Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/pgm39060

IMPACT OF SMOKING ON RENAL FUNCTION: A COMPARATIVE STUDY USING PROTEIN-CREATININE RATIO AND MICROALBUMIN AS BIOMARKERS

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ABSTRACT

Introduction: Cigarette smoking has been implicated in the pathogenesis of renal dysfunction, contributing to glomerular and tubular injury. Microalbuminuria serves as an early indicator of endothelial dysfunction and renal damage. The protein-creatinine ratio (PCR) offers a reliable and convenient method for assessing proteinuria in a single urine sample.

Aim and Objectives: To assess the prevalence of microalbuminuria and elevated protein-creatinine ratio in smokers, and to compare these findings with the duration and intensity of smoking exposure.

Methodology: A cross-sectional observational study was conducted involving 100 adult male participants aged 20–50 years, including 50 smokers and 50 age-matched non-smokers. Early morning midstream urine samples were collected for estimation of microalbumin (using immunoturbidimetric method) and urine protein and creatinine (for calculating PCR). Smoking history was obtained via structured questionnaire, and pack-years were calculated.

Conclusion: The study demonstrated a statistically significant increase in microalbuminuria and urine PCR in smokers compared to non-smokers. These findings reinforce the importance of routine renal function monitoring in smokers to facilitate early intervention and prevent long-term complications.

Keywords: Smokers, Microalbuminuria, Protein Creatinine Ratio, Kidney Function, Pack-Years, Early Nephropathy

INTRODUCTION

Cigarette smoking remains one of the most widespread preventable causes of morbidity and mortality worldwide [1]. Its adverse effects are well-documented in the cardiovascular and respiratory systems, but emerging evidence has also highlighted its detrimental impact on renal function [2]. Chronic exposure to the toxic constituents of tobacco smoke contributes to endothelial dysfunction, oxidative stress, and inflammation, which may progressively damage renal structures [3,4]. Microalbuminuria, defined as a urinary albumin excretion of 30–300 mg/L, is an early and sensitive marker of glomerular damage and a predictor of future cardiovascular and renal events [5]. Elevated levels of microalbumin

in urine can occur even before the clinical onset of renal disease, serving as a valuable screening tool for subclinical nephropathy [6].

The urine protein-creatinine ratio (PCR) is another reliable and non-invasive method for quantifying proteinuria in spot urine samples, eliminating the need for cumbersome 24-hour urine collections [7]. It is widely accepted as a surrogate marker of glomerular permeability and overall renal health [8].

Several studies have reported that smoking exacerbates renal injury in individuals with hypertension or diabetes [9]. However, limited data exist regarding its effect on apparently healthy individuals without known comorbidities [10]. Understanding the renal effects of smoking in such populations can provide insight into early pathophysiological changes and help guide preventive strategies [11].

This study aims to assess the protein-creatinine ratio and microalbuminuria in smokers and compare them with age-matched non-smokers. The findings could contribute to raising awareness about the renal risks associated with tobacco use, even in the absence of overt disease [12].

AIM AND OBJECTIVES

Aim:

To evaluate renal function markers—specifically protein-creatinine ratio and microalbuminuria—in smokers.

Objectives:

1. To estimate the urine protein-creatinine ratio in smokers and compare it with non-smokers.
2. To assess the level of microalbuminuria in smokers.
3. To correlate the duration and intensity (pack-years) of smoking with urinary biomarkers.
4. To identify early renal alterations that may necessitate preventive strategies in smokers.

MATERIALS AND METHODS

Study Design and Setting: A cross-sectional, comparative observational study conducted at a tertiary care teaching hospital.

Sample Size: Total 100 participants

- Smokers: 50
- Non-smokers (Controls): 50

Inclusion Criteria:

- Male subjects aged 20–50 years.
- Smokers with a minimum smoking history of 5 pack-years.
- Healthy non-smoker controls without known renal or metabolic diseases.

Exclusion Criteria:

- History of diabetes mellitus, hypertension, or known renal disease.
- Use of nephrotoxic drugs or anti-inflammatory medications.
- Acute illness or fever within the last two weeks.

Data Collection:

- Demographic data, detailed smoking history (type, duration, number of cigarettes/day), and pack-years were recorded.
- Morning midstream urine samples were collected from all participants.

Laboratory Analysis:

- **Urine Microalbumin:** Measured by immunoturbidimetric method.
- **Urine Protein and Creatinine:** Estimated using semi-automated biochemical analyzer. PCR calculated using the formula:

PCR (mg/g)=Urine Protein (mg/dL)Urine Creatinine (mg/dL)×1000PCR (mg/g)=Urine Creatinine (mg/dL)Urine Protein (mg/dL)×1000

Statistical Analysis:

- Data expressed as mean ± standard deviation.
- Student's t-test used for comparison between groups.
- Pearson correlation applied for assessing relationship between pack-years and urinary markers.
- Significance level set at $p < 0.05$.

RESULTS

Table 1: Baseline Demographic Characteristics of the Study Population

Variable	Smokers (n = 50)	Non-Smokers (n = 50)	*p*-value
Age (years, Mean ± SD)	35.8 ± 7.2	34.5 ± 6.9	0.312
BMI (kg/m²)	23.2 ± 2.8	22.9 ± 3.1	0.537
Duration of Smoking (years)	10.2 ± 4.5	N/A	—
Pack-Years	8.4 ± 3.7	N/A	—

This table shows that both groups (smokers and non-smokers) were age- and BMI-matched. Pack-years and smoking duration were recorded only for the smoker group. No statistically significant difference in age or BMI was found between groups ($p > 0.05$), ruling out demographic bias.

Table 2: Comparison of Urinary Parameters Between Smokers and Non-Smokers

Parameter	Smokers (n = 50)	Non-Smokers (n = 50)	*p*-value
Urine Microalbumin (mg/L)	42.3 ± 15.6	18.5 ± 6.7	< 0.001
Urine Protein (mg/dL)	35.2 ± 12.4	18.7 ± 7.5	< 0.001
Urine Creatinine (mg/dL)	177.5 ± 33.2	182.3 ± 31.7	0.328
Protein Creatinine Ratio (mg/g)	198.4 ± 52.7	102.8 ± 31.2	< 0.001

This table demonstrates significantly higher levels of urinary microalbumin, protein, and PCR in smokers compared to non-smokers ($p < 0.001$). Urine creatinine levels were comparable, supporting that the observed increase in PCR is driven by increased protein levels.

Table 3: Prevalence of Microalbuminuria in Both Groups

Microalbuminuria Category	Smokers (n = 50)	Non-Smokers (n = 50)
Normal (<30 mg/L)	33 (66%)	47 (94%)
Microalbuminuria (30–300 mg/L)	17 (34%)	3 (6%)
Overt Proteinuria (>300 mg/L)	0 (0%)	0 (0%)

This table shows that **34% of smokers had microalbuminuria**, whereas only **6% of non-smokers** showed abnormal levels. No cases of overt proteinuria were found. This highlights the early renal impact of smoking even before overt nephropathy develops.

Table 4: Correlation of Pack-Years with Urinary Parameters in Smokers

Parameter	Correlation Coefficient (r)	*p*-value
Urine Microalbumin	0.62	< 0.001
Protein Creatinine Ratio	0.58	< 0.001
Urine Protein	0.54	< 0.001
Urine Creatinine	-0.12	0.378

There was a **strong positive correlation** between **pack-years** and levels of **urine microalbumin (r = 0.62)** and **PCR (r = 0.58)**, indicating a dose-response relationship between smoking intensity and renal impairment. The correlation with urine creatinine was weak and non-significant.

Table 5: Distribution of Protein Creatinine Ratio Categories

PCR Category (mg/g)	Smokers (n = 50)	Non-Smokers (n = 50)
<150 (Normal)	20 (40%)	44 (88%)
150–300 (Borderline)	26 (52%)	6 (12%)
>300 (Overt Proteinuria)	4 (8%)	0 (0%)

This table classifies subjects based on PCR levels. A greater proportion of smokers fell into the **borderline** and **elevated PCR categories**, indicating a subclinical renal burden in a significant fraction of the exposed population.

DISCUSSION

The present study highlights a significant association between cigarette smoking and early indicators of renal dysfunction, namely microalbuminuria and the urine protein-creatinine ratio (PCR). Smokers showed notably higher levels of both parameters compared to non-smokers, even in the absence of overt comorbidities such as diabetes or hypertension. These findings underscore the silent yet progressive renal damage that smoking can cause, supporting existing literature while providing data specific to an Indian male population. Cigarette smoke is a complex mixture of over 7,000 chemicals, many of which are nephrotoxic. Nicotine, polycyclic aromatic hydrocarbons, and heavy metals like cadmium have all been shown to induce oxidative stress, endothelial dysfunction, and inflammation [13]. These mechanisms are central to glomerular injury and increased albumin permeability. The observed rise in microalbuminuria among smokers in this study aligns with previous investigations reporting similar findings in both diabetic and non-diabetic populations [14,15].

Microalbuminuria is an established marker of early kidney injury and a predictor of cardiovascular disease [16]. Its occurrence in apparently healthy smokers indicates the possibility of incipient endothelial dysfunction, which may evolve into chronic kidney disease (CKD) if not addressed. Our findings are in agreement with the study by Orth et al., which showed that microalbuminuria was more prevalent in smokers and correlated with cumulative smoking exposure [17].

In this study, a significant proportion (34%) of smokers exhibited microalbuminuria, whereas only 6% of non-smokers crossed this threshold. Moreover, PCR was significantly elevated in smokers (mean 198.4 mg/g) versus non-smokers (102.8 mg/g), supporting previous reports that protein-creatinine ratio is an effective proxy for proteinuria and an early sign of renal compromise [18]. The utility of PCR in place of 24-hour urine protein estimation has been validated in multiple studies, offering a practical advantage in large-scale screening and outpatient settings [19].

A strong positive correlation was also noted between pack-years and both microalbuminuria and PCR in this study, suggesting a dose-dependent relationship. This observation is consistent with the findings by Yacoub et al., who reported a linear increase in urinary albumin excretion with increasing smoking exposure [20]. Chronic smoking is known to increase sympathetic activity, raise glomerular pressure, and damage podocytes—all of which contribute to protein leakage into the urine [21].

Interestingly, urine creatinine levels did not differ significantly between smokers and non-smokers, ruling out major differences in muscle mass or hydration status. Therefore, the elevated PCR in smokers is attributable mainly to increased urinary protein excretion rather than changes in creatinine output. This enhances the reliability of PCR as an indicator of renal pathology in this population.

The clinical implications of these findings are considerable. First, microalbuminuria in smokers may serve as a red flag for systemic endothelial injury, with broader implications for cardiovascular risk. Second, the data reinforce the necessity of routine screening for microalbuminuria and PCR in chronic smokers, even in the absence of traditional risk factors. Early detection can prompt lifestyle interventions such as smoking cessation, blood pressure control, and dietary modifications that may reverse or halt the progression of renal damage [22]. While our study was limited to adult males and involved a relatively modest sample size, the results are consistent with global trends and highlight the insidious renal effects of smoking. Further studies with larger, more diverse populations and

longitudinal follow-up are warranted to assess the reversibility of microalbuminuria after smoking cessation and the progression to CKD in persistent smokers.

CONCLUSION: In conclusion, this study supports the growing body of evidence that cigarette smoking adversely affects renal function, even in young, otherwise healthy individuals. Both microalbuminuria and PCR are valuable, accessible biomarkers for detecting early renal changes in this high-risk group. Preventive nephrology must evolve to incorporate tobacco exposure as a modifiable risk factor for CKD, with early screening and education playing a pivotal role.

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