The Prevalence and Risk Factors of Microalbuminuria in Hypertensive Patients under Current Medical Treatment

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Abstract

Objective A link between urinary albumin excretion and an increased incidence of cardiovascular mortality has already been demonstrated. However, the reported prevalence of microalbuminuria (MAU) in patients with hypertension is highly variable. We therefore aimed to conduct a cross-sectional multicenter study to investigate the prevalence of urinary albumin excretion in treated hypertensive patients in our current practice.

Methods A total of 1,258 hypertensive patients were enrolled in this study. Patients with macroalbuminuria were excluded. The concentrations of urinary microalbumin and creatinine were measured. Urinary albumin excretion was expressed as the ratio of albumin to creatinine excretion.

Results The mean systolic and diastolic blood pressures were 130.9±12.7 mmHg and 74.7±8.9 mmHg, respectively. The overall prevalence of MAU was 42.8%, and it was observed in 35.8% of patients treated with a single medication. Patients with polyvascular disease exhibited a higher prevalence of MAU compared with patients with monovascular disease. The factors related to the presence of MAU included the estimated glomerular filtration rate (eGFR), systolic blood pressure, and glycated hemoglobin (HbA1c) level (odds ratios [ORs] of 0.988, 1.026, and 1.371, respectively).

Conclusion The present study showed that the prevalence of MAU among hypertensive patients was 42.8%, even in patients whose blood pressure was relatively well controlled. Additionally, the eGFR, systolic blood pressure, and HbA1c level are risk factors for the development of MAU. These findings suggest that a substantial number of hypertensive patients have MAU and highlight the importance of strictly controlling these factors to improve patient prognosis.

Key words: microalbuminuria, hypertension, chronic kidney disease

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Introduction

Epidemiological studies have shown that chronic kidney disease (CKD) is an independent risk factor for cardiovascular mortality and morbidity and that the proportion of patients with CKD has recently increased (1-3). Because coronary artery disease (CAD) remains the primary cause of mortality, much attention must be paid to the prevention and

treatment of CKD. One important point regarding CKD is that the risk of cardiovascular disease increases in both patients with end-stage renal disease (ESRD) and those with early-stage CKD (G1, G2) (2, 4, 5). Therefore, providing early detection tests and appropriate treatment for CKD is clinically meaningful. Treatment should be administered at an earlier stage to achieve a better outcome; however, the early stage of CKD is unlikely to be diagnosed in a timely manner and can be easily overlooked. Numerous studies

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have demonstrated that microalbuminuria (MAU), a powerful predictor of glomerular injury, is also a predictor for the development of renal and cardiovascular complications (6-10). This association is independent of the effects of widely accepted cardiovascular risk factors. Furthermore, the LIFE study demonstrated that reducing the level of urinary albumin excretion during treatment translated into a reduced incidence of cardiovascular events (11). However, the reported prevalence of MAU is highly variable among studied populations, ranging from 7 to 58.4% (12-14). This variation may be explained by differences in prescribed drugs and population characteristics. In particular, pharmacological therapies that have beneficial effects on blood pressure control may decrease the development of MAU. Therefore, we sought to investigate the prevalence of MAU and risk factors in Japanese hypertensive patients under current medical treatment.

Materials and Methods

The Jonan Irbesartan Microalbuminuria Study (JIMS) investigators conducted a cross-sectional, multicenter, cohort study to assess the prevalence of urinary albumin excretion in treated hypertensive patients under current medical therapy. Seven medical clinics and university-affiliated hospitals in the Jonan area of Tokyo participated in the present study, which was performed in a primary care setting. Consecutive patients with hypertension who visited each clinic/hospital were enrolled. The study was initiated in July 2009, and a total of 1,308 hypertensive patients were enrolled by the end of August 2010. The exclusion criteria included secondary hypertension, renal insufficiency with a plasma creatinine concentration >2.0 mg/dL, and persistent macroproteinuria on conventional dipstick tests of spot urine samples (positive $\geq 2+$). Patients with acute fever or concomitant urinary tract infection, who had engaged in strenuous physical activity within the preceding 24 hours, and female participants who were pregnant or menstruating were excluded due to the likely outcome of false-positive results. The patients' systolic and diastolic blood pressures were measured using a mercury manometer placed on the right arm of the seated subject after resting in a seated position for at least five minutes before measurement. Hypertension was defined as an average blood pressure $>140/90$ mmHg on at least two different occasions during routine examination. Treated diabetes was defined as diabetes treated with an oral hypoglycemic or insulin. Subjects with a fasting blood sugar level >126 mg/dL, a random blood sugar level >200 mg/dL, or a glycated hemoglobin (HbA1c) value $>6.1\%$ were also classified as diabetic. Hypercholesterolemia was defined as a total cholesterol level >240 mg/dL. Obesity was defined as a body mass index (BMI) >25 kg/m², calculated as the body weight in kilograms divided by the square of the height in meters. The study was approved by the medical ethics committee at Toho University Ohashi Medical Center (Approval number: 21-5), and all patients provided their informed con-

sent.

Laboratory findings

The patients' serum creatinine levels were measured using an enzymatic method. The glomerular filtration rate (GFR) was estimated (eGFR) based on the adjusted serum creatinine level using the simplified equation developed from the Modification of Diet in Renal Disease (MDRD) study as follows: $\text{GFR (mL/min/1.73 m}^2\text{)} = 186.3 \times (\text{serum creatinine})^{-1.154} \times \text{age}^{-0.203} \times (0.742 \text{ for female subjects})$ (15). Freshly voided urine was obtained, and dip stick urine tests were performed. Proteinuria was evaluated semiquantitatively (-, $\pm$, and +).

Quantitative measurement of the urinary albumin-to-creatinine ratio (UACR)

Each patient's urine albumin level was measured immediately after urine collection using the CLINITEK[®] Microalbumin 2 (Siemens Healthcare Diagnostics Inc., Erlangen, Germany). The CLINITEK urinary chemistry analyzer is a highly sensitive, portable, reflectance photometer-based, purely chemical albumin test strip device that assesses dye binding by albumin. The urinary dip reagent strips can be used to detect an albumin concentration between 10 and 150 mg/L in addition to simultaneously measuring the urinary creatinine concentration (16). The level of urinary albumin excretion was expressed as the ratio of albumin to creatinine excretion. The cutoff values for the presence of MAU and macroalbuminuria were 30 mg/gCr and 300 mg/gCr, respectively.

Statistical analysis

All data were sent to the professional statistical analysis department of a company independent from this study that deals with medical business. Continuous variables were expressed as the mean $\pm$ standard deviation, and categorical variables were expressed as frequencies. For comparisons between groups, Student's *t*-tests were used to evaluate differences in means, and χ^2 tests were used to evaluate differences in proportions. Regarding the prevalence of microalbuminuria according to age, bivariate χ^2 tests were used to generate a cross-table of age $\times$ CLINITEK test results. Univariate χ^2 tests were used for each stage of CKD to clarify the relationship between CKD staging and the prevalence of MAU. To test the independent relationships between MAU and the clinical variables, potential factors were selected using a univariate regression analysis, and the selected variables were assessed in a multiple logistic regression analysis model using a stepwise selection method (backward elimination method). The relationships between the risk factors and the incidence of MAU were also studied using a multiple regression method adjusted for sex and CKD stages 1 and 2. All statistical analyses were performed using the SPSS12.0 software program (SPSS Inc., Chicago, USA). A significant difference was defined as $p < 0.05$.

Table 1. Baseline Patient Demographics

	(n=1258)
Age(years)	70.0±11.5
male(%)	753(59.9)
Height(cm)	160.5±9.4
Body weight(kg)	61.8±12.1
BMI(kg/m ²)	23.9±3.5
Systolic BP(mmHg)	130.9±12.7
Diastolic BP(mmHg)	74.7±8.9
Diabetes Mellitus	452 (35.9%)
<i>Laboratory findings</i>	
WBC(μL)	6143±1629
Hb(g/dL)	14.0±1.6
Hct(%)	40.7±4.4
PLT(x10 ⁴ /μL)	21.4±6.0
eGFR(mL/min/1.73m ²)	65.2±19.1
TP(g/dL)	7.603±0.59
AST(IU/L)	23.3±10.3
ALT(IU/L)	21.609±21.2
LDH(IU/L)	373.5±125.258
γGTP(IU/L)	31.6±46.5
BUN(mg/dL)	17.2±8.5
Cr(mg/dL)	0.90±0.53
UA(mg/dL)	5.6±1.4
T-CHO(mg/dL)	188.2±32.0
TG(mg/dL)	135.8±83.4
HDL-CHO(mg/dL)	58.9±17.0
LDL-CHO(mg/dL)	103.5±27.0
GLU(mg/dL)	115.2±38.1
HbA1c(%; JDS)	5.7±0.8
<i>CKD staging</i>	
CKD stage1 (eGFR≥90)	117(9.27%)
CKD stage2 (60≤eGFR<90)	664(52.86)
CKD stage3 (30≤eGFR<60)	433(34.40)
CKD stage4 (15≤eGFR<30)	37(2.95%)
CKD stage5 (eGFR<15)	7(0.52%)
<i>Medical treatments</i>	
only diet & exercise	153(12.16)
single CB	199 (15.82)
single ARB	246 (19.56)
single ACEI	50 (3.98)
single diuretics	10(0.80)
single β blocker	22(1.75)
Single combination drug	17(1.35)
others	1(0.08)
2 medications with ARB	383(30.45)
3 medications with ARB	139(11.05)
4 medications (ARB, CB, diuretics, β blocker)	22(1.75)
more than 5 medications	16(1.27)

BMI: body mass index, BP: blood pressure, WBC: white blood cell, Hb: hemoglobin, Hct: hematocrit, PLT: platelet, eGFR: estimated glomerular filtration rate, TP: total protein, AST: aspartate aminotransferase, ALT: alanine aminotransferase, LDH: lactate dehydrogenase, γGTP: gamma-glutamyl transpeptidase, BUN: blood urea nitrogen, Cr: creatinine, UA: uric acid, T-CHO: total cholesterol TG: triglyceride, HDL-CHO: high density lipoprotein cholesterol, LDL-CHO: low density lipoprotein cholesterol, GLU: glucose, HbA1c: hemoglobin A1c, JDS: japan diabetes society, CKD: chronic kidney disease, CB: calcium channel blocker, ARB: angiotensin II receptor blocker, ACEI: angiotensin converting enzyme inhibitor

Results

Patient demographics

A total of 1,308 patients were enrolled in the present

study. Fifty patients were excluded from the analysis due to the presence of macroalbuminuria on examination. Consequently, 1,258 patients were included in the final analysis. The demographics of the registered patients are shown in Table 1. The mean age was 70.0±11.5 years, and 59.9% of the subjects were men. The mean systemic blood pressure was 130.9±12.7/74.7±8.9 mmHg, and the proportion of patients with obesity (BMI >25 kg/m²) was 30.6%. The mean HbA1c level (Japan Diabetes Society [JDS] value) was 5.7±0.79. In total, the proportions of subjects with stage 1 (eGFR >90 mL/min/1.73 m²), stage 2 (eGFR 60-89 mL/min/1.73 m²), stage 3 (eGFR 30-60 mL/min/1.73 m²), stage 4 (eGFR 15-30 mL/min/1.73 m²), and stage 5 (eGFR <15 mL/min/1.73 m²) disease were 9.27%, 52.86%, 34.40%, 2.95%, and 0.52%, respectively. A total of 47.72% of the patients were treated with single antihypertensive drugs, and the remaining patients were treated with multiple medications. The majority of patients treated with monotherapy were prescribed angiotensin receptor blockers (ARBs, 19.56%), angiotensin-converting enzyme inhibitors (ACEIs, 3.98%), or calcium channel blockers (15.82%).

Prevalence of urine albumin excretion

The study cohort included subjects with conventional spot urine dip stick test results of ± and + (5.8% and 5.0%, respectively). The prevalence of MAU in these subjects is shown in Table 2. Not all patients with positive urinary dip stick protein tests (± or +) had positive Clinitek MAU tests. The rate of positive Clinitek MAU results was 85.7% among the patients with positive urinary dip stick protein test results.

In addition, the Clinitek urinary dipstick test revealed that 42.8% of the total study population had evidence of MAU, with a prevalence rate of 38.1% among the subjects with negative proteinuria results on ordinary urine dip stick tests. MAU was prevalent across all age groups, and the proportion of subjects with MAU increased in association with age and CKD stage (Fig. 1, 2).

Relationships between MAU and clinical variables

Table 3 presents the profiles of the subjects with MAU. There was a significant decrease in the incidence of MAU among the patients treated with a single ARB or ACEI or a combination agents, most of which included ARBs. Regarding the relationship between the prevalence of MAU and vascular events, patients with peripheral artery disease (PAD) were more likely to be positive for MAU. In addition, patients with polyvascular disease tended to be positive for MAU; however, no statistical differences were observed. A univariate logistic regression analysis revealed that the following factors were associated with the presence of MAU: age, male gender, height, body weight, systolic blood pressure, eGFR, blood urea nitrogen (BUN), plasma glucose level, HbA1c level, a diagnosis of diabetes, and the presence of PAD (Table 4). A multiple logistic regression model with a stepwise selection method (backward elimination) identi-

Table 2. The Prevalence of MAU and Spot Urine Dip Stick Test

		Clinitek (-)			Clinitek (+)		
		number	ratio	negative rate	number	ratio	positive rate
qualitative U-TP	±	15	1.19%	20.5%	58	4.61%	79.5%
	+	9	0.72%	14.3%	54	4.29%	85.7%
total number for analysis		1258	100.00%		1258	100.00%	

MAU: microalbuminuria

U-TP: urinary total protein

Figure 1. Prevalence of MAU according to age. MAU was prevalent across all age groups and increased with age. MAU: microalbuminuria **Figure 2.** CKD stages and the prevalence of MAU. MAU was prevalent across all CKD groups and increased in association with the CKD stage. CKD: chronic kidney disease, MAU: microalbuminuria. Stage 1, $p=0.016$; Stage 2, $p<0.001$; Stage 3, $p=0.014$; Stage 4, $p=0.006$; Stage 5, $p=0.219$.

fied eGFR, systolic blood pressure, and HbA1c level as independent factors. The risk of developing MAU increased 1.026 times with each 1-mmHg increase in systolic blood pressure. Conversely, a 0.1-mL/min/1.73 m² increase in eGFR was associated with a 0.988-fold decrease in the risk of MAU (Table 5). Systolic blood pressure, HbA1c level, and eGFR were identified to be risk factors of MAU positivity according to a multivariate regression analysis adjusted for sex.

Discussion

The present study was an observational study of patients with treated hypertension in real-world practice in Japan. The main findings of the present study are as follows: 1) the prevalence of albuminuria was 42.8%; 2) the presence and absence of dip stick proteinuria were 85.7% and 38.1% in patients with MAU, respectively; and 3) the independent factors for MAU were eGFR, systolic blood pressure, and HbA1c. It has been shown that albuminuria is more sensitive than proteinuria in detecting CKD; therefore, screening programs to identify the disease before the clinical phase are meaningful, but there have been no direct comparisons between proteinuria and MAU in terms of utility.

In the present study, MAU was detected in 38.1% of the spot urine samples in patients with negative dip stick proteinuria results. Therefore, the present study confirmed the findings of a previous study showing the relationship between ordinary dip stick proteinuria and MAU (17).

Prevalence of MAU

The incidence of MAU was 42.8% in the present study. This finding suggests that the early stage of CKD is often overlooked and therefore is clinically underdiagnosed. The reported prevalence of MAU in hypertensive populations exceeds that observed in the general population (12-14, 18-20). However, the prevalence of MAU in hypertensive patients is highly variable among studies, with a range of 26.6 to 58.4% (14, 19, 20).

Several factors can affect the results of investigations. Aging is recognized as an independent risk factor for renal disease resulting from glomerular ischemia secondary to renal blood flow changes that occur with age. In addition, it has been demonstrated that the prevalence of MAU increases with age (13, 14). The mean age of the present cohort was approximately 70 years, which was older than that evaluated in previous studies. A total of 38.4% of the enrolled population was diabetic, whereas other studies excluded diabetic patients (21, 22). Additionally, the prevalence of subjects with moderate or severe renal insufficiency, which is also a reported predictor of albuminuria, was as high as 31.9% among the total patient population. Furthermore, hypertensive patients with known atherosclerotic disease were included in the present study. Therefore, the current cohort is likely to represent hypertensive populations encountered in real-world practice. On the other hand, the mean blood pressure was 130.9±21.7 mmHg in our cohort. In the i-SERACH study, 58.4% of patients had albuminuria, and the

Table 3. MAU and Patient Characteristics

	MAU(-)	MAU(+)	p value
Total number(%)	719(57.2)	539(42.8)	
age(years)	68.3±11.3	72.2±11.3	<0.001
male gender(%)	468(65.2)	285(53.0)	<0.001
height(cm)	161.5±9.2	159.0±9.4	<0.001
body weight(kg)	62.7±11.7	60.6±12.4	0.004
BMI(kg/m ²)	23.9±3.3	23.9±3.9	*0.802
systolic BP(mmHg)	129.3±12.2	132.8±13.2	<0.001
diastolic BP(mmHg)	74.9±8.9	74.4±9.0	0.335
diabetes mellitus	224(49.6%)	228(50.4%)	0.851
<i>laboratory findings</i>			
eGFR(ml/min/1.73m ²)	67.1±17.7	62.7±20.6	<0.001
AST(IU/L)	23.8±12.0	22.6±7.2	0.044
ALT(IU/L)	22.2±20.6	20.9±22.0	0.313
BUN(mg/dL)	16.7±8.6	18.1±8.4	0.009
Cr(mg/dL)	0.87±0.52	0.94±0.55	0.004
Glucose(mg/dL)	113±36	119±40	0.016
HbA1c(JDS)	5.59±0.71	5.83±0.87	<0.001
<i>medication</i>			
no medication			
single CB	57.4%	42.6%	0.059
single ARB	61.7%	38.3%	0.001
single ACEI	70.7%	29.3%	0.008
single diuretics	50.0%	50.0%	**1.000
single β blocker	66.7%	33.3%	0.157
Single combination drug	78.6%	21.4%	0.033
<i>vascular events</i>			
IHD	60.4%	39.6%	0.001
CVD	55.6%	44.4%	0.378
PAD	37.5%	62.5%	0.317
IHD+CVD	54.2%	45.8%	0.564
IHD+PAD	44.1%	55.9%	0.493
IHD+CVD+PAD	37.5%	62.5%	0.317

BMI: body mass index

*Welch t test

BP: blood pressure

GFR: glomerular filtration rate

AST: aspartate aminotransferase

ALT: alanine aminotransferase

BUN: blood urea nitrogen

Cr: creatinine

JDS: Japan Diabetes Society

CB: calcium channel blocker

ARB: angiotensin II receptor blocker

ACEI: angiotensin converting enzyme inhibitor

**Fisher's exact test

IHD: ischemic heart disease

CVD: cerebrovascular disease

PAD: peripheral artery disease

Table 5. Multivariate Analysis for the Presence of MAU

Factor	OR	95%CI	p value
Systolic BP	1.026	1.012-1.041	<0.001
HbA1c	1.371	1.082-1.736	0.009
eGFR	0.988	0.978-0.998	0.016

MAU: microalbuminuria

OR: odds ratio

CI: confidence interval

BP: blood pressure

GFR: glomerular filtration rate

Table 4. Univariate Analysis for Related Factors on MAU

Variable	OR	95%CI	p value
Age	1.030	1.019-1.042	<0.001
Gender	1.698	1.332-2.164	<0.001
Height	0.971	0.958-0.985	<0.001
Body weight	0.987	0.977-0.998	0.018
systolic BP	1.025	1.015-1.035	<0.001
diastolic BP	1.003	0.991-1.016	0.593
eGFR	0.988	0.981-0.995	<0.001
BUN	1.019	1.001-1.039	0.044
Glu	1.004	1.001-1.008	0.021
HbA1c (JDS)	1.449	1.197-1.753	<0.001
DM	1.620	1.284-2.044	<0.001
PAD	1.925	1.169-3.170	0.010

MAU: microalbuminuria

OR: odds ratio

CI: confidence interval

BP: blood pressure

GFR: glomerular filtration rate

BUN: blood urea nitrogen

JDS: Japan Diabetes Society

DM: diabetes mellitus

PAD: peripheral artery disease

were included (14). Therefore, an incidence of albuminuria of 42% in our relatively well-controlled hypertensive population suggests a remarkably high prevalence of MAU in current practice. Another possible explanation for this high value is methodological differences, including urine sample collection. Furthermore, the diagnostic criteria may have affected the outcomes in our series. Weir et al. reported an incidence of MAU of 40% among Asian hypertensive diabetic patients (23). Konta et al. also demonstrated a higher prevalence of MAU in the Japanese general population (13). Therefore, it is possible that Asian populations are susceptible to MAU.

Risk factors of MAU

The results of the present study also demonstrated that, among hypertensive patients, the risk of developing MAU is significantly greater if the patient also has a low eGFR. Age was not determined to be a risk factor of MAU in multiple regression analysis because it was considered a confounding factor. The eGFR value is calculated with age and serum creatinine levels, so age itself is a confounder for eGFR. This is the reason why age did not appear in the final multiple regression analysis results. These data suggest the presence of strong and independent influences of systemic arterial pressure on urinary albumin excretion, which is consistent with the findings of a recent report showing that the development of MAU is linked to insufficient blood pressure control in patients with essential hypertension (24, 25).

A relationship between obesity and urinary albumin excretion was reported in a large cross-sectional study, while a correlation between weight loss and decreased proteinuria has also been documented (26). Obesity affects the renal glomerular filtration rate, renal blood flow, and the development of renal hypertrophy and is known to have a negative impact on renal disease. Furthermore, Ramirez et al. re-

mean blood pressure was 149.2±20.2 mmHg. In addition, a total of 76.8% of the uncontrolled hypertensive patients

ported a J-shaped relationship between BMI and the prevalence of proteinuria (18). In the present study, 30.6% of patients had a BMI >25 kg/m², and the adjusted risk factors of MAU were unclear when BMI was considered as a continuous variable.

Recent investigations have demonstrated that strict blood pressure control reduces the level of proteinuria and prevents the progression of ESRD (11, 27-29). In this analysis, the mean systolic blood pressures of patients with positive and negative MAU results were $132.8 \pm 13.2/74.4 \pm 9.0$ mmHg and $129.3 \pm 12.2/74.9 \pm 8.9$ mmHg, respectively. Therefore, the difference in the mean systolic blood pressure between the two groups was 3.5 mmHg. These findings confirm the importance of strictly controlling blood pressure to prevent glomerular injury. MAU was more frequently observed in men than women, which is consistent with a previous study reporting that men have a higher risk of developing ESRD and tend to develop ESRD earlier in life than women (30). Therefore, we performed a multiple logistic regression analysis adjusted for sex and CKD stages 1 and 2, and the identified risk factors remained the same. These findings strongly suggest that blood pressure and glucose levels should be managed more strictly in the early phase of hypertension.

It has been reported that certain classes of antihypertensive medications, such as ACEIs and ARBs, reduce proteinuria (21, 27-29). However, there were no clear differences in renal function preservation effects between drugs in this study. Because information regarding the dose and duration of prescribed medications and the duration of a hypertensive status was not available, we were unable to further assess the possibility of differences in the class effects of antihypertensive drugs.

Other important contributions to an increased prevalence of MAU were the comorbidities of PAD and diabetes. Murakami et al. demonstrated that the brachial-ankle pulse wave velocity is an independent risk factor for MAU (19). Diabetes is a well-known predictor of proteinuria, and it has been shown that strictly controlling glucose levels can reduce and prevent proteinuria (26, 31). These findings are consistent with the results of the present study. MAU was more frequently observed in patients with polyvascular disease. It has been demonstrated that a lower ankle-brachial index is associated with a greater risk of cardiovascular complications. Moreover, in the REACH registry, the incidence of future cardiovascular events was higher among patients with polyvascular disease than those with monovascular disease (32). Taken together, the proposed hypothesis that MAU is a marker of more generalized and widespread endothelial dysfunction and atherosclerosis is consistent with the findings of the present study. Moreover, the view that MAU is an independent risk factor for atherosclerotic disease and carries prognostic information beyond that of other risk factors is supported by our data. Therefore, clinicians should strive to achieve better control of the blood pressure and glucose levels to prevent MAU among patients seen in

their daily practice.

Limitations

There are several limitations that should be considered. First, this was an observational study, and there may be selection bias in our study population. This somewhat limits the ability to generalize the present study outcomes; however, we enrolled consecutive outpatients, meaning our results are likely to represent actual findings. Second, the urinalyses were only performed once, which does not comply with the requirement for multiple urine collections to diagnose MAU (33). However, Brantsma et al. reported that a single measurement has sufficient power to predict future prognosis (34). Third, single measurements of UACR may overestimate the prevalence of MAU in patients with a low level of creatinine excretion, such as females and the elderly. Fourth, the eGFR values determined using the simplified prediction equation derived from the MDRD study might not have been sufficiently correct because they were based on single blood samples. However, this equation is considered to be the most precise (35). Finally, no information regarding the severity or duration of hypertension was obtained in the present study.

Conclusion

The present study showed that the prevalence of MAU among hypertensive patients was 42.8%, even in those with relatively well controlled blood pressure. In addition, the risk factors for the presence of MAU include eGFR, systolic blood pressure, and HbA1c level. These findings suggest that a substantial number of patients with CKD have MAU. Early detection and awareness of this sensitive marker are quite important for the management of hypertensive patients in real-world practice.

The authors state that they have no Conflict of Interest (COI).

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