Section: General Medicine

Original Research Article

A STUDY ON MICROALBUMINURIA IN SYSTEMIC HYPERTENSION AS AN INDICATOR OF TARGET ORGAN DAMAGE

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ABSTRACT

Background: Systemic hypertension is a major cause of cardiovascular, cerebrovascular, and renal complications. Microalbuminuria may reflect early vascular and renal injury and could serve as a simple marker of hypertension-mediated target-organ damage. **Aim/Objectives:** To determine the prevalence of microalbuminuria in patients with systemic hypertension and assess its relationship with target-organ damage, particularly cardiac and cerebral involvement.

Materials and Methods: A hospital-based prospective observational study was conducted among 100 adults with essential hypertension at the Department of General Medicine, Katihar Medical College and Hospital, Bihar, from March 2024 to August 2025. Clinical evaluation, blood pressure measurement, ECG, CT brain where indicated, echocardiography, and urinary albumin assessment were performed. Urinary albumin-to-creatinine ratio was measured using a first-morning urine sample.

Results: Microalbuminuria was present in 90 (90%) patients and absent in 10 (10%). ECG-LVH was present in 52 (52%) patients, all of whom had microalbuminuria ($p<0.05$). CT evidence of cerebral infarction was present in 32 (32%), and all had microalbuminuria ($p<0.05$). Overall, target-organ damage was identified in 92 (92%) patients, including 90 (97.8%) with microalbuminuria, compared with none of the 8 patients without target-organ damage ($p<0.05$).

Conclusion: Microalbuminuria was highly prevalent and significantly associated with target-organ damage, supporting its potential role as an early marker of hypertensive organ involvement.

Keywords: Microalbuminuria; Hypertension; Target-organ damage; UACR; Left ventricular hypertrophy; Cerebral infarction.

INTRODUCTION

Systemic hypertension is one of the most important modifiable risk factors for cardiovascular, cerebrovascular, and renal morbidity worldwide. Despite substantial advances in detection and treatment, hypertension remains highly prevalent and a large proportion of affected individuals continue to have inadequately controlled blood pressure. Global data demonstrate a persistent burden of hypertension, emphasizing the importance of identifying early, clinically silent organ involvement before irreversible complications develop.[1] Hypertension-mediated organ damage (HMOD) may involve the heart, kidneys, brain, retina, and vasculature and can develop even before overt cardiovascular or renal disease becomes clinically apparent.[2]

The kidney is particularly vulnerable to sustained elevations in blood pressure because of its extensive microvascular network. Albuminuria represents abnormal leakage of albumin through the

glomerular filtration barrier and may reflect early renal and systemic vascular injury. Contemporary evidence suggests that albuminuria is not merely a marker of established kidney disease but may also provide information regarding generalized endothelial dysfunction and cardiovascular risk.[3] In hypertensive individuals, increased urinary albumin excretion has been associated with adverse cardiovascular outcomes, renal disease progression, and a greater burden of target organ damage. Recent evidence further supports the prognostic relevance of microalbuminuria in essential hypertension and its potential role in identifying patients at increased risk of cardiovascular and renal complications.[4]

The urinary albumin-to-creatinine ratio (ACR), particularly when measured in a first-morning urine sample, provides a practical and relatively non-invasive method for detecting increased urinary albumin excretion. Current kidney disease guidance emphasizes standardized assessment of albuminuria for renal risk stratification, while recognizing its broader cardiovascular significance.[5] Similarly, contemporary hypertension guidelines recommend systematic evaluation for hypertension-mediated organ damage as an important component of cardiovascular risk assessment.[2,6]

The present study aimed to determine the prevalence of microalbuminuria among patients with systemic hypertension and to examine its association with hypertension-related target organ damage. It also sought to assess the clinical significance of microalbuminuria as an early marker of otherwise subclinical organ involvement. By evaluating urinary albumin excretion alongside relevant clinical and cardiovascular findings, the study aimed to explore its potential usefulness in the early identification of hypertensive complications.

MATERIALS AND METHODS

Study design: This was a hospital-based prospective observational study conducted to assess the prevalence of microalbuminuria among patients with systemic hypertension and to evaluate its association with hypertension-related target organ damage.

Study population: The study included adult patients diagnosed with essential hypertension who attended the outpatient and inpatient departments of the Department of General Medicine. Both male and female patients were considered for participation after fulfilling the predefined eligibility criteria.

Sample size: A total of 100 patients with essential hypertension were enrolled in the study.

Study duration: The study was conducted over 18 months, from March 2024 to August 2025.

Study setting/location: The study was carried out in the Department of General Medicine, Katihar Medical College and Hospital, Katihar, Bihar, India, a tertiary care teaching hospital serving both rural and urban populations.

Inclusion Criteria

1. Adults aged >18 years.
2. Patients of either sex.
3. Patients with newly diagnosed hypertension detected during routine examination or hospital evaluation.
4. Patients fulfilling the predefined eligibility criteria.
5. Patients who provided written informed consent to participate in the study.

Exclusion Criteria

1. Patients with secondary hypertension, irrespective of the underlying cause.
2. Patients with diabetes mellitus.
3. Patients with acute coronary syndrome.
4. Patients with acute kidney injury (AKI).
5. Patients with chronic kidney disease (CKD).
6. Patients with urinary tract infection (UTI).
7. Patients with macroproteinuria.
8. Pregnant women.
9. Smokers.
10. Individuals with a history of alcohol consumption.

Statistical Analysis

Data collected from the study participants were entered into a structured database and analyzed using appropriate descriptive and inferential statistical methods. Categorical variables, including age groups, sex, duration of hypertension, BMI categories, blood-pressure categories, microalbuminuria, ECG-detected LVH, CT evidence of cerebral infarction, and overall target-organ damage, were summarized as frequencies and percentages. The association between microalbuminuria and individual target-organ parameters was assessed using the Chi-square test or Fisher's exact test, as appropriate based on the expected cell frequencies. A p-value <0.05 was considered statistically significant. Continuous variables, where applicable, were summarized using mean and standard deviation or median and interquartile range depending on data distribution. The analysis was primarily aimed at determining the prevalence of microalbuminuria and evaluating whether its presence was significantly associated with evidence of hypertension-mediated target-organ damage.

RESULTS

Table 1: Sociodemographic and Clinical Characteristics of the Study Population

Parameter	Category	No. of Patients (N)	Percentage (%)
Age (years)	18–30	23	23
	31–45	33	33
	46–60	22	22

	>60	22	22
	Total	**100**	**100**
Gender	Male	59	59
	Female	41	41
	Total	**100**	**100**
Duration of HTN (years)	0–2	16	16
	3–5	20	20
	6–10	27	27
	>10	37	37
	Total	**100**	**100**
BMI (kg/m²)	<23	19	19
	23–27.4	32	32
	27.5–32	33	33
	>32	16	16
	Total	**100**	**100**

Table 2: Blood Pressure, BMI and Urinary Albumin Excretion Characteristics

Parameter	Category	No. of Patients (N)	Percentage (%)
SBP (mmHg)	140–149	16	16
	150–159	22	22
	160–169	21	21
	≥170	41	41
	Total	**100**	**100**
DBP (mmHg)	90–99	40	40
	100–109	26	26
	110–119	34	34
	Total	**100**	**100**
UACR (mg/g)	<30	10	10
	30–100	27	27
	101–200	30	30
	201–300	33	33
	Total	**100**	**100**
Microalbuminuria	No	10	10
	Yes	90	90
	Total	**100**	**100**

Table 3: Association of Target-Organ Parameters with Microalbuminuria

Target-organ parameter	Category	Microalbuminuria No, n	Microalbuminuria Yes, n	Total, n	p-value
ECG-LVH	No	10	38	48	**<0.05**
	Yes	0	52	52	
	Total	**10**	**90**	**100**	
CT Brain Infarct	No	10	58	68	**<0.05**
	Yes	0	32	32	
	Total	**10**	**90**	**100**	

Table 4: Overall Association of Target-Organ Damage with Microalbuminuria

Target Organ Damage	Microalbuminuria No, n	Microalbuminuria Yes, n	Total, n	p-value
No target-organ damage	8	0	8	**<0.05**
Target-organ damage present	2	90	92	
Total	**10**	**90**	**100**	

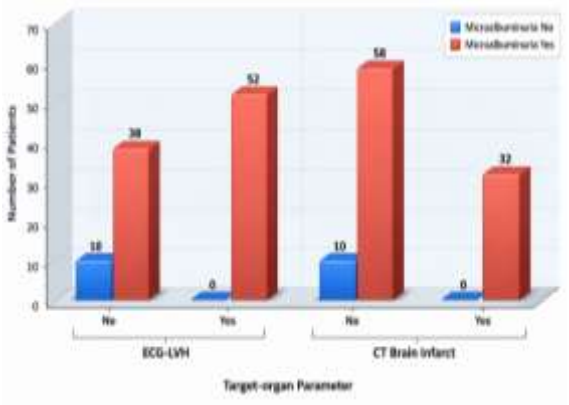

Figure 1: Association of Target-Organ Parameters with Microalbuminuria

Figure 2: Overall Association of Target-Organ Damage with Microalbuminuria

Among the 100 patients included in the study, the largest proportion belonged to the 31–45-year age group (33%), followed by those aged 18–30 years (23%), while patients aged 46–60 years and >60 years each accounted for 22%. A male predominance was observed, with 59 males (59%) compared with 41 females (41%). Regarding the duration of hypertension, 37% of patients had hypertension for >10 years, followed by 27% with a duration of 6–10 years, 20% with 3–5 years, and 16% with 0–2 years. In terms of BMI, 33% of participants had a BMI of 27.5–32 kg/m², while 32% were in the 23–27.4 kg/m² range. A BMI of <23 kg/m² was observed in 19%, whereas 16% had a BMI >32 kg/m². Overall, the study population showed a predominance of middle-aged individuals, males, longer-standing hypertension, and higher BMI categories.

The distribution of blood pressure showed that a substantial proportion of patients had markedly elevated systolic blood pressure. Forty-one patients (41%) had an SBP of ≥170 mmHg, followed by 21% with SBP of 160–169 mmHg, 22% with 150–159 mmHg, and 16% with 140–149 mmHg. For diastolic blood pressure, 40% of patients had values between 90–99 mmHg, 26% had 100–109 mmHg, and 34% had 110–119 mmHg. Urinary albumin excretion was also considerably elevated in the study population. The UACR was <30 mg/g in 10% of patients, while 27% had values of 30–100 mg/g, 30% had 101–200 mg/g, and 33% had 201–300 mg/g. Overall, microalbuminuria was present in 90 patients (90%), whereas only 10 patients (10%) had no microalbuminuria, indicating a high prevalence of increased urinary albumin excretion among the hypertensive patients studied.

A significant association was observed between microalbuminuria and the target-organ parameters evaluated. Left ventricular hypertrophy (LVH) on ECG was present in 52 patients, all of whom had microalbuminuria, while none of the patients without microalbuminuria had ECG evidence of LVH. Among the 48 patients without ECG-LVH, 38 had microalbuminuria and 10 did not. This association was statistically significant ($p<0.05$), suggesting that microalbuminuria was strongly associated with cardiac target-organ involvement in the study population. Similarly, CT evidence of brain infarction was present in 32 patients, and all 32 had microalbuminuria. Of the 68 patients without CT-detected brain infarction, 58 had microalbuminuria, while 10 did not. This relationship was also statistically significant ($p<0.05$), indicating an association between microalbuminuria and cerebrovascular target-organ involvement.

The overall analysis demonstrated a strong and statistically significant relationship between microalbuminuria and the presence of target-organ damage. Of the 92 patients with target-organ damage, 90 (97.8%) had microalbuminuria, while only 2 patients with target-organ damage did not have microalbuminuria. In contrast, among the 8 patients without target-organ damage, none had microalbuminuria, while all 8 were classified as not having microalbuminuria. The association was statistically significant ($p<0.05$). These findings indicate that microalbuminuria was markedly more frequent among patients with evidence of target-organ damage and may therefore serve as an early indicator of hypertension-related organ involvement.

DISCUSSION

The present study evaluated 100 patients with systemic hypertension to determine the prevalence of microalbuminuria and its relationship with hypertension-mediated target-organ damage. Overall, microalbuminuria was detected in 90% of patients, and its presence was significantly associated with ECG-detected LVH, CT evidence of cerebral infarction, and overall target-organ damage. The findings therefore support the clinical relevance of urinary albumin excretion as a marker of subclinical vascular and organ involvement in hypertension.

In the present study, the largest age group was 31–45 years (33%), followed by 18–30 years (23%), while patients aged 46–60 years and >60 years each represented 22%. Thus, a considerable proportion of the study population consisted of relatively young and middle-aged adults. Male patients predominated, accounting for 59%, compared with 41% females. Hypertension duration was relatively long in many participants, with 37% having hypertension for >10 years and another 27% having the disease for 6–10 years. Higher BMI was also common, with 33% of patients having a BMI of 27.5–32 kg/m² and 16% having BMI >32 kg/m².

These findings are broadly consistent with the recognized relationship between longer hypertension exposure, adverse metabolic characteristics, and hypertension-mediated organ damage. In a community-based study, hypertension-mediated organ damage was found to increase with higher systolic blood pressure and age, and albuminuria frequently occurred alongside other forms of organ involvement.[7] Similarly, an Indian study of patients with essential hypertension reported that microalbuminuria was associated with older age, longer duration and greater severity of hypertension, as well as higher BMI.[8] The somewhat younger age distribution in the present study may reflect the hospital-based nature of the sample and the inclusion of patients detected at different stages of hypertension. Nevertheless, the high proportion of patients with longstanding hypertension emphasizes the cumulative effect of sustained blood-pressure elevation on vascular and renal structures.

Markedly elevated blood pressure was common in the present study. Forty-one percent of patients had an SBP ≥170 mmHg, while 21% had SBP of 160–

169 mmHg. Regarding DBP, 34% had values between 110 and 119 mmHg and 26% had values between 100 and 109 mmHg. Thus, a substantial proportion of participants had poorly controlled or severe hypertension. Importantly, 90% of the study population had microalbuminuria, with UACR values of 30–100 mg/g in 27%, 101–200 mg/g in 30%, and 201–300 mg/g in 33%.

The prevalence observed in the present study is considerably higher than that reported in several earlier studies. An Indian tertiary-care study involving 100 patients with essential hypertension reported microalbuminuria in 47% of participants and found higher age, systolic blood pressure, and mean arterial pressure to be important correlates.[9] Another Indian study of newly diagnosed hypertensive patients reported microalbuminuria in 51.88% of cases.[10] The very high prevalence of 90% in the present study may therefore reflect the particularly high blood-pressure burden and the clinical characteristics of this hospital-based population. It should also be interpreted cautiously because the present study did not include a normotensive comparison group.

The association between blood-pressure burden and albuminuria is biologically plausible. Persistent elevation of intraglomerular pressure can impair the glomerular filtration barrier and increase urinary albumin leakage. Recent evidence has further reinforced the prognostic significance of albuminuria in hypertension; a meta-analysis involving nearly 20,000 hypertensive patients found that microalbuminuria was associated with increased risks of major adverse cardiovascular events and all-cause mortality.[11] A recent review likewise emphasized the relationship of microalbuminuria with increasing blood pressure, endothelial dysfunction, renal disease progression, stroke, and cardiovascular events.[4]

A particularly strong relationship was observed between microalbuminuria and cardiac target-organ damage. ECG-LVH was present in 52 patients, and all 52 had microalbuminuria, whereas none of the 10 patients without microalbuminuria had ECG-LVH. Among patients without ECG-LVH, 38 had microalbuminuria and 10 did not. This association was statistically significant ($p<0.05$).

The present finding is consistent with recent Indian evidence. Moidu et al. reported a significant association between microalbuminuria and concentric LVH in patients with primary hypertension, with microalbuminuria remaining an independent risk factor for LVH after multivariable analysis.[12] Another recent study also found that microalbuminuria was particularly common among hypertensive patients with LVH and concluded that assessment of microalbuminuria may help identify patients with greater cardiac target-organ involvement.[13] Earlier work similarly demonstrated that hypertensive patients with microalbuminuria had greater left ventricular mass and other evidence of subclinical vascular injury.[14]

The strength of the association in the present study may be partly related to the high prevalence of severe hypertension. Chronic pressure overload increases left ventricular afterload and promotes myocardial hypertrophy, while systemic endothelial and microvascular dysfunction may simultaneously increase urinary albumin leakage. Thus, albuminuria and LVH may represent parallel manifestations of prolonged hypertension-mediated vascular injury rather than isolated abnormalities of the kidney.

The study also demonstrated a significant association between microalbuminuria and cerebrovascular target-organ involvement. CT evidence of brain infarction was present in 32 patients, and all 32 had microalbuminuria. Among the 68 patients without CT-detected infarction, 58 had microalbuminuria and 10 did not. The association was statistically significant ($p<0.05$).

These findings are in agreement with previous research linking albuminuria with cerebrovascular complications of hypertension. In an Indian study specifically examining microalbuminuria and target-organ damage, patients with microalbuminuria had substantially greater odds of stroke, together with higher frequencies of LVH and hypertensive retinopathy.[8] More recent evidence also identifies albuminuria as an important marker of cardiovascular and cerebrovascular risk in hypertensive individuals, with microalbuminuria associated with increased risks of major cardiovascular outcomes, including stroke.[11,4]

The observed relationship may be explained by the fact that albuminuria reflects generalized endothelial and microvascular injury. The same pathological processes that increase glomerular permeability may contribute to cerebral small-vessel disease, atherosclerotic vascular changes, and ischemic brain injury. Therefore, the presence of microalbuminuria in a hypertensive patient may indicate a broader burden of vascular damage rather than renal involvement alone.

The most important finding of the present study was the strong association between microalbuminuria and overall target-organ damage. Target-organ damage was present in 92 patients, of whom 90 had microalbuminuria and only 2 did not. In contrast, among the 8 patients without target-organ damage, none had microalbuminuria. This association was statistically significant ($p<0.05$).

These findings strongly support the proposed role of microalbuminuria as an indicator of hypertension-mediated organ injury. A large community-based study demonstrated that microalbuminuria frequently clusters with other manifestations of hypertension-mediated organ damage, including LVH and abnormal brain imaging findings.[7] Similarly, earlier Indian research showed that microalbuminuria was associated with several forms of target-organ damage, including stroke and LVH.[8] The recent literature also continues to support the prognostic value of microalbuminuria

for identifying hypertensive patients at increased risk of cardiovascular events and mortality.[11,4] However, the magnitude of the association in the present study should be interpreted in light of the study design and sample size. The cross-sectional assessment of target-organ damage and microalbuminuria demonstrates a significant association but cannot establish that microalbuminuria directly causes organ damage. In addition, the unusually high prevalence of microalbuminuria may have amplified the observed relationship. Nevertheless, the consistent association across cardiac, cerebral, and overall target-organ parameters suggests that urinary albumin excretion may serve as a simple and clinically useful marker for identifying hypertensive patients who warrant more comprehensive evaluation for target-organ involvement.

CONCLUSION

The present study demonstrates that microalbuminuria is highly prevalent among patients with systemic hypertension and is strongly associated with hypertension-mediated target-organ damage. Ninety percent of the participants had microalbuminuria, while significant associations were observed with ECG-detected left ventricular hypertrophy and CT evidence of cerebral infarction. Overall, microalbuminuria was present in almost all patients with target-organ damage, highlighting its potential value as an early marker of systemic vascular injury. Routine assessment of urinary albumin excretion, particularly through UACR, may therefore help identify hypertensive patients at increased risk of silent organ involvement and facilitate timely evaluation, closer monitoring, and appropriate management.

REFERENCES

1. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in hypertension prevalence and progress in treatment and control from 1990 to 2019: a pooled analysis of 1201 population-representative studies with 104 million participants. Lancet. 2021;398(10304):957-980.
2. McEvoy JW, McCarthy CP, Bruno RM, Brouwers S, Canavan MD, Ceconi C, et al. 2024 ESC Guidelines for the management of elevated blood pressure and hypertension. Eur Heart J. 2024;45(38):3912-4018.
3. Claudel SE, Verma A. Albuminuria in cardiovascular, kidney, and metabolic disorders: a state-of-the-art review. Circulation. 2025;151(10):716-732.
4. Dimitriadis K, Pyrpyris N, Vakka A, Iliakis P, Theofilis P, Tatakis F, et al. Microalbuminuria as a prognostic marker in essential hypertension. Curr Med Chem. 2025;32(39):8855-8884.
5. Levin A, Ahmed SB, Carrero JJ, Foster B, Francis A, Hall RK, et al. Executive summary of the KDIGO 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease: known knowns and known unknowns. Kidney Int. 2024;105(4):684-701.
6. Unger T, Borghi C, Charchar F, Khan NA, Poulter NR, Prabhakaran D, et al. 2020 International Society of Hypertension global hypertension practice guidelines. J Hypertens. 2020;38(6):982-1004.
7. Fagard RH, Celis H, Thijs L, Wouters S, et al. Hypertension-mediated organ damage: prevalence, correlates, and prognosis in the community. Hypertension. 2022;79(4):886-896.
8. Kumar R, et al. Microalbuminuria in patients with essential hypertension and its relationship to target organ damage: an Indian experience. J Assoc Physicians India. 2008;56:587-592.
9. Gupta R, et al. Prevalence and clinical correlates of microalbuminuria in patients with essential hypertension: a tertiary care center cross-sectional study. J Clin Diagn Res. 2018.
10. Majumdar A, et al. Prevalence and association of microalbuminuria in essential hypertensive patients. J Clin Diagn Res. 2012;6:1652-1655.
11. Wang Y, et al. Association of microalbuminuria and adverse outcomes in hypertensive patients: a meta-analysis. Hypertens Res. 2021;44:450-460.
12. Moidu A, et al. Microalbuminuria as an independent risk factor for developing concentric left ventricular hypertrophy in primary hypertension: a single-center observational study from South India. Cureus. 2022;14:e22882.
13. Prevalence of microalbuminuria in patients of essential hypertension and its correlation with left ventricular hypertrophy and carotid artery intima-media thickness. Cureus. 2023.
14. Pontremoli R, Nicolella C, Viazzi F, Ravera M, Sofia A, Berruti V, et al. Microalbuminuria is an early marker of target organ damage in essential hypertension. Am J Hypertens. 1998;11(4 Pt 1):430-435.