TUMI HEALTH SCIENCES RESEARCH
e-ISSN 3084-7915

TUMI Health Sciences Research
Gabriel-Huamanchumo, B. TUMI Health Sci. Res. 2026;1(2):15–21
https://doi.org/10.64716/wnh9mb14

ORIGINAL RESEARCH **OPEN ACCESS**

Twenty-four-hour proteinuria and acute kidney injury in women with preeclampsia in Peru

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ABSTRACT

Background: Proteinuria and acute kidney injury describe different aspects of renal involvement in preeclampsia. **Objective:** To evaluate the association between 24-hour proteinuria and acute kidney injury (AKI) among women with preeclampsia at a referral hospital in Trujillo, Peru, during 2018–2024. **Methods:** A retrospective analytical record review included 127 women selected by simple random sampling. Proteinuria status and category, AKI diagnosis and stage, age group, and residence were extracted from clinical records. Frequencies and percentages summarized categorical variables. Associations were evaluated using two-sided Fisher exact, Fisher–Freeman–Halton exact, or Pearson chi-square tests, according to table dimensions and expected frequencies. **Results:** Proteinuria was documented in 48 women (37.8%): 35 had mild proteinuria, eight moderate proteinuria, and five nephrotic-range proteinuria. Three women (2.4%) had AKI, comprising two stage I cases and one stage III case. All three AKI cases occurred among women with proteinuria, corresponding to 6.3% of that group, compared with 0.0% among women without proteinuria; the association did not reach statistical significance ($p = 0.052$). Proteinuria was not significantly associated with age group ($p = 0.573$) or residence ($p = 0.367$); corresponding AKI comparisons were also nonsignificant ($p = 1.000$ and $p = 0.470$). **Conclusions:** Proteinuria was more frequent than AKI in this sample. The primary comparison did not establish a statistically significant association, and the small number of AKI events warrants cautious interpretation of the magnitude of the relationship.

Keywords: Pre-Eclampsia; Proteinuria; Acute Kidney Injury; Pregnancy; Retrospective Studies.

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Journal homepage: https://tumijournal.com/index.php/health-sciences-research/en
https://doi.org/10.64716/wnh9mb14
Editor-in-Chief: Yovana Melisza Gutierrez-Polanco

Received: September 30, 2026
Revised: October 10, 2026
Accepted: October 20, 2026
Available online: October 31, 2026

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Introduction

Preeclampsia is a multisystem disorder of pregnancy with important consequences for maternal and perinatal health. Its clinical expression extends beyond hypertension and urinary protein excretion to include neurological, hepatic, hematological, renal, and uteroplacental dysfunction [1,2]. Evidence-based guidance developed for the Peruvian Social Health Insurance system similarly emphasizes integrated assessment, management, and follow-up of hypertensive disorders of pregnancy [3]. Within this framework, distinguishing urinary protein loss from acute deterioration of kidney function is clinically important because these findings describe related but different aspects of renal involvement.

Acute kidney injury (AKI) during pregnancy presents a diagnostic challenge. Physiological increases in glomerular filtration lower serum creatinine, while preeclampsia, hemorrhage, sepsis, and thrombotic microangiopathies can produce overlapping clinical manifestations [4]. A systematic review and meta-analysis estimated a pooled frequency of pregnancy-related AKI of 2.0%, with substantial variation across settings, and identified preeclampsia as a common underlying condition [5]. In a case series of critically ill women, Lu et al. documented substantial maternal and fetal morbidity, illustrating the clinical importance of renal impairment in complicated pregnancies [6].

Proteinuria is commonly assessed in women with suspected preeclampsia, but it is not required for diagnosis when other qualifying manifestations are present [2]. Twenty-four-hour urine collection measures protein excretion over a defined interval, whereas spot urine protein-to-creatinine ratios offer a more rapid assessment. Protein excretion must be interpreted alongside blood pressure, excretory kidney function, and other manifestations of maternal disease [7,8]. The presence of proteinuria and a diagnosis of AKI therefore should not be treated as interchangeable clinical findings.

Studies of urinary protein measurements have addressed different questions. Xiao et al. examined the relationship between spot protein-to-creatinine ratios, 24-hour protein excretion, and adverse pregnancy outcomes; Farzaneh et al. compared the diagnostic performance of the two urine measurements [9,10]. Other cohorts have associated greater protein excretion or nephrotic-range proteinuria with adverse maternal and neonatal outcomes [11,12]. These findings support assessment of urinary protein, while also showing the importance of specifying the outcome and the clinical population when interpreting an association.

Local hospital evidence can help characterize how proteinuria and AKI occur together among women with preeclampsia in Peru. The objective of this study was to evaluate the association between documented 24-hour proteinuria and AKI in women with preeclampsia treated at a referral hospital in Trujillo during 2018–2024. Secondary objectives were to describe proteinuria categories and AKI stages and to examine their distributions according to maternal age group and place of residence. This assessment provides clinical context for interpreting urinary protein findings alongside kidney injury in obstetric care.

Materials and methods

Study design and setting

A quantitative, observational, analytical study was conducted through retrospective review of clinical records from a public referral hospital in Trujillo, Peru. Records corresponded to pregnancies managed during 2018–2024. Proteinuria and AKI were evaluated from the clinical information documented during care, without intervention or manipulation of either variable. Reporting followed the applicable Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations for observational research [13].

Participants and sampling

The study population comprised women beyond 20 weeks of gestation with a clinical diagnosis of preeclampsia. Medical records were selected using simple random sampling. Eligibility required documentation of preeclampsia, a 24-hour urine protein assessment, and information permitting classification of AKI status. Women with and without AKI were included. Records were excluded for pre-existing kidney disease, diabetes, treatment with diuretics, immunosuppressants or corticosteroids, other concurrent pregnancy complications specified in the study criteria, or absence of the required laboratory assessments. The final analytical sample included 127 women.

Clinical variables

The principal variables were proteinuria and AKI. Proteinuria was recorded as present or absent according to the clinical interpretation of the 24-hour urine protein

assessment. The proteinuria categories documented in the clinical records and extraction form were absent, mild, moderate, and nephrotic range. These categories described urinary protein excretion and were not used to classify the overall severity of preeclampsia.

AKI status and stage were abstracted from the clinical diagnosis documented in each record. The analysis distinguished women without AKI from those with AKI, and summarized stages I, II, and III. This was an analysis of documented clinical diagnoses rather than a diagnostic-accuracy evaluation of a urinary protein threshold. Maternal age was grouped as 15–26, 27–38, and 39–50 years. Place of residence was recorded as urban or rural.

Data collection and quality control

Data were collected by documentary review using a structured extraction form covering age, residence, 24-hour proteinuria, and AKI diagnosis and stage. The form underwent content review by two obstetrician-gynecologists and two specialists in internal medicine. Institutional authorization was obtained before access to the records. Information was entered in Microsoft Excel 2019 and organized for statistical analysis. Frequencies, category totals, and percentage denominators were checked for consistency across the study tables.

Statistical Analysis

Categorical variables were summarized as counts and percentages rounded to one decimal place. Descriptive distributions used the full sample of 127 women as the denominator. Cross-tabulations presented column percentages, with denominators identified in their headings and notes. For the primary clinical comparison, the proportion with AKI was also calculated separately within the groups with and without proteinuria.

The association between proteinuria and AKI was evaluated using a two-sided Fisher exact test because of the small cell counts. Pearson chi-square tests without continuity correction were used for the associations of proteinuria with age group and residence, for which all expected frequencies exceeded five. AKI comparisons used the Fisher–Freeman–Halton exact test for the three age groups and the two-sided Fisher exact test for residence. The probability-based two-sided definition was used for exact tests. Analyses were unadjusted, and the age and residence comparisons were exploratory. Statistical significance was defined as $p < 0.05$. The study analysis used IBM SPSS Statistics, version 26; tabulated frequencies were additionally checked using reproducible calculations in Python and SciPy.

Ethical considerations

The study received approval from the research ethics bodies of the participating hospital and university medical school before its execution. It was conducted in accordance with the principles of the Declaration of Helsinki and the applicable institutional research ethics requirements [14]. Informed consent was obtained for the research use of participants' clinical information. Privacy and confidentiality were protected throughout the review, and clinical information was used exclusively for the study. Results are presented in aggregate without patient identifiers. Access to individual clinical records remains subject to institutional authorization and confidentiality safeguards.

Results

The analysis included 127 women with preeclampsia. Proteinuria was documented in 48 women, and AKI in three. All five tables use this same analytical sample.

All three women with AKI had proteinuria. Among the 48 women with proteinuria, three had AKI (6.3%); no AKI was documented among the 79 women without proteinuria (0.0%). The two-sided Fisher exact test yielded $p = 0.052$, which did not meet the prespecified threshold for statistical significance (Table 1).

Table 1. Association between 24-hour proteinuria and acute kidney injury

24-hour proteinuria	No AKI (n = 124)		AKI (n = 3)		Total (N = 127)		p-value
	n	%	n	%	n	%	
Absent	79	63.7	0	0.0	79	62.2	0.052
Present	45	36.3	3	100.0	48	37.8	
Total	124	100.0	3	100.0	127	100.0	—

Values are counts and column percentages. Denominators are 124 women without AKI, three with AKI, and 127 overall. The p-value corresponds to the two-sided Fisher exact test for the complete 2 × 2 table. AKI: acute kidney injury. —: not applicable.

Proteinuria was absent in 79 women (62.2%). Mild proteinuria was the most frequent category among women with proteinuria, accounting for 35 women (27.6% of the total sample), followed by moderate proteinuria in eight (6.3%) and nephrotic-range proteinuria in five (3.9%). Together, the three proteinuria categories comprised 48 women (37.8%) (Table 2).

Table 2. Categories of 24-hour proteinuria in women with preeclampsia

24-hour proteinuria category	n	%
Absent	79	62.2
Mild	35	27.6
Moderate	8	6.3
Nephrotic range	5	3.9
Total	127	100.0

Percentages use the full sample (N = 127) as the denominator. Categories refer to the clinical classification of the 24-hour urine protein assessment recorded in the extraction form.

AKI was absent in 124 women (97.6%). Two women had stage I AKI (1.6%) and one had stage III AKI (0.8%); no stage II cases were recorded. The total number of women with AKI was three (2.4%) (Table 3).

Table 3. Recorded stages of acute kidney injury in women with preeclampsia

Acute kidney injury stage	n	%
No AKI	124	97.6
Stage I	2	1.6
Stage II	0	0.0
Stage III	1	0.8
Total	127	100.0

Percentages use the full sample (N = 127) as the denominator. AKI: acute kidney injury. Stages correspond to the clinical diagnoses documented in the records.

The most frequent age group was 27–38 years (60 women; 47.2%), and 103 women (81.1%) lived in rural areas. Within the proteinuria group, 25 of 48 women (52.1%) were aged 27–38 years and 37 (77.1%) were rural residents. Proteinuria was not significantly associated with age group ($\chi^2 = 1.115$; $p = 0.573$) or residence ($\chi^2 = 0.813$; $p = 0.367$) (Table 4).

Of the three women with AKI, one was aged 15–26 years and two were aged 27–38 years. One lived in an urban area and two in rural areas. Exact tests did not identify statistically significant associations between AKI and age group ($p = 1.000$) or residence ($p = 0.470$) (Table 5).

Discussion

The principal finding was that all three AKI cases occurred among women with proteinuria, although the exact comparison did not reach statistical significance. AKI was documented in 6.3% of women with proteinuria and in none of those without proteinuria, with a two-sided Fisher p-value of 0.052. This result should be interpreted together with the small number of events. It does not establish equivalence between the groups or demonstrate that proteinuria has no relationship with AKI. The descriptive findings were clearer: proteinuria affected 37.8% of the sample, whereas AKI was recorded in 2.4%, and mild proteinuria was the most frequent proteinuria category.

The distinction between urinary protein loss and acute loss of kidney function is central to interpreting these findings. Proteinuria reflects altered renal handling of protein, while AKI is a clinical syndrome involving an acute change in excretory kidney function. Pregnancy modifies glomerular filtration and baseline serum creatinine, and several obstetric and non-obstetric conditions may contribute to AKI [4]. Reviews of pregnancy-associated AKI emphasize the need to consider clinical context and competing etiologies, especially when manifestations of preeclampsia overlap with other disorders [15]. Consequently, the presence of proteinuria alone does not fully characterize renal function.

The predominance of women without documented proteinuria is compatible with contemporary definitions of preeclampsia, which allow diagnosis in the presence of qualifying maternal organ or uteroplacental dysfunction even when proteinuria is absent [2]. It should not be interpreted as evidence that most participants had mild preeclampsia. Proteinuria category and overall disease severity describe different dimensions of the clinical presentation, a distinction reflected in evolving definitions of hypertensive disorders of pregnancy [16]. Fishel Bartal et al. emphasized the importance of blood pressure and end-organ involvement when evaluating maternal and neonatal prognosis, rather than relying on the amount of protein excretion alone [7].

Studies linking proteinuria with adverse outcomes provide relevant comparisons but do not all measure AKI. Xiao et al. found a strong correlation between spot urine protein-to-creatinine ratios and 24-hour protein excretion and evaluated several maternal and neonatal outcomes [9]. Farzaneh et al. examined agreement between urinary protein measurements in 60 women with

Table 4. Proteinuria according to maternal age group and place of residence

Age group or residence	No proteinuria (n = 79)		Proteinuria (n = 48)		Total (N = 127)		χ^2	p-value
	n	%	n	%	n	%		
Maternal age								
15–26 years	32	40.5	15	31.3	47	37.0	1.115	0.573
27–38 years	35	44.3	25	52.1	60	47.2		
39–50 years	12	15.2	8	16.7	20	15.7		
Place of residence								
Urban	13	16.5	11	22.9	24	18.9	0.813	0.367
Rural	66	83.5	37	77.1	103	81.1		
Total	**79**	**100.0**	**48**	**100.0**	**127**	**100.0**	—	—

Values are counts and column percentages within each variable. Denominators are 79 women without proteinuria, 48 with proteinuria, and 127 overall. Percentages may differ from 100.0% by 0.1% because of rounding. Pearson chi-square tests: age, 2 degrees of freedom; residence, 1 degree of freedom. —: not applicable.

Table 5. Acute kidney injury according to maternal age group and place of residence

Age group or residence	No AKI (n = 124)		AKI (n = 3)		Total (N = 127)		p-value
	n	%	n	%	n	%	
Maternal age							
15–26 years	46	37.1	1	33.3	47	37.0	1.000
27–38 years	58	46.8	2	66.7	60	47.2	
39–50 years	20	16.1	0	0.0	20	15.7	
Place of residence							
Urban	23	18.5	1	33.3	24	18.9	0.470
Rural	101	81.5	2	66.7	103	81.1	
Total	**124**	**100.0**	**3**	**100.0**	**127**	**100.0**	—

Values are counts and column percentages within each variable. Denominators are 124 women without AKI, three with AKI, and 127 overall. Percentages may differ from 100.0% by 0.1% because of rounding. Age was assessed using the Fisher–Freeman–Halton exact test; residence was assessed using the two-sided Fisher exact test. AKI: acute kidney injury. —: not aplicable

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preeclampsia [10]. The latter study primarily informs how proteinuria can be measured; it does not establish that a higher urine protein result predicts AKI. Keeping these research questions separate avoids attributing a renal prognostic meaning to a study of diagnostic agreement.

In a larger retrospective cohort, Aynaoğlu Yıldız and Topdağı Yılmaz studied 1,379 women with preeclampsia and observed poorer pregnancy outcomes in those with the highest protein excretion [11]. Ghosh et al. subsequently reported a higher frequency of AKI and other adverse outcomes among women with nephrotic-range proteinuria in a prospective cohort of 278 women [12].

These studies assessed gradients of protein excretion and broader outcome profiles. The primary comparison in the present study instead distinguished the presence from the absence of proteinuria, and only five women were classified in the nephrotic range. The differing exposure definitions and clinical settings limit direct comparisons of the results.

The overall AKI proportion was lower than that in the multicenter South African study by Conti-Ramsden et al., in which 237 of 1,547 women admitted with preeclampsia met creatinine-based AKI criteria (15.3%) [17]. Their study also documented important maternal and perinatal complications and incomplete renal recovery in some women. By contrast, the pooled estimate of 2.0% in the meta-analysis by Trakarnvanich

et al. incorporated heterogeneous pregnancy populations and cannot be treated as an expected rate specifically for women with preeclampsia [5]. Similarly, the critically ill population studied by Lu et al. represents a different clinical spectrum [6]. Differences in selection, clinical acuity, and outcome ascertainment are therefore relevant to interpreting the observed frequencies.

Age group and residence were not significantly associated with proteinuria or AKI. These exploratory comparisons describe the present sample and should not be interpreted as demonstrating that sociodemographic characteristics are clinically irrelevant. Most participants lived in rural areas, and only three AKI events were distributed across the age and residence categories. Exact testing was appropriate for these sparse AKI comparisons. A broader assessment of demographic relationships would require consideration of the clinical course and other potential explanatory variables alongside age and residence.

The clinical implication is to assess urinary protein in conjunction with renal function and the overall maternal condition. FIGO advice on monitoring and management of preeclampsia incorporates changing serum creatinine and other evidence of organ dysfunction into decisions about care [18]. Contemporary guidance on proteinuria likewise emphasizes investigation and surveillance in the appropriate clinical context [8]. The present study does not support using a negative proteinuria classification as a stand-alone rule-out test for AKI, nor does it establish diagnostic or prognostic accuracy for a particular 24-hour protein threshold.

Renal assessment after pregnancy is also relevant to the broader care pathway. Kountouris et al. found renal dysfunction at 6–8 weeks postpartum in a substantial proportion of women with hypertensive disorders of pregnancy [19]. In longer-term observational cohorts, preeclampsia was associated with subsequent reduced kidney function and albuminuria, and with AKI occurring at least 90 days after delivery [20,21]. These outcomes differ from AKI documented during the index pregnancy, but they support continuity of maternal care beyond delivery. The present analysis addresses the hospital episode and does not evaluate long-term renal prognosis.

Strengths include the use of clinical records, a structured extraction form reviewed by four medical specialists, consistent sample totals across all analyses, and exact tests suited to the small AKI counts. The retrospective, single-hospital design limits generalizability and is susceptible to the characteristics of routine clinical documentation. Exclusion of selected comorbid conditions further defines the population to which the results apply. The principal statistical limitation is the occurrence of only three AKI events, which restricts precision and the scope for adjusted comparisons. The analysis concerns recorded clinical categories and does not establish temporal or causal relationships. Prospective multicenter research with standardized renal assessments and sufficient AKI events would better quantify the relationship between the magnitude of proteinuria and kidney injury.

Conclusions

Among 127 women with preeclampsia, proteinuria was documented in 37.8% and AKI in 2.4%. All three AKI cases occurred in women with proteinuria, but the association did not reach statistical significance ($p = 0.052$). Mild proteinuria and stage I AKI were the most frequent categories among the respective affected groups. No statistically significant associations with age group or residence were identified. These findings support interpreting proteinuria alongside clinical and biochemical assessment of kidney function; they do not establish the absence of an association with AKI.

Author Contributions Statement (CrediT)

BBG: Conceptualization, Methodology, Investigation, Data curation, Writing – original draft, and Project administration. VSGS: Methodology, Investigation, Formal analysis, Validation, Visualization, and Writing – review and editing. Both authors critically reviewed the intellectual content and approved the final manuscript for publication. They are responsible for its scientific content and integrity.

Acknowledgments

The authors thank the clinical and medical-records personnel of the participating hospital for facilitating access to the documentation and acknowledge the academic support received during the development of the study.

Funding

The research received no external funding from public, commercial, or nonprofit organizations.

Conflict of Interest

The authors declare no financial or non-financial competing interests related to the conduct, interpretation, or publication of this research.

Data Availability

The aggregate data supporting the reported analyses are presented in the article. Additional information about the extraction form and tabulated results may be requested from the corresponding author upon reasonable request. Access to individual clinical records is subject to institutional approval and applicable confidentiality requirements.

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