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Urine Microalbumin And Hba1c As Early Markers Of Chronic Kidney Disease In Type 2 Diabetes Mellitus

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Abstract

The correlation between urine microalbumin and HbA1c levels is a significant early indicator of chronic kidney disease (CKD) in individuals with type 2 diabetes mellitus (T2DM). Microalbuminuria, characterised by an increased urine albumin-to-creatinine ratio, frequently serves as the initial indicator of diabetic nephropathy, which may advance to end-stage renal disease if not identified promptly. This study aims to ascertain the correlation between urine microalbumin and creatinine levels and HbA1c in individuals diagnosed with type 2 diabetes. This research was an analytical observational study employing a cross-sectional strategy. This study involved 40 individuals with type 2 diabetes who received routine check-ups at Sultan Agung Hospital in Semarang. Jaundice, lipemic and hemolyzed serum samples will not be used for HbA1c testing. The study results indicated no correlation between HbA1c and microalbumin or creatinine levels in patients with type 2 diabetes. The duration of diabetes mellitus patients was quite short, averaging 5.73 years of illness.

Keywords : *Diabetes Mellitus; urine microalbumin; creatinine; early markers*

INTRODUCTION

Diabetes Mellitus (DM) is a degenerative condition estimated to rise approximately a quarter by twenty-first century, with a double effect in developing countries[1,2]. In Indonesia based on Riskesdas from 2013 to 2018, the prevalence of Diabetes Mellitus (DM) increased from 6.9 per cent to 8.5 per cent, which means that there are 22.9 million people with DM prevalence [3]. Kidney disease or kidney damage is one of the complications of diabetes. Patients with diabetes mellitus have a tendency to suffer from nephropathy 17 times more often than non-diabetic people[4,5]. Factors that influence the development of DM towards nephropathy include genetics, blood sugar control, and blood pressure [6,7].

Abnormalities that occur in the kidneys of people with diabetes mellitus begin with the presence of microalbuminuria[5]. Microalbuminuria prevalence in T2DM patients is approximately 39.1%[4]. Microalbuminuria is generally defined as albumin excretion of more than 30 mg per day and is considered important for the onset of

diabetic nephropathy which if not controlled will then progress to clinical proteinuria and continue with a decrease in glomerular filtration rate function and end in renal failure[8]. It is estimated that 20-30% of people with type 2 diabetes will suffer from diabetic nephropathy at some point which can end in kidney failure [6,9].

Microalbuminuria and HbA1c are essential early indicators for identifying chronic kidney disease (CKD) in individuals with type 2 diabetes mellitus (T2DM)[10]. Microalbuminuria, characterised by an elevated urine albumin-to-creatinine ratio, is the initial clinical indicator of diabetic nephropathy, a prevalent consequence of diabetes that may progress to end-stage renal disease (ESRD) if inadequately controlled[4,5,8]. HbA1c, an indicator of chronic glycaemic regulation, is strongly correlated with the onset of microalbuminuria and ensuing renal impairment in individuals with diabetes[11,12].

Despite urine microalbumin and HbA1c are significant indicators for the early identification of chronic kidney disease in type 2 diabetes mellitus, additional biomarkers and variables also contribute to the evaluation of renal health[13]. Podocyte damage markers and fibroangiogenesis indicators can offer more insights into renal impairment prior to the manifestation of conventional symptoms[14]. Furthermore, lifestyle improvements, including dietary changes and physical activity, are crucial for treating diabetes and delaying the advancement of chronic kidney disease (CKD) [15,16]. These broader issues underscore the complex strategy necessary for efficient management of CKD in diabetic individuals.

METHOD

This research is an analytical observational study with a cross-sectional design, comprising a sample of 40 patients with type 2 diabetes who were examined at Sultan Agung Hospital, Semarang, in 2022-2024. The data in this study were analysed both descriptively and inferentially. The descriptive analysis pertains to the respondents' health status, while the inferential analysis involves the chi-square test and risk analysis of the prevalence between urine creatinine and microalbumin levels in relation to HbA1c levels in patients with type 2 diabetes.

RESULT AND DISSCUSS

The characteristics of respondents in this study included age, gender, duration of suffering from type 2 diabetes, weight, height, HbA1C, microalbumin, urine creatinine, and history of drug consumption. As seen in the following table.

Table 1. Table of characteristics of respondents based on age, sex, duration of suffering from type 2 DM, weight, height, HbA1C, microalbumin, urine creatinine, and history of drug consumption

lo.	Parameter	Result (Mean)
		5 Years Old
	time suffering from diabetes mellitus	Years Old
	ght	1 Kg
	ght	,13 Cm
	1C	
	roalbumin Urine	5

ıtinin Urine	'6
ıory of drug consumption	(11 people); No (29 people)
	e (17 people); Female (23 People)

Table 1 which presents the characteristics of the respondents, it can be seen that of the 40 respondents, the average age of the respondents is 56.55 years. This is in accordance with previous research and theories which state that the risk of developing diabetes will increase with age, especially over 40 years [17(p2)]. However, recent cases of type 2 diabetes in children and adolescents are increasing due to obesity and modern lifestyles[18,19]. While gender is dominated by women, namely 23 respondents. Judging from the length of suffering from DM, the average respondent suffers from DM is 5.73 years. The average bodyweight of the respondents is 63.91 Kg. From table 1, what can be noticed is that the average HbA1C value is 9.55 or the average respondent has an HbA1C level that is more than the normal HbA1C value. While the average value of respondents' microalbumin levels was 77.85 or higher than the normal value (reference normal value 18 mg/L). From the table 1, it can be seen that the respondents had HbA1C and microalbumin levels more than normal values.

In individuals with Type 2 Diabetes Mellitus (T2DM), HbA1c and microalbumin concentrations are frequently increased as a result of persistent hyperglycemia and its related consequences[20]. HbA1c, an indicator of sustained glycaemic regulation, represents the mean blood glucose concentrations over the preceding two to three months. Increased HbA1c values signify inadequate glycaemic regulation, a prevalent concern among T2DM patients[20,21]. Microalbuminuria, characterised by the presence of albumin in urine, serves as an early sign of diabetic nephropathy, a prevalent consequence of diabetes[8]. The correlation between these two markers is substantial, as inadequate glycaemic regulation frequently results in renal impairment, leading to elevated microalbumin concentrations[22].

While several areas of self-care improved, such as diet and home blood sugar monitoring, exercise and medication adherence did not[23]. These findings may be due to high rates of medication adherence at baseline, which led to limited room for change, or, in the case of exercise, potential barriers patients had in making lifestyle change and the need for more support in increasing their physical activity [24–26].

Table 2. Respondent's HbA1C, microalbumin, and urine creatinine levels

ʌ1C Level		Sum	ːentage (%)
eria	trolled	7	17,5
	controlled	33	82,5
	ıl	40	100,0
roalbumin level		Total	Percentage (%)
eria	mal	16	40,0
	ormal	24	60,0
	ıl	40	100,0
ıe Creatinine level		Sum	Percentage (%)
eria	mal	36	90,0
	ormal	4	10,0
	ıl	40	100,0

Table 2 indicates that 33 out of 40 respondents had uncontrolled HbA1C levels, 24 out of a total of 40 respondents had abnormal microalbumin levels, also out of 40 respondents, only 4 respondents had abnormal urine creatinine

levels. Glycate haemoglobin or HbA1c is the fraction of haemoglobin that binds directly to glucose which indicates blood sugar levels for 8-12 weeks[12]. HbA1c examination is a standard examination to assess the long-term glycaemic status and is effective in all types of people with Diabetes Mellitus[16,27]. The HbA1c test has so far been successful in providing a level of control over diabetes. The test shows the average amount of blood sugar in 2-3 months, therefore diabetics are recommended to routinely control at least 2 times a year [28].

In individuals with Type 2 Diabetes Mellitus (T2DM), elevated HbA1c levels are mostly attributable to chronic hyperglycemia, resulting from insulin resistance and insufficient insulin production[29]. HbA1c indicates the mean blood glucose levels during the preceding two to three months, rendering it a dependable indicator of long-term glycaemic regulation. In Type 2 Diabetes Mellitus, the sustained elevation of blood glucose levels results in heightened glycation of haemoglobin, consequently elevating HbA1c values beyond the normal range[30]. This rise signifies inadequate glycaemic management and is connected with multiple problems related to diabetes[31]. Enhancing metabolic regulation, averting and addressing problems, and improving quality of life in a cost-efficient manner necessitates a comprehensive strategy that incorporates regular monitoring, lifestyle adjustments, personalised care, and novel healthcare frameworks[32]. Efficient care of metabolic disorders such as diabetes and obesity necessitates a multifaceted approach that encompasses both pharmacological and lifestyle interventions, while also accounting for economic limitations[33,34].

Microalbuminuria, an early sign of diabetic nephropathy, is frequently detected in individuals with Type 2 Diabetes Mellitus (T2DM) owing to various interconnected variables. It indicates the beginning of renal impairment and serves as a prognostic factor for cardiovascular problems[35,36]. The increased microalbumin levels in urine of T2DM patients are mainly due to inadequate glycaemic management, hypertension, and the duration of diabetes, among other reasons[4,37]. These factors enhance the permeability of the glomerular filtration barrier, resulting in albumin excretion in the urine[5,38].

Urine microalbumin in patients with type 2 diabetes mellitus not only affects the condition of kidney damage, but other studies also mention that patients with type 2 diabetes mellitus with high microalbumin levels can also cause sleep apnea, although The exact mechanism between OSAHS and microalbuminuria is unclear, these mechanisms can elevate the insulin resistance in T2DM patients and affect other related factors of microalbuminuria[20,37,39]

Urine creatinine was included in the examination in this study because to correct the results of urine microalbumin which were examined using a urine sample so that the results of urine microalbumin needed to be corrected using urine creatinine examination. For patients with type 2 diabetes mellitus, quantitative urine albumin examination is carried out as an initial examination immediately after being diagnosed with diabetes and periodically once a year.

Urine creatinine levels in individuals with Type 2 Diabetes Mellitus (T2DM) are crucial for evaluating renal function and possible consequences[40]. Increased urine creatinine levels may signify compromised kidney function, a frequent consequence in people with type 2 diabetes mellitus (T2DM). The urine albumin to creatinine ratio (UACR) is commonly utilised to assess renal health, with elevated ratios indicating a heightened risk of renal dysfunction and cardiovascular incidents[41,42]. UCPCR is positively correlated with insulin resistance and diabetic kidney disease, making it a useful biomarker for assessing renal function and classifying T2DM subtypes[41]. This ratio is a significant indicator of diabetic nephropathy, a common disease in individuals with T2DM[43]. While urine creatinine levels are crucial for assessing kidney health in T2DM patients, it is important to consider other factors such as duration of diabetes, lifestyle habits, and additional biomarkers like UCPCR and UACR for a comprehensive evaluation. These markers collectively help in early detection and management of renal complications in T2DM.

Table 3. Bivariate analysis of HbA1C against Microalbumin

		Microalbumin				
		mal	ıormal	al	alue	(95% CI)
\1C	trolled	5	3	8		
	controlled	11	21	32	0,262	2,545 48 – 13,45)
ıl		16	24	40		

Table 5 indicates an absence of correlation between HbA1C levels and urine microalbumin levels, as evidenced by the p-value of 0.262 (> 0.005). However, when observed from the OR, which has an extensive range, it may be deduced that the sample utilised is excessively diverse. The absence of sufficient samples in this study may also result in findings that indicate no correlation between HbA1C and microalbumin. The examination of the p-value data indicates that type 2 diabetes mellitus patients with abnormal HbA1C levels have a twofold increased chance of abnormal microalbumin levels, serving as an early indicator of chronic kidney disease, compared to those with normal HbA1C levels. Microalbuminuria serves as an indicator of early-stage renal glomerular problems, during which kidney conditions remain amenable to treatment. Inversely, once renal failure has transpired, treatment becomes challenging. Moreover, microalbuminuria may elevate the risk of cardiovascular disease. This investigation yields different results compared to another study that identified a strong association (r=0.24, p<0.05) between HbA1c levels and urine microalbumin levels, suggesting that elevated HbA1c is linked to increased microalbuminuria[11].

The relationship between HbA1c levels and urine microalbumin levels in diabetic patients is complex and not always directly correlated. While some studies suggest a significant association between high HbA1c levels and increased microalbuminuria, others do not find a strong correlation[44]. This discrepancy can be attributed to various factors, including differences in study design, patient populations, and the multifactorial nature of diabetes complications[11,21].

Detecting microalbuminuria facilitates the early identification of diabetic nephropathy and allows for the assessment of cardiovascular disease risk[4–6]. Individuals with diabetes exhibiting persistent microalbuminuria are at heightened risk for significant renal impairment, as 50% of dialysis patients are diabetic. Consequently, the early identification of microalbuminuria is an effective first measure for preserving renal function and averting subsequent deterioration of kidney performance[16]. For individuals diagnosed with type 2 diabetes mellitus, a quantitative urine albumin assessment is performed as an initial evaluation immediately upon diagnosis and subsequently on an annual basis[5,10].

Table 4. Bivariate analysis of HbA1C on urine creatinine

		Creatinin urine				
		Normal	bnormal	Total	P-value	(95% CI)
\1C	trolled	7	0	7		
	Controlled	29	4	33	·8	1,138 03 – 1,292)
ıl		36	4	40		

Table 4 indicates the lack of a correlation between HbA1C and urine creatinine. The p-value exceeds 0.005. Despite the absence of a relationship identified by statistical analysis, p-value analysis indicates that respondents with abnormal HbA1C levels held a fourfold increased chance of developing chronic kidney disease, as determined by

urine creatinine levels. The administration of diabetic medicine acquired by the respondent may exert influence. Various categories of oral hypoglycemic agents can lead to a reduction in urine microalbumin concentrations. The absence of association between HbA1c and urine creatinine in diabetic patients can be ascribed to the differing physiological processes they signify[44]. HbA1c serves as an indicator of long-term glycaemic control, representing average blood glucose levels over the preceding two to three months, whereas urinary creatinine values predominantly signify renal function[45]. Although diabetes is frequently linked to renal issues, research has repeatedly demonstrated no direct correlation between these two factors in diabetic people[46].

Whereas HbA1c and urine creatinine are both crucial for diabetes management, their absence of association indicates that they should be utilised complementarily rather than interchangeably. This distinction underscores the intricacy of diabetes care, wherein various indicators are essential to furnish a holistic view of a patient's health[10,40,42]. Moreover, factors such as age, duration of diabetes, and the existence of other comorbidities can independently affect these markers[47].

CONCLUSION

Results from studies indicate that renal impairment in patients with Type 2 Diabetes Mellitus typically manifests over an extended period. This study revealed no correlation between microalbumin and creatinine, markers of renal damage, and HbA1c, which reflects glucose levels in haemoglobin over the preceding three months.

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