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CLINICAL AND BIOCHEMICAL CHARACTERISTICS OF HAEMODIALYSIS PATIENTS: INSIGHTS INTO PRURITUS, INTERLEUKIN-31 AND SKIN HYDRATION

Revinanda Venincia Pangaribuan[1 2], Dina Arwina Dalimunthe[1]*, Riana Miranda Sinaga[1]
[1]Department of Dermatology and Venereology, Faculty of Medicine, Universitas Sumatera Utara, Jl. Dr. Mansyur No.5, Padang Bulan, Medan Baru, Medan, Sumatera Utara 20155, Indonesia
[2]Master Programme in Clinical Medicine Sciences, Faculty of Medicine, Universitas Sumatera Utara, Jl. Dr. Mansyur No.5, Padang Bulan, Medan Baru, Medan, Sumatera Utara 20155, Indonesia
*dina.arwina@usu.ac.id

ABSTRACT
Chronic kidney disease-associated pruritus (CKD-aP) is a common complication of maintenance haemodialysis. Interleukin-31 (IL-31) and impaired skin hydration may contribute to its multifactorial pathophysiology. To describe the clinical and biochemical characteristics of haemodialysis patients, focusing on pruritus severity, serum IL-31 concentrations and stratum corneum hydration. This descriptive cross-sectional study included 45 adults with stage 5 chronic kidney disease undergoing maintenance haemodialysis in Medan, Indonesia, recruited using consecutive sampling. Pruritus severity was assessed using the UP-Dial questionnaire, stratum corneum hydration using a Corneometer CM 825, and serum IL-31 concentrations using an enzyme-linked immunosorbent assay (ELISA). Data were summarised using descriptive statistics. The mean age was 54.9 ± 11.9 years, and 51.1% of participants were female. Pruritus was mild in 57.8%, moderate in 22.2% and severe in 20.0%. Mean skin hydration was 28.88 ± 7.77 arbitrary units, with 84.4% classified as having very dry skin. Mean serum IL-31 concentration was 76.32 ± 60.26 pg/mL, with the highest mean concentration observed in patients with severe pruritus (134.78 ± 102.97 pg/mL). Mild pruritus predominated among haemodialysis patients, while reduced skin hydration was common. Serum IL-31 concentrations showed considerable variability, with the highest mean levels observed in severe pruritus. These findings highlight the heterogeneous clinical and biochemical characteristics of this population.

Keywords: chronic kidney disease; interleukin-31; pruritus; skin hydration; xerosis

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INTRODUCTION

Chronic kidney disease (CKD) is defined by persistent abnormalities in kidney structure or function for at least three months (Yan et al., 2021; Stevens et al., 2024; Susianti, 2019). Affecting approximately 10–20% of the global population, kidney disease represents a major public health burden, with over 850 million individuals affected worldwide (Yan et al., 2021; Stevens et al., 2024). In Indonesia, 713,783 individuals were reported to have CKD in 2018 (Ministry of Health of the Republic of Indonesia, 2018). Advanced CKD may require kidney replacement therapy, including haemodialysis, peritoneal dialysis, or transplantation (Suwitra, 2024). Haemodialysis facilitates uraemic toxin removal and maintains fluid and electrolyte balance (Suahrdjono, 2024).

CKD-associated pruritus (CKD-aP) is a common complication among haemodialysis patients and contributes substantially to impaired quality of life (Verduzco & Shirazian, 2020; Titapiccolo et al., 2023; Manenti & Leuci, 2021; Cheng & Wong, 2022). Approximately 40% of haemodialysis patients experience moderate-to-severe pruritus, while its overall prevalence approaches 50%

(Titapiccolo et al., 2023; Manenti & Leuci, 2021). Symptoms are often persistent, bilateral, and nocturnally aggravated, frequently accompanied by xerosis and scratching-related skin lesions (Verduzco & Shirazian, 2020; Cheng & Wong, 2022; Agarwal et al., 2021; Ko et al., 2022).

The pathogenesis of CKD-aP involves immune dysregulation, systemic inflammation, uraemic toxin accumulation, neurological alterations, and epidermal barrier dysfunction (Molina et al., 2023; Schricker & Kimmel, 2021). Interleukin-31 (IL-31), a predominantly T-helper 2-derived cytokine, is implicated in pruritic inflammation through signalling via IL-31 receptor A and oncostatin M receptor (Oweis et al., 2021; Güvercin et al., 2019; Ko et al., 2014). Its involvement in atopic dermatitis, psoriasis, and prurigo nodularis further supports its relevance as a pruritus-related biomarker (Byeon et al., 2020; Bodoor et al., 2020; Kabashima & Irie, 2021).

Impaired stratum corneum hydration represents another important feature of CKD-related cutaneous dysfunction (Kabashima & Irie, 2021; Zhai et al., 2024; Chang & Liao, 2022). Reduced sebaceous and eccrine gland activity, altered epidermal lipids, and barrier disruption may contribute to xerosis and increased susceptibility to pruritic stimuli (Zhai et al., 2024; Chang & Liao, 2022). Pruritus severity can be characterised using validated instruments such as the Uraemic Pruritus in Dialysis Patients (UP-Dial) questionnaire (Titapiccolo et al., 2023; Manenti & Leuci, 2021; Świerczyńska et al., 2022). Given the multifactorial nature of CKD-aP, further descriptive characterisation of its clinical and biochemical features is warranted. This study aimed to describe demographic characteristics, pruritus severity, serum IL-31 concentrations, and stratum corneum hydration among patients with stage 5 CKD undergoing maintenance haemodialysis

METHOD

Study Design and Participants. This descriptive cross-sectional study was conducted at Prof. Dr. Chairuddin Panusunan Lubis Hospital, Universitas Sumatera Utara, Medan, Indonesia, from September to December 2025. Forty-five patients with stage 5 chronic kidney disease undergoing maintenance haemodialysis were recruited through consecutive sampling. Inclusion criteria were age ≥18 years, haemodialysis duration ≥3 months, and written informed consent. Patients with chronic primary dermatoses, liver disease, malignancy, psychiatric disorders affecting questionnaire completion, or inability to complete the questionnaire were excluded. Demographic and clinical data were obtained through interviews, examinations, and medical records.

Pruritus Assessment. Pruritus severity was evaluated using the 14-item Uraemic Pruritus in Dialysis Patients (UP-Dial) questionnaire, with total scores ranging from 0 to 56. Severity was categorised as mild (≤12), moderate (13–21), or severe (≥22). Serum IL-31 Measurement. Serum IL-31 concentrations were measured using a human IL-31 ELISA kit (E3254Hu). Venous blood samples (3 mL) were centrifuged, and serum was stored at −20°C until analysis. Results were expressed in pg/mL. Skin Hydration Assessment. Stratum corneum hydration was measured using a Corneometer CM 825 at three sites on each forearm. The mean of bilateral measurements was expressed in arbitrary units (AU) and classified as very dry (<30 AU), dry (30–45 AU), or adequately hydrated (>45 AU).

Statistical Analysis. Data were analysed descriptively. Categorical variables were presented as frequencies and percentages, while continuous variables were summarised using means and standard deviations or medians and interquartile ranges, as appropriate. Normality was assessed using the Shapiro–Wilk test. Ethical Considerations. Ethical approval was obtained from the Health Research Ethics Committee of Universitas Sumatera Utara (No. 877/KEPK/USU/2025), with institutional authorisation (No. 4951/UN5.5.6.D2/PT.01.04/2025). All participants provided written informed consent.

RESULT

A total of 45 patients with stage 5 chronic kidney disease undergoing maintenance haemodialysis completed the study (Table 1). Of these, 23 (51.1%) were female and 22 (48.9%) were male, with a mean age of 54.9 ± 11.9 years. Most participants (80.0%) were aged ≥46 years.

Table 1.
Respondent characteristics (n = 45)

Respondent characteristics	f	%
Sex		
Male	22	48.9
Female	23	51.1
Age group (years)		
18-25	0	0.0
26-35	4	8.9
36-45	5	11.1
46-55	13	28.9
56-65	13	28.9
>65	10	22.2
Pruritus severity (UP-Dial band)		
Mild (score ≤ 12)	26	57.8
Moderate (score 13-21)	10	22.2
Severe (score ≥ 22)	9	20
Stratum corneum hydration band		
Very dry (< 30 AU)	38	84.4
Dry (30-45 AU)	7	15.6
Adequately hydrated (> 45 AU)	0	0

All participants reported pruritus, predominantly mild (57.8%), followed by moderate (22.2%) and severe (20.0%) symptoms. Very dry skin was observed in 84.4% of patients, while 15.6% had dry skin. The mean serum interleukin-31 (IL-31) concentration was 76.32 ± 60.26 pg/mL, with a median of 55.82 pg/mL. Mean stratum corneum hydration was 28.88 ± 7.77 arbitrary units (AU), while the mean UP-Dial score was 12.91 ± 9.47 (Table 2).

Table 2.
Distribution of serum interleukin-31, stratum corneum hydration and pruritus severity (n = 45)

Variable	Mean ± SD	Median
Serum IL-31 (pg/mL)	76.32 ± 60.26	55.82
Skin hydration (AU)	28.88 ± 7.77	28.70
UP-Dial total score	12.91 ± 9.47	9.00

Table 3.
Serum interleukin-31 and nd UP-Dial scores by sex and age group (n = 45)

Subgroup	n	Serum IL-31 (pg/mL) Mean ± SD	UP-Dial score Mean ± SD
Sex			
Male	22	74.52 ± 43.56 (57.22)	13.45 ± 10.91
Female	23	78.04 ± 73.78 (53.29)	12.39 ± 8.07
Age group (years)			
26-35	4	135.54 ± 124.51	11.75 ± 9.81
36-45	5	92.55 ± 108.97	14.00 ± 10.77
46-55	13	63.28 ± 24.92	14.77 ± 12.69
56-65	13	84.14 ± 51.16	13.77 ± 8.04
>65	10	51.30 ± 15.90	9.30 ± 5.66
Overall	45	76.32 ± 60.26	12.91 ± 9.47

Serum IL-31 concentrations were slightly higher in females than males (78.04 ± 73.78 vs 74.52 ± 43.56 pg/mL), whereas mean UP-Dial scores were higher in males (13.45 ± 10.91 vs 12.39 ± 8.07). Across age groups, the highest mean IL-31 concentration was observed in patients aged 26–35

years (135.54 ± 124.51 pg/mL), while the highest mean UP-Dial score occurred among those aged 46–55 years (14.77 ± 12.69) (Table 3). Very dry skin predominated in both sexes, affecting 20 females (87.0%) and 18 males (81.8%). Across age groups, all participants aged 26–35 and 36–45 years were classified as having very dry skin. Among participants aged 46–55, 56–65, and over 65 years, the proportions with very dry skin were 84.6%, 69.2%, and 90.0%, respectively. The highest proportion of participants classified as having dry skin, rather than very dry skin, was observed in the 56–65-year age group (30.8%). These findings demonstrate that reduced stratum corneum hydration was consistently observed across all demographic subgroups, with very dry skin representing the predominant hydration category.

Table 4.
Distribution of stratum corneum hydration categories by sex and age group (n = 45)

Subgroup	n	Very dry, **f** (%)	Dry, **f** (%)	Adequately hydrated, **f** (%)
Sex				
Male	22	18 (81.8)	4 (18.2)	0 (0.0)
Female	23	20 (87.0))	3 (13.0)	0 (0.0)
Age group (years)				
26-35	4	4 (100.0)	0 (0.0)	0 (0.0)
36-45	5	5 (100.0)	0 (0.0)	0 (0.0)
46-55	13	11 (84.6)	2 (15.4)	0 (0.0)
56-65	13	9 (69.2)	4 (30.8)	0 (0.0)
>65	10	9 (90.0)	1 (10.0)	0 (0.0)

The highest mean serum IL-31 concentration was observed in patients with severe pruritus (134.78 ± 102.97 pg/mL), followed by mild (62.92 ± 33.50 pg/mL) and moderate pruritus (58.60 ± 30.36 pg/mL) (Table 5). Considerable interindividual variability was observed in the severe pruritus group, while mean IL-31 concentrations were relatively similar between the mild and moderate groups. Mild pruritus predominated among patients with very dry skin (52.6%) and dry skin (85.7%). All patients with severe pruritus were classified as having very dry skin, whereas no participants exhibited adequate skin hydration (Table 6).

Table 5.
Serum interleukin-31 concentrations according to pruritus severity (n = 45))

Pruritus severity	n (%)	Serum IL-31 (pg/mL) mean ± SD
Mild (UP-Dial ≤12)	26 (57.8)	62.92 ± 33.50
Moderate (UP-Dial 13–21)	10 (22.2)	58.60 ± 30.36
Severe (UP-Dial ≥22)	9 (20.0)	134.78 ± 102.97

Table 6.
Distribution of pruritus severity according to skin hydration categories (n = 45)

Pruritus severity	Very dry, **f** (%)	Dry, **f** (%)	Total, **f** (%)
Mild	20 (76.9)	6 (23.1)	26 (57.8)
Moderate	9 (90.0)	1 (10.0)	10 (22.2)
Severe	9 (100.0)	0 (0.0)	9 (20.0)

DISCUSSION

This study describes the clinical, biochemical, and biophysical characteristics of patients undergoing maintenance haemodialysis. Mild pruritus predominated, reduced stratum corneum hydration was common, and serum IL-31 concentrations varied considerably, with the highest mean concentration observed in patients with severe pruritus. Females comprised 51.1% of participants, consistent with reports of higher CKD prevalence among females in NHANES and other populations (Vart et al., 2020; Jiang et al., 2010; Duff et al., 2024). Conversely, Indonesian Riskesdas data indicated higher CKD prevalence among males (Riskesdas, 2018). Sex-related differences in CKD prevalence and progression may reflect biological, hormonal, and clinical factors (Deng et al., 2021; Kovesdy, 2022). Most participants were aged 46–65 years, comparable to haemodialysis cohorts reported by Daraghmeh et al. (2022) and Shetty et al. (2023). The increasing burden of CKD with age may reflect renal functional decline, accumulated

comorbidities, and prolonged exposure to risk factors (Duff et al., 2024; Shetty et al., 2023; Kovesdy, 2022; KDIGO, 2017; Yovalwan & Arofiati, 2023).

Mild pruritus was the predominant severity category (57.8%), consistent with findings by Engler et al., Shetty et al. (2023), and Akhyani et al. (2005). In contrast, Asmara et al. (2026) reported predominantly moderate pruritus using the Visual Analogue Scale, highlighting differences potentially attributable to assessment instruments, patient characteristics, dialysis-related factors, and treatment. Very dry skin was observed in 84.4% of participants, consistent with the frequent xerosis reported by Dalimunthe et al. (2024), Rashid et al. (2026), and Dwiyana et al. (2023). Uraemia-related glandular changes and epidermal barrier dysfunction may contribute to impaired moisture retention (Zhai et al., 2024). Very dry skin was proportionally more frequent among females in this study, contrasting with Dwiyana et al. (2023), possibly reflecting differences in patient characteristics and assessment methods.

Mean serum IL-31 concentration was 76.32 ± 60.26 pg/mL, lower than values reported by Oweis et al. (2021) and Nazzal et al. (2022). Differences in patient populations, comorbidities, and laboratory methods may explain this variation. The highest mean concentration occurred among participants aged 26–35 years, although this subgroup comprised only four patients. Age-related immune changes may influence cytokine expression (Rodriguez et al., 2021), while Ulambayar et al. (2019) reported lower IL-31 concentrations in older patients with asthma, limiting direct comparison with haemodialysis populations. Mean IL-31 concentrations were slightly higher in females than males, resembling findings by Ko et al. (2014). Hormonal modulation of immune responses may contribute to sex-related differences (Rahrovan et al., 2018). IL-31 is predominantly produced by Th2 cells, with expression potentially influenced by type 2 inflammatory cytokines (Oweis et al., 2021; Datsi et al., 2021; Akhtar et al., 2024). However, these mechanisms cannot be established from the present descriptive data.

The highest mean IL-31 concentration was observed in patients with severe pruritus (134.78 ± 102.97 pg/mL), whereas concentrations were relatively similar in mild and moderate cases. Świerczyńska et al. (2022) reported higher IL-31 concentrations among CKD patients with pruritus than those without pruritus. Nevertheless, the considerable variability observed here suggests that IL-31 alone may not adequately characterise differences in pruritus severity. Mild pruritus predominated in both hydration categories, although all patients with severe pruritus were classified as having very dry skin. Uraemia-related barrier dysfunction and impaired moisture retention may contribute to xerosis and cutaneous sensory stimulation (Thomas et al., 2012). However, the occurrence of mild pruritus despite very dry skin indicates that skin hydration alone may not explain symptom severity.

These findings support routine pruritus screening and skin assessment in haemodialysis care, particularly given the documented under-recognition of pruritus (Rayner et al., 2017). The frequent occurrence of skin dryness also highlights the relevance of appropriate moisturising care. Further longitudinal studies should investigate IL-31, skin hydration, dialysis adequacy, and inflammatory markers in larger populations. A key strength of this study was the simultaneous assessment of pruritus severity, serum IL-31, and stratum corneum hydration. However, its small sample size, single-centre setting, cross-sectional design, absence of a non-pruritic control group, and limited assessment of potential confounders restrict generalisability and interpretation. Nevertheless, the findings provide descriptive insights into the heterogeneous characteristics of haemodialysis patients experiencing CKD-associated pruritus.

CONCLUSION

This study highlights the clinical, biochemical, and biophysical characteristics of patients undergoing maintenance haemodialysis. Mild pruritus was the most frequently reported severity category, while reduced stratum corneum hydration was common among participants. Serum IL-31 concentrations showed considerable interindividual variability, with the highest mean levels observed in patients with severe pruritus. These findings illustrate the heterogeneity of pruritus manifestations and related biological characteristics in haemodialysis patients.

DECLARATIONS

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Conflicts of interest: The authors declare no conflicts of interest related to this study.

Ethical approval: This study was approved by the Health Research Ethics Committee of Universitas Sumatera Utara (Approval No. 877/KEPK/USU/2025), with institutional research authorisation from Prof. Chairuddin Panusunan Lubis Hospital, Universitas Sumatera Utara (No. 4951/UN5.5.6.D2/PT.01.04/2025). Written informed consent was obtained from all participants.

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Author Contributions: [Author / RVP]: Conceptualisation, methodology, investigation, data collection, formal analysis, and writing – original draft. [Co-author / DAD, RMS]: Supervision, validation, and writing – review and editing. All authors reviewed and approved the final manuscript.

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