significant	No effect on OHI-S
Gender	OLS Regression	>0.05	Not significant	No effect on OHI-S
Economic Status	OLS Regression	>0.05	Not significant	No effect on OHI-S
Glycemic Control	OLS Regression	0.613	Not significant	No effect on OHI-S
Smoking Habits	OLS Regression	0.980	Not significant	No effect on OHI-S

Demographic factors (age, gender, and economic status) did not significantly influence oral hygiene behavior (OHI-S) ($p > 0.05$), indicating that these characteristics were not associated with differences in OHI-S scores among DM patients. Glycemic control did not significantly affect oral hygiene behavior (OHI-S) ($p = 0.613$), indicating that metabolic condition was not associated with differences in oral hygiene status among DM patients. Smoking habits did not significantly affect oral hygiene behavior (OHI-S) ($p = 0.980$), indicating no association between smoking status and oral hygiene in this study.

Table 4. Effect of Oral Health Knowledge and Type of Diabetes Mellitus on OHI-S

Variable	Statistical Test	β (Coefficient)	p-value	Significance	Interpretation
Oral Health Knowledge Level	OLS Regression	-0.496	<0.001	Significant	Higher knowledge improves OHI-S (lower score)
Type of Diabetes Mellitus	OLS Regression	-0.334	0.012	Significant	DM type influences OHI-S (lower score)

Oral health knowledge had a significant negative effect on OHI-S ($\beta = -0.496$; $p < 0.001$), indicating that higher knowledge levels are associated with better oral hygiene (lower OHI-S scores). Type of diabetes mellitus had a significant effect on OHI-S ($\beta = -0.334$; $p = 0.012$), indicating that variations in DM type are associated with differences in oral hygiene behavior.

Table 5. Effect of DM Duration and Genetic Factors on OHI-S

Variable	Statistical Test	p-value	Significance	Interpretation
DM Duration	OLS Regression	0.383	Not significant	No effect on OHI-S
Genetic Factors	OLS Regression	0.349	Not significant	No effect on OHI-S

DM duration did not significantly affect oral hygiene behavior (OHI-S) ($p = 0.383$), indicating that longer disease duration does not necessarily lead to better oral hygiene practices. Genetic factors did not significantly influence oral hygiene behavior (OHI-S) ($p = 0.349$), indicating that genetic background is not associated with differences in oral hygiene practices.

Table 6. Effect of OHI-S on Oral Complications in DM Patients

Variable	Statistical Test	β (Coefficient)	p-value	OR	Significance	Interpretation
OHI-S	Logistic Regression	0.0139	0.9568	1.014	Not significant	No effect on oral complications

OHI-S was not a significant predictor of oral complications ($p = 0.9568$; OR = 1.014), suggesting that differences in oral hygiene status were not associated with oral complications in DM patients.

Table 7. Role of OHI-S as a Mediating Variable

Pathway	Statistical Test	Result	Significance	Interpretation
Risk Factors → OHI-S	OLS Regression	Significant (knowledge variable)	Significant	Knowledge affects OHI-S
OHI-S → Oral Complications	Logistic Regression	$\beta = 0.0139$; $p = 0.9568$	Not significant	OHI-S does not affect complications
Mediation	Path Analysis (OLS)	Not fulfilled	Not significant	No mediation effect

Although oral health knowledge significantly influenced OHI-S, OHI-S did not significantly affect oral complications. Therefore, the mediation pathway was not supported, indicating that OHI-S does not mediate the relationship between risk factors and oral complications in DM patients.

DISCUSSION

This study found that among demographic factors, only age was significantly associated with the incidence of oral complications in patients with diabetes mellitus (DM), while gender and economic status were not. Increasing age may reflect cumulative exposure to chronic

hyperglycemia, systemic inflammation, and long-term metabolic dysregulation, all of which contribute to the deterioration of oral tissues. In contrast, clinical variables such as glycemic control, type of DM, disease duration, and genetic factors did not show significant associations. These findings suggest that oral complications in DM patients are not determined by isolated clinical indicators but rather by complex and long-term biological processes (Țica et al., 2025).

Behavioral factors, including smoking habits and oral health knowledge, were not directly associated with the incidence of oral complications. Although smoking is widely recognized as a risk factor for periodontal disease, its lack of significance in this study may be due to variations in smoking intensity, duration, or sample size limitations. Similarly, the absence of a direct association between knowledge and complications indicates that awareness alone may not be sufficient to influence clinical outcomes. This highlights the possibility that behavioral factors exert indirect rather than immediate effects on oral health status (Devi et al., 2024).

The analysis of factors influencing oral hygiene behavior revealed that most demographic and clinical variables, including age, gender, economic status, glycemic control, smoking habits, duration of DM, and genetic factors, did not significantly affect OHI-S scores. However, oral health knowledge and DM type were significantly associated with OHI-S, suggesting that cognitive and disease-related factors may play a more important role in shaping oral hygiene practices. Higher levels of knowledge were associated with better oral hygiene, suggesting that educational interventions can positively influence self-care behaviors (Lipman et al., 2023).

Despite its theoretical importance, oral hygiene status (OHI-S) was not a significant predictor of oral complications in this study. The regression results indicated a negligible effect size and a non-significant association, suggesting that variations in OHI-S scores did not correspond to meaningful differences in the incidence of oral complications. This finding contrasts with the existing literature, which emphasizes the role of oral hygiene in preventing oral diseases, and may indicate that, in DM patients, systemic factors and disease-related mechanisms play a more dominant role than local hygiene alone (Chan, 2024).

The mediation analysis demonstrated that oral hygiene (OHI-S) did not mediate the relationship between risk factors and oral complications. Although oral health knowledge significantly influenced OHI-S, the lack of a significant relationship between OHI-S and oral complications prevented the establishment of an indirect pathway. This suggests that the influence of determinant factors on oral complications occurs primarily through direct mechanisms rather than through oral hygiene behavior. These findings underscore the multifactorial nature of oral complications in DM patients and highlight the need to consider broader systemic and biological pathways beyond behavioral mediation (Ghanem & Nagy, 2024; Petropoulou et al., 2023).

CONCLUSION

Oral complications in patients with diabetes mellitus are multifactorial and not determined by a single factor. Age was the only variable significantly associated with oral complication incidence, suggesting a role for long-term biological and metabolic exposure. Other demographic, clinical, behavioral, and genetic factors were not significantly associated. Although oral health knowledge significantly improved oral hygiene behavior, oral hygiene (OHI-S) did not significantly predict oral complications. In addition, OHI-S did not mediate the relationship between risk factors and oral complications, indicating that risk factors influence oral complications primarily through direct pathways rather than through oral hygiene behavior. These findings highlight the importance of comprehensive approaches that address systemic conditions and patient education to prevent oral complications among patients with diabetes mellitus.

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