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Research article

Exploring the Links: Age, Gender, and HbA1C as Predictors of Microalbuminuria in Hypertensive Patients with Type 2 Diabetes in the Prolanis Community

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Abstract

Diabetes mellitus (DM) complications are categorized into microvascular and macrovascular types. Hypertension (HT), commonly encountered in DM patients, can exacerbate these conditions and increase the likelihood of developing microvascular complications. Nephropathy, a microvascular complication, is often initially indicated by microalbuminuria (MA). Key risk factors for MA include age, gender, and HbA1c levels. This study employed a cross-sectional design, utilizing secondary data from the medical records of Prolanis (Chronic Disease Management Program) community patients between January and December 2024. The independent variables were gender, age, and HbA1c levels, while the dependent variable was the presence of microalbuminuria. Hypothesis testing was conducted using the chi-square test and logistic regression analysis. The analysis revealed that both age and gender were significantly associated with microalbuminuria levels. Patients aged under 60 had a 3.9-fold higher risk of microalbuminuria, while males had a 3.8-fold increased risk. HbA1c levels, however, were not significantly correlated with microalbuminuria. Logistic regression analysis further showed that age and gender were not independent predictors of microalbuminuria. Age and gender are identified as risk factors for microalbuminuria in diabetic patients with hypertension, though HbA1c levels did not show a significant association.

INTRODUCTION

According to data from the Ministry of Health, the prevalence of diabetes mellitus (DM) in Indonesia currently stands at 19.5 million individuals, with projections indicating an increase to 28.5 million by 2045.[1] DM-related complications are typically categorized into microvascular and macrovascular types. Hypertension, frequently observed in DM patients, can aggravate these complications and heighten the risk of developing microvascular conditions.[2]

Nephropathy, a microvascular complication, is often first identified by the presence of microalbuminuria (MA).Microalbuminuria is defined as elevated urine albumin levels, which, while

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higher than normal, remain detectable by conventional dipstick tests.[2] Prevention of complications is largely reliant on achieving optimal glycemic control, which is commonly assessed by monitoring HbA1c levels.[2] Research has shown that initial HbA1c levels ≤8% in patients with a disease duration of 2 years are associated with an increased risk of developing MA.[3] Some studies have found a significant relationship between HbA1c levels and albuminuria, indicating a strong correlation, while others have observed no significant link between creatinine and microalbumin levels in individuals with HbA1c levels <6.5%. However, HbA1c levels ≥5.5% have been positively correlated with the occurrence of microalbuminuria.[45]

Several factors, including age and gender, can influence the development of microalbuminuria. Advanced age is frequently correlated with diminished renal function and an increased prevalence of microalbuminuria. Studies have indicated that the majority of affected individuals fall within the 51-60 year age range.[6] For instance, a study conducted in India reported an average age (SD) of 54 years among patients. In this cohort, over one-third (38.2%, 95% CI: 31.6-44.4) of patients with diabetes mellitus (DM) and/or hypertension (HT) exhibited microalbuminuria. The highest prevalence was observed in individuals with both DM and HT (48%, 95% CI: 37-59), followed by those with only DM (40.6%, 95% CI: 29-52.2) and only HT (27.7%, 95% CI: 18.1-38.6).[2] Another study demonstrated that 86% of participants had microalbumin levels exceeding 20 mg/L, with 86% of these individuals being over the age of 45.[7] This phenomenon may be attributed to the aging process, which exacerbates kidney function, as well as the increased prevalence of comorbid conditions such as hypertension and diabetes in older populations.

Gender is also considered a significant factor influencing the prevalence of microalbuminuria. Several studies have identified disparities in prevalence between men and women, which may be attributed to hormonal, metabolic, or genetic differences. The prevalence of microalbuminuria is particularly high among women with diabetes mellitus (DM) and/or hypertension (HT), as indicated by multiple studies.[68] Specifically, the prevalence in women is twice as high (adjusted prevalence ratio [aPR]= 2.1, 95% CI: 1.1-3.9) and 2.4 times higher (95% CI: 1.12-5.1) in individuals with both DM and HT, compared to those with only HT.[8]

Despite these findings, the relationship between various risk factors for microalbuminuria remains inconsistent, suggesting that further research is necessary. The primary aim of this study is to analyze the association between age, gender, and HbA1c levels with the incidence of microalbuminuria. Additionally, this study seeks to explore the interactions among these variables, considering their potential mutual influence. By gaining a deeper understanding of the factors contributing to the development of microalbuminuria, this research hopes to provide valuable insights that could inform better prevention strategies and enhance the management of renal and cardiovascular complications in affected patients.

METHODS

This study employed a descriptive observational design. Data collection was conducted using primary data sourced from the medical records of Prolanis (Chronic Disease Management Program) patients between January and December 2024, applying a cross-sectional approach.

The study population comprised 100 patients Prolanis (Chronic Disease Management Program) patients diagnosed with both diabetes mellitus (DM) and hypertension (HT). A total sampling technique, in accordance with the inclusion

and exclusion criteria, was used to select 41 patients for analysis. The independent variables were gender, age, and HbA1c levels, while the dependent variable was microalbuminuria.

Univariate analysis was performed to describe the characteristics of the respondents, including gender, age, HbA1c levels, and microalbuminuria. The results were presented in terms of mean, median, and frequency, and displayed in tables and bar charts. To assess relationships between variables, the Chi-square test was employed. A significance level of 95% was applied, with the null hypothesis (H0) being accepted if the p-value (sig.) > 0.05, and the alternative hypothesis (Ha) being accepted if the p-value (sig.) < 0.05.

Multivariate analysis in this study employed logistic regression due to the categorical nature of the variables, which include both nominal and ordinal data. The analysis process began with a bivariate examination of each independent variable in relation to the dependent variable. Variables with a p-value (sig.) < 0.25 were considered eligible for inclusion in the multivariate analysis. Once potential candidates for multivariate modeling were identified, logistic regression modeling was conducted to determine which independent variables were most strongly associated with the dependent variable. If the significance value (Sig.) was < 0.05, this indicated a simultaneous effect. An interaction test was performed if there was a suspicion of a significant interaction. A p-value < 0.05 in this test would indicate the presence of an interaction between the independent variables. In the case of an interaction, the final model used was a multivariate model incorporating the interaction effects.

RESULTS

Table 1 indicates that the average age of the patients was 61.5 ± 10.37 years. When age was categorized into two groups, the majority (61.0%) were in the ≥ 60 years age group. In terms of gender, a higher proportion of female patients (56.1%) was observed compared to male patients (43.9%).

Table 1.
Patient characteristics

Patient characteristics	Mean ± SD	n (%)
Age (years)	61,5 ± 10,37	
< 60 years		16 (39.0)
≥ 60 years		25 (61,0)
Gender		
Male		18 (43,9)
Female		23 (56,1)

Table 2 shows that the average HbA1c level among patients was 7.97 ± 1.91%. When categorized by a cutoff of 6.5%, the majority of patients (78.0%) had elevated HbA1c levels. Microalbumin levels ranged from 2 to 300 mg, with a median of 30 mg, and 48.8% of patients were found to have microalbuminuria.

Table 2.
Overview of HbA1c and microalbumin levels

Variables	Mean ± SD	Median (min-max)	n (%)
HbA1c level (%)	7,97 ± 1,91		
High (>6.5%)			32 (78,0)
Normal (≤ 6.5%)			9 (22.0)
Microalbumin level (mg)		30 (2 - 300)	
High (≥ 30 mg)			20 (48,8)
Normal (< 30 mg)			21 (51,2)

Table 3 illustrates that among patients under 60 years of age, a higher proportion (26.8%) had elevated microalbumin levels (≥30 mg) compared to those with normal levels (12.2%). In contrast, patients aged 60 years or older had a greater proportion of normal microalbumin levels (39.0%) than high levels (22.0%). The results of the chi-square test yielded a p-value of 0.041 (<0.05), indicating a significant association between age and microalbumin levels. The odds ratio (OR) was 3.911 with a 95% confidence interval (CI) of 1.028 - 14.875. Since the OR is greater than 1 and the 95%

CI does not include 1, this suggests that age is a risk factor for microalbuminuria. Specifically, patients under 60 years of age have a 3.9-fold higher risk of developing microalbuminuria compared to those aged 60 years or older.

Table 3.
Bivariate analysis of the association of age, gender and HbA1c levels with microalbuminaria

Variables	Microalbumin levels		Total	p	OR (95% CI)
	High	Normal			
Age					
< 60 years	11 (26,8)	5 (12,2)	16 (39.0)	0.041[CS]	3,911 (1,028-14,875)
≥ 60 years	9 (22,0)	16 (39,0)	25 (61,0)		
Gender					
Male	12 (29,3)	6 (14,6)	18 (43,9)	0.043[CS]	3,750 (1,019-13,795)
Female	8 (19,5)	15 (36,6)	23 (56,1)		
HbA1c levels					
High	17 (41,5)	15 (36,6)	32 (78,0)	0.454 [FE]	2,267 (0,481-10,680)
Normal	3 (7,3)	6 (14,6)	9 (22.0)		

CS: chi square, FE: fisher exact

Figure 1 illustrates the distribution of microalbuminuria by age, showing a higher prevalence of microalbuminuria in patients under 60 years of age compared to those aged 60 years or older. Regarding gender, among the 43.9% of male patients, 29.3% had elevated microalbumin levels, which was higher than the 14.6% with normal levels. In contrast, among the 56.1% of female patients, a larger proportion had normal microalbumin levels (36.6%) compared to those with high levels (19.5%). The chi-square test revealed a p-value of 0.043 (<0.05), indicating a significant association between gender and microalbumin levels. The odds ratio (OR) was 3.750, with a 95% confidence interval (CI) of 1.019 - 13.795. Since the OR is greater than 1 and the 95% CI does not include 1, gender is identified as a risk factor for microalbuminuria. Specifically, males have a 3.8-fold higher risk of microalbuminuria than females. Figure 2 further demonstrates that microalbuminuria is more common in males than females.

Based on HbA1c levels, it was observed that among the 78% of patients with elevated HbA1c levels, the proportions of those with high and normal microalbumin levels were relatively similar, at 41.5% and 36.6%, respectively. Among the 22% of patients with normal HbA1c levels, 14.6% had normal microalbumin levels, and 7.3% had elevated microalbumin levels. The results of the Fisher's exact test yielded a p-value of 0.454 (>0.05), indicating that HbA1c levels are not significantly associated with microalbumin levels. The odds ratio (OR) was 2.267, with a 95% confidence interval (CI) of 0.481 - 10.680; although the OR is greater than 1, the 95% CI includes 1, suggesting that high HbA1c levels are not a risk factor for microalbuminuria. Figure 3 further illustrates the distribution of microalbuminuria according to high and normal HbA1c levels, showing that among patients with high HbA1c levels, both microalbuminuria and normoalbuminuria statuses were relatively rare, with 15 and 17 patients, respectively.

The results of the bivariate test found that age and gender were included in the multivariate analysis requirements, but the results of the logistic regression test found that both were not independent predictors of microalbuminaria, because the p values obtained were all > 0.05.

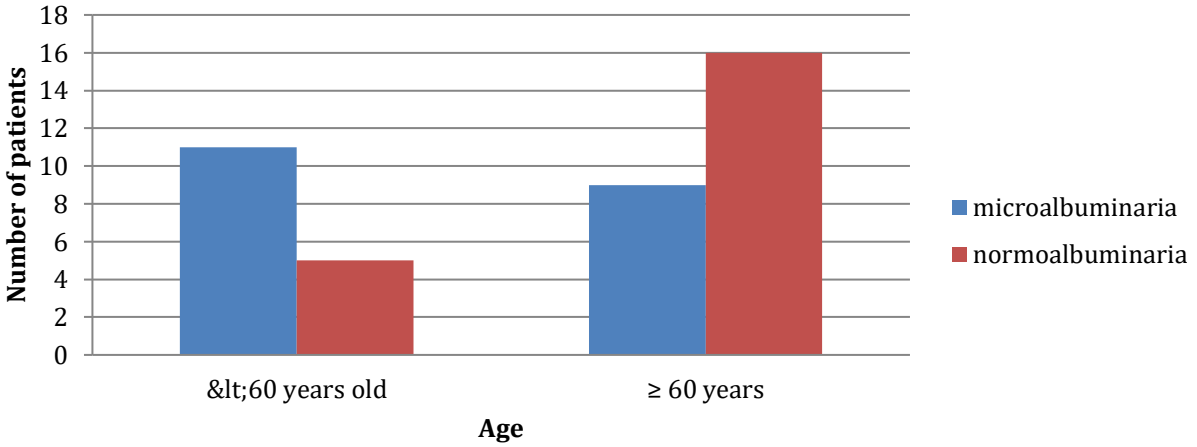

Figure 1.
Distribution of the incidence of microalbuminuria by age

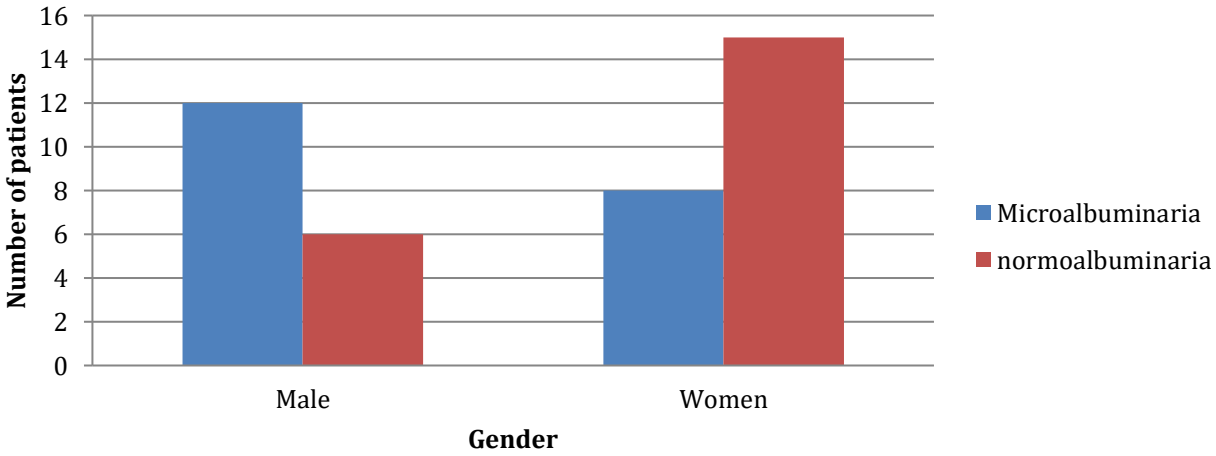

Figure 2.
Distribution of the incidence of microalbuminuria by gender

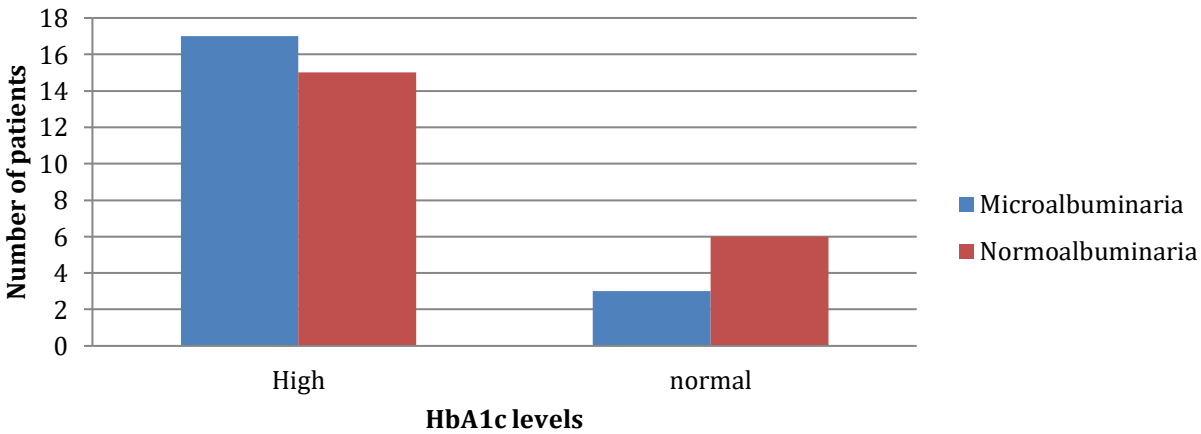

Figure 3.
Distribution of microalbuminaria according to HbA1c levels

Table 3.
Multivariate analysis of the association of age and gender with microalbuminaria

Variables	Microalbumin levels		Total	p	OR (95% CI)
	High	Normal			
Age				0,057	3,929 (0,962-16,048)
< 60 years	11 (26,8)	5 (12,2)	16 (39.0)		
≥ 60 years	9 (22,0)	16 (39,0)	25 (61,0)		
Gender				0,059	3,767 (0,953-14,892)
Male	12 (29,3)	6 (14,6)	18 (43,9)		
Female	8 (19,5)	15 (36,6)	23 (56,1)		

DISCUSSION

Exploring the Links: Age as Predictors of Microalbuminuria in Hypertensive Patients with Type 2 Diabetes in the Prolanis Community

The mean age of the patients was 61.5 ± 10.37 years, which aligns with findings from several studies indicating a high prevalence of diabetes mellitus (DM) with hypertension (HT) among the elderly.[9] In terms of the relationship between age and microalbuminuria, 39.0% of patients under 60 years of age exhibited elevated microalbumin levels (≥30 mg), compared to those with normal levels. Conversely, patients aged 60 years and older had a higher proportion of normal microalbumin levels. Statistical analysis revealed that age is significantly associated with microalbumin levels, indicating that age is a risk factor for microalbuminuria. Specifically, patients under 60 years old had a 3.9-fold higher risk of developing microalbuminuria compared to those aged 60 or older. These findings are consistent with several studies that have identified advanced age as a risk factor for microalbuminuria in individuals with DM and HT.[78109]

The prevalence of microalbuminuria generally increases with age. In older adults, renal function tends to decline, and various risk factors, such as hypertension, diabetes, and age-related changes, may exacerbate damage to the small blood vessels in the kidneys. This damage increases the leakage of proteins, including albumin, into the urine, resulting in microalbuminuria. Therefore, the risk of microalbuminuria is heightened in older populations, particularly those with additional risk factors such as type 2 diabetes or hypertension. [78109]

Exploring the Links: Gender as Predictors of Microalbuminuria in Hypertensive Patients with Type 2 Diabetes in the Prolanis Community

According to gender, there were relatively more female patients (56.1%) than male patients (43.9%). The relationship between gender and microalbuminuria showed that 43.9% of male patients tended to have high microalbumin levels, more than normal ones. Meanwhile, 56.1% of female patients tended to have normal microalbumin levels more than high ones. Hypothesis testing results show that gender is significantly associated with microalbumin levels and gender is a risk factor for microalbuminaria. Male gender has a 3.8 times higher risk of microalbuminaria than female. There are several studies that are not in line with this study stating the prevalence of microalbuminuria in patients with DM and/or HTN is very high, especially women.[68] The prevalence of microalbuminuria was twice as high (aPR = 2.1, 95% CI: 1.1-3.9) in women and 2.4 times as high (95% CI: 1.12-5.1) in patients who had both DM and HT, compared with patients who only had HT.[8] Another study stated that there was no association of gender with microalbuminuria.[11]

The relationship between gender and microalbuminuria in patients with DM and HT suggests a difference in prevalence

between men and women. Some studies indicate that men are more likely to develop microalbuminuria than women, although these results may vary depending on other factors such as age, duration of diabetes, glycaemic control, and the presence of other complications such as hypertension.[211]

Exploring the Links: HbA1C as Predictors of Microalbuminuria in Hypertensive Patients with Type 2 Diabetes in the Prolanis Community

The mean HbA1c level of patients was 7.97 ± 1.91%. According to the 6.5% cutoff, the majority of patients (78.0%) had elevated HbA1c levels. Microalbumin levels ranged from 2 to 300 mg, with a median of 30 mg, and 48.8% of patients exhibited microalbuminuria. Regarding the relationship between HbA1c levels and microalbuminuria, it was observed that 78% of patients with high HbA1c levels had both high and normal microalbumin levels, with the distribution being relatively similar. In contrast, 22.0% of patients with normal HbA1c levels had normal microalbumin levels, while 7.3% had elevated microalbumin levels. This study did not find a clear association between HbA1c levels and microalbuminuria, suggesting that elevated HbA1c levels may not be a direct risk factor for microalbuminuria. However, other studies have reported a significant association between HbA1c levels and microalbuminuria in diabetic patients. These studies indicated that patients with higher HbA1c levels are at an increased risk of developing microalbuminuria, an early indicator of diabetic nephropathy.[12]

HbA1c, which reflects the average blood glucose level over the past 2-3 months, can impact kidney function and elevate the risk of microalbuminuria. High HbA1c levels indicate poor glycemic control, which can further damage the small blood vessels in the kidneys, resulting in albumin leakage into the urine—known as microalbuminuria.[13] Thus, improving blood glucose control, as indicated by reduced HbA1c levels, may help mitigate the risk of microalbuminuria and other renal complications in diabetic patients.

Exploring the Links: Age, Gender, and HbA1C as Predictors of Microalbuminuria in Hypertensive Patients with Type 2 Diabetes in the Prolanis Community

The results of the bivariate analysis indicated that age and gender met the criteria for inclusion in the multivariate analysis. However, the findings from the logistic regression test revealed that neither age nor gender were independent predictors of microalbuminuria. Other factors, such as the duration of diabetes mellitus (DM), medication adherence, and the presence of other disease-related complications, can significantly influence the development of microalbuminuria.[14]

Insulin resistance, which is characteristic of type 2 diabetes, also contributes to the development of hypertension. This condition leads to inflammation and oxidative stress, which can result in microvascular complications, including diabetic nephropathy (DN), often manifested by microalbuminuria in its early stages. Diabetic nephropathy is associated with specific functional and morphological changes in the kidneys, particularly in the glomeruli, such as podocyte damage, podocyte apoptosis, detachment, and destruction. Changes within the nephron, particularly in the glomerulus, lead to glomerular hyperfiltration, hypertrophy, and renal damage. These alterations contribute to an increase in microalbuminuria (urinary albumin excretion, UAE). Elevated urinary protein levels activate tubular cells, which subsequently synthesize inflammatory mediators, such as chemokines (e.g., MCP-1, RANTES, fractalkine), and molecules that promote fibrogenesis, including endothelin, angiotensin II, and TGF-β. Patients with type 2 diabetes are generally twice as likely to

develop hypertension compared to those without diabetes, and the prevalence of hypertension is particularly high among individuals with increased urinary albumin excretion.[81516,17]

CONCLUSION

Age was found to be significantly associated with microalbumin levels and serves as a risk factor for microalbuminuria. Specifically, patients under 60 years of age exhibited a 3.9-fold higher risk of developing microalbuminuria compared to those aged 60 years or older. Gender also demonstrated a significant association with microalbumin levels, with males having a 3.8-fold increased risk of microalbuminuria compared to females. However, HbA1c levels did not show a significant relationship with microalbumin levels, suggesting that elevated HbA1c levels are not a risk factor for microalbuminuria. Bivariate analysis indicated that age and gender met the criteria for inclusion in the multivariate analysis, but logistic regression results revealed that these factors were not independent predictors of microalbuminuria. The findings of this study are intended to complement previous research and provide a foundation for further investigations in this area.

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CONFLICTS OF INTEREST

Neither of the authors has any conflicts of interest that would bias the findings presented here.

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