HTechJ Health and Technology Journal (HTechJ)

Volume 04 Number 02
April 2026
p-ISSN: 2986-5662
e-ISSN: 2985-959X

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

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**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→Y), Ordinary Least Squares (OLS) regression to evaluate the effects of independent variables on OHI-S scores (X→M), multivariate logistic regression to examine the association between OHI-S and oral complications (M→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.

**Article info:**
Submitted:
09-02-2026
Revised:
31-03-2026
Accepted:
02-04-2026

**Keywords:**
diabetes mellitus, oral complications, oral health knowledge, OHI-S

DOI: https://doi.org/10.53713/htechj.v4i2.635


## 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

Volume 04 Number 02
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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→Y). Ordinary Least Squares (OLS) regression was applied to evaluate the effects of determinants on OHI-S scores (X→M). Multivariate logistic regression analysis was used to examine the relationship between OHI-S and the occurrence of oral complications (M→Y). Mediation analysis was further conducted using OLS regression to assess the indirect effects of independent variables through OHI-S (X→M→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.

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p-ISSN: 2986-5662
e-ISSN: 2985-959X

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 (β = -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 (β = -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 | β = 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.

## REFERENCES

Alfarisi, H., & Saheb, S. D. (2026). Oral complications of diabetes mellitus and their underlying pathogenic mechanisms: a narrative review. *IIUM Journal of Orofacial and Health Sciences, 7*(1), 62–69. https://doi.org/10.31436/ijohs.v7i1.395

AlOmeir, O., Almuqbil, M., Alotaibi, N. F., Alotaibi, F. R., Alnazer, W. R., Alenazi, L. K., Alotaibi, F. N., Otaif, H. A., Alsanie, W. F., Alamri, A. S., Alhomrani, M., Alshammary, A. F., & Asdaq, S. M. (2025). Prevalence and impact of sociodemographic factors, comorbidities, and lifestyle on diabetes complications among patients with type 2 diabetes in Riyadh. *Scientific Reports, 15*(1), 17299. https://doi.org/10.1038/s41598-025-02559-x

Alqadi, S. F. (2024). Diabetes Mellitus and Its Influence on Oral Health: Review. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy, 17,* 107–120. https://doi.org/10.2147/DMSO.S426671

Alsaidan, A. A., Alanazi, M. I., & Thirunavukkarasu, A. (2024). Assessment of Diabetes-Related Knowledge and Dietary Patterns Among Type 2 Diabetes Mellitus Patients in Central Saudi Arabia: Insights for Tailored Health Education Strategies. *Healthcare, 13*(3), 233. https://doi.org/10.3390/healthcare13030233

Bolchis, V., Alexa, I., Toderas, N. A., Dumitrescu, R., Sava-Rosianu, R., Balean, O., Alexa, V. T., Popescu, S., Jumanca, D., Galuscan, A., Ilia, I., & Chioran, D. (2024). Associations Between Lifestyle Factors, Oral Health Behaviors, and Glycemic Control in Type 2 Diabetic Patients. *Journal of Clinical Medicine, 14*(2), 450. https://doi.org/10.3390/jcm14020450

Chan, W. S. H. (2024). The role of oral health in the prevention of systemic diseases. *Universal Library of Medical and Health Sciences, 1*(1). https://doi.org/10.70315/uloap.ulmhs.2023.0101005

Chung, Y., Lee, J., Chien, H., Chang, M., & Jeng, J. (2024). Interplay between diabetes mellitus and periodontal/pulpal-periapical diseases. *Journal of Dental Sciences, 19*(3), 1338-1347. https://doi.org/10.1016/j.jds.2024.03.021

Devi, O. M., Sood, S., Gupta, J., & Jain, A. (2024). Prevalence and Severity of Periodontal Disease and its Association with Type-II Diabetes Mellitus and Smoking by Using Periodontal Screening and Recording: A Retrospective Study. *Indian Association of Preventive & Social Medicine, 49*(1), 56–63. https://doi.org/10.4103/ijcm.ijcm_642_22

Ghanem, A. S., & Nagy, A. C. (2024). Oral health's role in diabetes risk: A cross-sectional study with sociodemographic and lifestyle insights. *Frontiers in Endocrinology, 15,* 1342783. https://doi.org/10.3389/fendo.2024.1342783

Grisi, D. C., Vieira, I. V., de Almeida Lima, A. K., de Oliveira Mattos, M. C., Damê-Teixeira, N., Salles, L. P., ... & do Carmo Machado Guimarães, M. (2022). The complex interrelationship between diabetes mellitus, oral diseases and general health. *Current Diabetes Reviews, 18*(3), 8-22. http://doi.org/10.2174/1573399817666210322153210

Hossain, M. J., Al-Mamun, M., & Islam, M. R. (2024). Diabetes mellitus, the fastest growing global public health concern: Early detection should be focused. *Health science reports, 7*(3), e2004. https://doi.org/10.1002/hsr2.2004

Inchingolo, A. D., Malcangi, G., Semjonova, A., Inchingolo, A. M., Patano, A., Coloccia, G., Ceci, S., Marinelli, G., Di Pede, C., Ciocia, A. M., Mancini, A., Palmieri, G., Barile, G., Settanni, V., De Leonardis, N., Rapone, B., Piras, F., Viapiano, F., Cardarelli, F., . . . Dipalma, G. (2022). Oralbiotica/Oralbiotics: The Impact of Oral Microbiota on Dental Health and Demineralization: A Systematic Review of the Literature. *Children, 9*(7), 1014. https://doi.org/10.3390/children9071014

Jadon, A. S., Kaushik, M. P., Anitha, K., Bhatt, S., Bhadauriya, P., & Sharma, M. (2024). Types of diabetes mellitus, mechanism of insulin resistance and associated complications. In *Biochemical immunology of diabetes and associated complications* (pp. 1-18). Academic Press. https://doi.org/10.1016/B978-0-443-13195-0.00001-6

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April 2026
p-ISSN: 2986-5662
e-ISSN: 2985-959X

Lipman, R. D., O'Brien, K. K., Bardsley, J. K., & Magee, M. F. (2023). A scoping review of the relation between toothbrushing and diabetes knowledge, glycemic control, and oral health outcomes in people with type 2 diabetes. *Diabetes Spectrum, 36*(4), 364-372. https://doi.org/10.2337/ds22-0089

Luo, H., Wu, B., Kamer, A. R., Adhikari, S., Sloan, F., Plassman, B. L., Tan, C., Qi, X., & Schwartz, M. D. (2022). Oral Health, Diabetes, and Inflammation: Effects of Oral Hygiene Behaviour. *International Dental Journal, 72*(4), 484-490. https://doi.org/10.1016/j.identj.2021.10.001

Păunică, I., Giurgiu, M., Dumitriu, A. S., Păunică, S., Pantea Stoian, A. M., Martu, M. A., & Serafinceanu, C. (2022). The Bidirectional Relationship between Periodontal Disease and Diabetes Mellitus—A Review. *Diagnostics, 13*(4), 681. https://doi.org/10.3390/diagnostics13040681

Petropoulou, P., Kalemikerakis, I., Dokoutsidou, E., Evangelou, E., Konstantinidis, T., & Govina, O. (2023). Oral Health Education in Patients with Diabetes: A Systematic Review. *Healthcare, 12*(9), 898. https://doi.org/10.3390/healthcare12090898

Pradeepa, R., & Mohan, V. (2024). Epidemiology of chronic complications of diabetes: A global perspective. In *chronic complications of diabetes mellitus* (pp. 11-23). Academic Press. https://doi.org/10.1016/B978-0-323-88426-6.00006-3

Regina, I., & Tong, F. (2025). Overview of insulin: more than a hormone for controlling glucose level. *Biomed. Eng. Commun, 4*(2), 10. https://doi.org/10.53388/BMEC2025010

Țica, O., Romanul, I., Ciavoi, G., Pantea, V. A., Scrobota, I., Șipoș, L., Daina, C. M., & Țica, O. (2025). A Clinical Review of the Connections Between Diabetes Mellitus, Periodontal Disease, and Cardiovascular Pathologies. *Biomedicines, 13*(9), 2309. https://doi.org/10.3390/biomedicines13092309

Zhao, X., An, X., Yang, C., Sun, W., Ji, H., & Lian, F. (2023). The crucial role and mechanism of insulin resistance in metabolic disease. *Frontiers in Endocrinology, 14,* 1149239. https://doi.org/10.3389/fendo.2023.1149239