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Association between Patient Characteristics and HbA1c Levels in Type 2 Diabetes Mellitus

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Abstract

Type 2 Diabetes Mellitus (T2DM) is a growing health challenge, with the International Diabetes Federation (IDF) Diabetes Atlas 2021–2023 reporting rising prevalence worldwide, including in Indonesia. Glycemic control in T2DM is commonly assessed using HbA1c levels, which reflect average blood glucose levels over the preceding 2–3 months and serve as a key indicator of treatment effectiveness. This study investigated the association between demographic characteristics (age, gender, and occupation) and HbA1c levels among patients with T2DM at Port Medical Center Hospital from 2021 to 2023. Using a cross-sectional design, secondary data were collected from the medical records of 75 eligible patients. All records meeting the inclusion criteria were analyzed. Age, gender, and occupation were treated as independent variables, while HbA1c level was the dependent variable. Associations were tested using Chi-square or Fisher's Exact Test, with significance set at $p < 0.05$. Results showed no significant association between gender and HbA1c ($p = 0.851$; OR = 0.96, 95% CI: 0.34-2.70). However, older age was strongly linked to poor glycemic control ($p = 0.010$; OR = 11.0, 95% CI: 1.27–95.4), and certain occupations were associated with elevated HbA1c levels ($p = 0.024$; OR = 9.21, 95% CI: 1.71–49.6). These findings suggest that age-related metabolic changes and occupational factors such as physical inactivity and work-related stress may contribute to inadequate glycemic control. In conclusion, age and occupation were significantly associated with HbA1c levels, while gender was not. Targeted interventions focusing on older adults and individuals with sedentary occupations are recommended, including lifestyle modification, patient education, and routine HbA1c monitoring to improve glycemic outcomes.

Keywords: Type 2 Diabetes Mellitus, HbA1c, Level Age, Occupation.

INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is one of the most pressing global public health challenges, with prevalence rising steadily in both developed and developing countries. According to international epidemiological data, T2DM accounts for approximately 90% of all diabetes cases worldwide, largely driven by rapid urbanization, unhealthy dietary patterns, sedentary lifestyles, population aging, and increasing obesity rates (Khan et al., 2019; Rob et al., 2025). Across Asia, Europe, and North America, the incidence of T2DM continues to grow, accompanied by a rising burden of complications, particularly cardiovascular disease, the leading cause of illness and death among people with diabetes (Khan et al., 2019; Rob et al., 2025; Zheng et al., 2018). These trends underscore that T2DM is not merely a metabolic disorder but a complex condition shaped by demographic, socioeconomic, and behavioral factors.

In Indonesia, national surveys show that diabetes and pre-diabetes prevalence have increased over the past decade, influenced by demographic and socioeconomic changes. Data from Muharram et al (2025) reveal that prevalence rose from 10.7% in 2013 to 11.8% in 2018, before slightly declining to 11.3% in 2023 (Muharram et al., 2025). Clinical studies in Indonesia have examined HbA1c patterns by age and gender, highlighting differences in glycemic control across groups (Bakri et al., 2023; Byambasukh et al., 2024; Permatasari & Artanti, 2025; Suharni et al., 2021). However, most research has focused on overall prevalence and clinical profiles, with limited attention to how specific demographic characteristics such as age, gender, and occupation relate to HbA1c levels in the Indonesian context (Kautzky-Willer et al., 2023; Ramadhan & Marissa, 2015; Stedman et al., 2025).

HbA1c is widely recognized as a reliable marker of long-term glycemic status and a strong predictor of both microvascular and macrovascular complications (Bakri et al., 2023; Prihantini et al., 2023; Ramadhan & Marissa, 2015; Suharni et al., 2021). Although HbA1c measurement is commonly used in clinical practice, evidence regarding the relationship between demographic characteristics, specifically age, gender, and occupation, and HbA1c levels among patients with type 2 diabetes mellitus (T2DM) in Indonesia remains limited. Few studies were seen to have examined this association within specific clinical settings. Therefore, the present study addresses the limited understanding of how demographic characteristics are associated with HbA1c levels among patients with T2DM in Indonesia. The objective is to determine whether age, gender, and occupation are associated with HbA1c levels among patients with T2DM treated at Port Medical Center Hospital. Addressing this research question will provide evidence to support more personalized and effective diabetes management, enhance risk stratification in clinical practice, and inform health policies to improve glycemic control and reduce diabetes-related complications in Indonesia.

METHODS

This study follows an observational analytical design with a cross-sectional approach to investigate the association between demographic characteristics and glycated hemoglobin (HbA1c) levels among patients with Type 2 Diabetes Mellitus (T2DM). Secondary data were collected from the medical records of patients at Port Medical Center Hospital between January 2021 and December 2023. Ethical approval was obtained from the Lembaga Penelitian dan Pengabdian kepada Masyarakat (LPPM) of the Christian University of Indonesia (Ethical Approval No.: 075/UKI.LPPM/PPM. 00.00/ET.2024). The dependent variable was HbA1c

level, and the independent variables included demographic characteristics: age, gender (male or female), and occupation.

The study population included all patients diagnosed with type 2 diabetes mellitus (T2DM) who attended Port Medical Center Hospital during the specified period. Subjects were selected using purposive sampling based on predefined criteria. A total of 75 patients met the eligibility requirements and were included in the analysis. The inclusion criteria were: age ≥18 years, a confirmed diagnosis of T2DM documented by physician assessment and medical records, at least one recorded HbA1c measurement during the study period, and complete demographic data (age, gender, and occupation). Exclusion criteria comprised: diagnosis of other types of diabetes mellitus (Type 1 diabetes, gestational diabetes, or secondary diabetes), presence of acute medical conditions that could significantly affect HbA1c interpretation (e.g., severe anemia or recent blood transfusion), and medical records with missing or incomplete data relevant to the study variables.

Data analysis was performed using IBM SPSS Statistics version 26.0. Descriptive statistics were used to summarize respondent characteristics, presented as frequencies and percentages. Before conducting inferential tests, data distribution was assessed to confirm the suitability of statistical procedures. Associations between independent variables and categorized HbA1c levels were examined using the Chi-square test, with Fisher's exact test applied when Chi-square assumptions were not met. A p-value of <0.05 was considered statistically significant.

RESULTS

Table 1. Distribution of T2DM Patients' Characteristics (n=75)

Variable	Frequency (n)	Percentage (%)
HbA1c		
>6.5	21	28
5.7-6.4	27	36
<5.7	27	36
Total	**75**	**100**
Age		
25 - 35 years	25	33.3
36 - 45 years	21	28
46 - 55 years	17	22.7
56 - 65 years	7	9.3
> 65 years	5	6.7
Total	**75**	**100**
Gender		
Male	47	62.7
Female	28	37.3
Total	**75**	**100**

Occupation		
Civil Servants (PNS)	1	1.3
Private Employees	63	84.0
Self-Employed/Freelancers	0	0
Students/College Students	0	0
Retired/Unemployed	11	14.7
Total	**75**	**100**

Based on the data presented in Tables 1, HbA1c levels among T2DM patients at PMC Hospital were classified into three categories: >6.5%, 5.7% - 6.4%, and <5.7%. HbA1c levels were >6.5% in 21 patients (28%), 5.7–6.4% in 27 patients (36%), and <5.7% in 27 patients (36%). The analysis indicated that the most common HbA1c categories were 5.7-6.4% and <5.7%, each observed in 27 patients (36%).

The profile of T2DM patients at PMC Hospital was categorized into 5 age groups: 25-35 years, 36-45 years, 46-55 years, 56-65 years, and >65 years. The data showed that 7 patients (9.3%) were in the 56-65 years group, 17 patients (22.7%) in the 46-55 years group, 21 patients (28%) in the 36-45 years group, 5 patients (7%) in the >65 years group, and 25 patients (33.3%) in the 25-35 years group. The analysis indicated that the largest proportion of patients belonged to the young adult group (25-35 years), with 25 individuals (33.3%).

These findings are consistent with those reported by Nur Wahidah et al. (2022), who also identified young adults as the most prevalent age group. The analysis demonstrated associations between total cholesterol levels, LDL levels, smoking status, smoking intensity, and consumption of sugary drinks with the incidence of diabetes mellitus in young adults in Indonesia. Among these factors, consumption of sugary drinks was found to play the most significant role in the development of diabetes mellitus in this population (Wahidah & Rahayu, 2022).

The gender profile of T2DM patients at Port Medical Center Hospital showed that 47 patients (62.7%) were male and 28 patients (37.3%) were female. These results indicate that male patients with T2DM outnumber female patients at PMC Hospital. Specifically, 47 male patients (62.7%) and 28 female patients (37.3%) were recorded. Interestingly, this finding contrasts with Hestiana (2017), who reported that 71.9% of T2DM patients were women, compared to only 28.1% of men. Women are considered more susceptible to T2DM due to factors such as obesity. Supporting this, Riskesdas (2013) data show that obesity prevalence among women is higher than among men, rising from 14.8% in 2007 to 32.9% in 2013 (Balgis et al., 2022; Luthfa, 2016).

Conversely, the obesity rate among men was 13.9% in 2007 and increased to 19.7% in 2013. Another factor contributing to women's higher susceptibility to diabetes mellitus is

pregnancy, particularly gestational diabetes. Women who give birth to infants weighing more than 4 kg face a sevenfold higher risk of developing diabetes mellitus compared to those who deliver babies of normal weight (Bakri et al., 2023).

The occupational profile of T2DM patients at PMC Hospital was categorized into 5 groups: Civil Servants, Private Employees, Self-Employed/Freelancers, Students, and Retirees/Unemployed. The data showed that no patients were recorded in the Self-Employed/Freelancers or Students categories. One patient (1.3%) was a Civil Servant, 63 patients (84%) were Private Employees, and 11 patients (14.7%) were Retirees or Unemployed.

Table 2. Relationship between Gender and HbA1c Levels

Gender	HBA1c levels			Total	OR (95% CI)	P-Value
	> 6.5	5.7 – 6.4	< 5,7			
Male	13	16	18	47	0.96 (0.34–2.70)	0.851
Female	8	11	9	28	reference	

Bivariate analysis yielded a p-value of 0.851 (p>0.05), indicating no significant association between gender and HbA1c levels in the study population. This suggests that gender does not exert a statistically significant influence on HbA1c levels. Instead, other factors, such as lifestyle, diet, physical activity, and comorbid health conditions, may play a more substantial role. Consequently, strategies for the prevention and management of diabetes mellitus should prioritize modifiable risk factors rather than focusing solely on gender differences.

Table 3. Relationship between Age and HbA1c Levels

Age	HBA1c levels			Total	OR (95% CI)	P-Value
	> 6.5	5.7 – 6.4	< 5,7			
25 - 35 years	3	11	11	25	Reference	
36 - 45 years	2	9	10	21	0.77 (0.12–4.87)	
46 - 55 years	9	6	2	17	8.25 (1.76–38.6)	0.010
56 - 65 years	4	1	2	7	9.78 (1.29–73.9)	
>65 years	3	0	2	5	11.0 (1.27–95.3)	

Bivariate analysis yielded a p-value of 0.010 (p < 0.05), indicating a significant relationship between age and HbA1c levels in the study population. The findings suggest that HbA1c levels tend to increase with advancing age. This result is consistent with Bakri et al. (2023), who reported that the risk of developing diabetes mellitus rises with age, particularly among individuals over 40 years, who are more susceptible to glucose intolerance (Committee, 2023). This may be attributed to age-related declines in pancreatic function and increased insulin resistance. These findings highlight the importance of monitoring HbA1c levels in older populations to enable early detection and effective management of diabetes mellitus.

Table 4. Relationship between Occupational and HbA1c levels

Occupational	HBA1c levels			Total	OR (95% CI)	P-Value
	> 6.5	5.7 – 6.4	< 5,7			
Civil Servants (PNS)	1	0	0	1	5.77 (0.22–149.2)	
Private Employees	13	25	25	63	Reference	
Self-Employed/Freelancers	0	0	0	0	-	0.024
Students/College Students	0	0	0	0	-	
Retired/Unemployed	7	2	2	11	9.21 (1.71–49.6)	

Bivariate analysis yielded a p-value of 0.024 ($p < 0.05$), indicating a significant relationship between occupation type and HbA1c levels in the study population. The results suggest that occupations characterized by low physical activity, irregular schedules, or high stress are associated with elevated HbA1c levels. For instance, positions involving prolonged sitting or substantial workplace stress may increase the risk of insulin resistance and poor glycemic control. These findings emphasize the importance of promoting health-supportive work environments by encouraging physical activity, implementing stress management strategies, and fostering healthy dietary practices. Such interventions may contribute to better management and prevention of elevated HbA1c levels among employees.

DISCUSSION

The results indicate that age and occupation were significantly associated with HbA1c levels among patients with type 2 diabetes mellitus (T2DM) treated at Port Medical Center Hospital between 2021 and 2023, whereas gender was not. These findings suggest that specific demographic and socioeconomic characteristics may influence long-term glycemic control, although the magnitude and direction of these effects can vary across populations and settings (Widiasari et al., 2021).

Age and HbA1c Levels

A significant association was observed between age and HbA1c levels ($p = 0.010$), suggesting that older patients tend to experience poorer glycemic control. However, recent international studies highlight that the relationship between age and HbA1c in individuals with established diabetes is complex and inconsistent (Shao et al., 2022). For example, a large multicenter study conducted in Mongolia and Japan reported an inverse relationship between age and HbA1c after adjusting for diabetes duration, complications, and hematological parameters (Byambasukh et al., 2024). Conversely, several population-based and clinical studies have found higher HbA1c levels in older adults, particularly when comorbidities and functional decline are present. These inconsistencies may reflect differences in study design, population characteristics, and analytical adjustments.

The study by Byambasukh et al. incorporated extensive adjustment for clinical and lifestyle confounders, whereas the current study relied on unadjusted medical record data. In the Indonesian clinical context, increasing age may be associated with longer disease duration, multiple comorbidities, reduced insulin sensitivity, and challenges in maintaining lifestyle modifications, all of which contribute to suboptimal glycemic control.

Recent international guidelines recommend individualized diabetes management in older adults, as age-related physiological changes and treatment complexity can influence HbA1c outcomes. Accordingly, these findings underscore the importance of closer monitoring and tailored interventions for older patients with type 2 diabetes mellitus (T2DM) (Byambasukh et al., 2024). Meanwhile, in the general non-diabetic population, HbA1c typically increases with age, a trend linked to physiological changes such as reduced β-cell function, increased insulin resistance, and longer red blood cell lifespan (Stedman et al., 2025)

Occupation and HbA1c Levels

The results demonstrated a significant association between occupation and HbA1c levels ($p = 0.024$). Although specific literature examining occupation type (e.g., sector, shift work, occupational physical activity) and HbA1c is limited, existing evidence indicates that work-related physical activity, sedentary lifestyle, irregular schedules, and job stress can influence glycemic control. For example, a recent meta-analysis reported that physical activity interventions, including those related to work or daily routines, led to reductions in HbA1c among individuals with T2DM. The optimal dose of physical activity was estimated to be approximately 1,100 MET min/week, resulting in HbA1c reductions of 0.66% to −1.02% in uncontrolled cases (Gallardo-Gómez et al., 2024). This suggests that occupations promoting physical activity (e.g., those with less sedentary work) may contribute to better HbA1c control compared to highly sedentary jobs (Tjendera & Yulia, 2019). Furthermore, a systematic review of working-age adults with diabetes found that interventions increasing physical activity, whether through modifications to work type or post-work activities, positively impacted HbA1c outcomes (Zhao et al., 2024).

Gender and HbA1c Levels

This study found no significant association between gender and HbA1c levels. Recent research has shown that HbA1c patterns may vary by gender and age, particularly in non-diabetic or prediabetic populations. For example, Putri et al. (2022) reported that median HbA1c in women under 45 years was slightly lower than in men (34 vs. 35 mmol/mol), although this difference disappeared in individuals aged ≥45 years. Similarly, a study by Ahmed et al (2023) in northern Sudan found no association between gender, BMI, and HbA1c

in adults with HbA1c <6.5% (Ahmed et al., 2023; Huang et al., 2021; Younes et al., 2019). These findings suggest that the influence of gender may be subtle or dependent on factors such as age, ethnicity, or hormonal status (e.g., menstruation, menopause) and may not have emerged as significant in the present study with a sample of 75 patients. The absence of a gender effect here may also be attributable to sample size, age distribution, employment type, or limited variability in gender-related occupational characteristics. Nevertheless, the results reinforce the conclusion that age and occupation are significant determinants of glycemic control among T2DM patients at PMC Hospital.

Study Limitation

Several important limitations should be acknowledged. First, the relatively small sample size may limit statistical power, reducing the ability to detect subtle associations, particularly with respect to gender. Second, the cross-sectional design precludes causal inference regarding the relationship between demographic characteristics and HbA1c levels. Third, occupational status was classified into broad categories, which may not adequately capture differences in physical activity, stress, income, or job stability. Fourth, the analysis did not adjust for key confounding variables known to influence HbA1c, such as body mass index, diabetes duration, treatment type and intensity, dietary intake, and physical activity. Fifth, reliance on a single-center, record-based dataset introduces potential selection bias and restricts the generalizability of the findings. Finally, analyzing HbA1c as a categorical variable may have reduced sensitivity to detect more nuanced associations compared with continuous analysis.

Implication

Despite these limitations, the findings highlight the potential importance of age- and occupation-related factors in long-term glycemic control among patients with type 2 diabetes mellitus (T2DM). The absence of a gender effect suggeststhat diabetes management strategies should prioritize modifiable lifestyle and socioeconomic factors rather than demographic characteristics alone. Future research involving larger, multicenter samples, longitudinal designs, more detailed occupational assessments, and comprehensive adjustment for clinical and behavioral confounders will be essential to clarify these relationships within the Indonesian context.

CONCLUSIONS

The study identified significant associations between age and occupation with HbA1c levels among patients with type 2 diabetes mellitus (T2DM) treated at Port Medical Center

Hospital from 2021 to 2023, whereas no association was observed with gender. These results suggest that age-related and occupational factors may influence glycemic control; however, causal relationships cannot be established due to the cross-sectional study design. In clinical practice, older patients may benefit from more frequent HbA1c monitoring and tailored counseling. Meanwhile, individuals in predominantly sedentary occupations could be supported through interventions such as scheduled movement breaks, increased daily physical activity, and lifestyle counseling integrated into routine outpatient care. Incorporating occupational information into patient assessments may help identify those at greater risk for poor glycemic control. Future studies with larger sample sizes, longitudinal designs, and more detailed occupational and lifestyle assessments are needed to validate these findings and further elucidate the impact of demographic and socioeconomic factors on HbA1c levels in patients with T2DM.

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