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Original Research Article

A Study of Clinical and Biochemical Evaluation of Skin Manifestations in Chronic Kidney Disease

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Abstract:

Background: (CKD) is a progressive disorder with multisystem involvement, including frequent and often debilitating cutaneous manifestations. These dermatologic changes significantly affect the quality of life and may reflect underlying biochemical imbalances. Despite their predominance, such manifestations are often underdiagnosed and undertreated in routine nephrology care.

Aim: To evaluate the predominance, pattern, and biochemical correlations of cutaneous manifestations in patients with chronic kidney disease.

Methods: This prospective clinical and biochemical study was conducted at Maharaja Jajati Keshari Medical College & Hospital, Jajpur, and PRM Medical College & Hospital, Mayurbhanj, Odisha, from January 2024 to July 2025. A total of 1,200 CKD patients were enrolled and examined for dermatological changes. Relevant biochemical parameters including serum urea, creatinine, phosphate, calcium, and hemoglobin were measured. Data were analyzed using SPSS version 23.0, with $p<0.05$ considered statistically significant.

Results: Out of 1,200 patients, 87% exhibited one or more cutaneous manifestations. The most common findings were xerosis (66.7%), pruritus (58.2%), hyperpigmentation (42.4%), and pallor (39.1%). Pruritus was significantly associated with elevated serum urea and phosphate levels ($p<0.001$). Advanced CKD stages (Stage 4 and 5) showed a higher frequency and complexity of skin findings, especially among dialysis-dependent patients.

Conclusion: Cutaneous manifestations are highly prevalent in CKD and tend to increase in severity with disease progression. These symptoms often correlate with underlying biochemical abnormalities, particularly uremia and hyperphosphatemia. Early dermatologic assessment and integrated management can improve patient outcomes and quality of life.

Recommendations: Routine skin examinations should be incorporated into the standard care of CKD patients. Clinicians should be trained to recognize key dermatologic signs and manage them alongside renal treatment. Future research should explore targeted therapies to alleviate uremic pruritus and other distressing symptoms.

Keywords: Chronic Kidney Disease, Cutaneous Manifestations, Pruritus, Biochemical Correlation, Dialysis.

Introduction

Chronic Kidney Disease (CKD) is a progressive and irreversible condition characterized by the gradual loss of kidney function over months or years. It is a major global health concern, affecting approximately 10–15% of the adult population worldwide, with a rising trend attributed to the increasing predominance of diabetes mellitus, hypertension, and aging populations [1,2]. The disease not only contributes significantly to morbidity and mortality but also has multisystemic implications, including various dermatological manifestations that are often overlooked in routine clinical practice.

Cutaneous manifestations in CKD patients result from multiple pathophysiological mechanisms such as accumulation of uremic toxins, electrolyte imbalances, anemia, metabolic disturbances, and prolonged dialysis exposure [3]. Common skin changes include xerosis (dry skin), pruritus,

hyperpigmentation, pallor, nail and hair abnormalities, and in severe cases, uremic frost or calciphylaxis [4]. These conditions, although not life-threatening, greatly impair the quality of life, contribute to psychological distress, and may signal underlying systemic imbalances [5].

Recent studies have demonstrated a strong correlation between biochemical parameters and the severity of cutaneous symptoms in CKD patients. For example, elevated serum urea and phosphate levels have been independently associated with the intensity of pruritus, while anemia has been linked to pallor and hair changes [6]. Moreover, the predominance and complexity of dermatological features increase with CKD progression, particularly in patients on maintenance hemodialysis [7]. Despite this, there is limited literature in Indian settings that comprehensively evaluates both clinical and biochemical aspects of cutaneous involvement in CKD patients, especially with large sample sizes.

In view of this gap, the present prospective clinical and biochemical study aims to investigate the predominance, pattern, and associations of skin manifestations in CKD patients attending tertiary care hospitals in Odisha. By examining both the dermatological profile and relevant laboratory parameters, this study seeks to enhance early recognition, guide timely interventions, and ultimately improve the quality of care and life in this vulnerable population.

Methodology

Study Design: This study is a prospective clinical and biochemical observational study.

Study Setting: The study was carried out in the Departments of Dermatology and Medicine at Maharaja Jajati Kesari Medical College & Hospital, Jajpur, Odisha, and PRM Medical College & Hospital, Mayurbhanj, Odisha. Both institutions provided the clinical infrastructure and laboratory support necessary for comprehensive data collection and analysis.

Study Duration: The study was conducted over a period of one and a half years, from 1st January 2024 to 1st July 2025.

Participants: A total of 1,200 patients diagnosed with various stages of chronic kidney disease were enrolled during the study period. Patients attending medicine or dermatology outpatient departments or those admitted to the wards in either of the two medical colleges were considered for inclusion in the study.

Inclusion Criteria

- Patients aged 18 years and above.
- Diagnosed cases of (CKD stages 1–5) based on KDIGO 2021 criteria.
- Patients who provided informed written consent.
- Patients willing to undergo both clinical dermatological evaluation and biochemical investigations.

Exclusion Criteria

- Patients with (AKI).
- Patients with pre-existing dermatological conditions unrelated to CKD (e.g., psoriasis, atopic dermatitis).
- Patients on immunosuppressive therapy or with autoimmune diseases.
- Individuals with malignancies or HIV-positive status.

Bias: Efforts were made to minimize selection bias by consecutively enrolling all eligible patients from the two centers. Observer bias was reduced by employing standardized diagnostic criteria for cutaneous lesions and laboratory tests. Inter-observer reliability was improved by involving two dermatologists for confirmation in ambiguous cases.

Data Collection

A pre-validated structured proforma was used to collect the following information:

- Demographic data (age, sex, occupation).
- CKD stage and underlying etiology.
- Duration of illness and dialysis status (if applicable).
- Comprehensive dermatological examination findings.
- Biochemical parameters including serum creatinine, urea, eGFR, hemoglobin, calcium, phosphate, parathyroid hormone levels, and other relevant markers.

Procedure: Each participant underwent a thorough clinical dermatological evaluation performed by a dermatologist. Suspected lesions were documented and, if necessary, biopsied for histopathological confirmation. Blood samples were collected under aseptic conditions and analyzed in institutional biochemistry laboratories. All findings were recorded in digital format and cross-verified.

Statistical Analysis: All collected data were entered and analyzed using IBM SPSS software version 23.0. Descriptive statistics such as mean, standard deviation, percentages, and frequencies were used to summarize demographic and clinical data. Inferential statistical methods such as Chi-square test, Student's t-test, and ANOVA were employed to find associations between cutaneous manifestations and biochemical parameters. A p-value <0.05 was considered statistically significant.

Results

Out of the 1200 CKD patients enrolled in the study, 720 (60%) were male and 480 (40%) were female, with a mean age of 52.4 ± 14.6 years (range: 19–85 years). The majority of patients belonged to the 51–60 years' age group (n=368, 30.7%).

Table 1: Demographic Characteristics of Study Participants (n = 1200)

Characteristic	Frequency (n)	Percentage (%)
Gender		
Male	720	60.0
Female	480	40.0
Age Group (years)		
18–30	108	9.0
31–40	156	13.0
41–50	224	18.7
51–60	368	30.7
61–70	244	20.3
>70	100	8.3

A male preponderance was observed. The highest representation was from the 51–60 age group.

Distribution of CKD Stages: Most participants were in Stage 4 (30.2%) and Stage 5 (34.1%), with 310 patients (25.8%) on maintenance hemodialysis.

Table 2: Stage-wise Distribution of CKD Patients

CKD Stage	Frequency (n)	Percentage (%)
Stage 1	60	5.0
Stage 2	120	10.0
Stage 3	192	16.0
Stage 4	362	30.2
Stage 5 (non-dialysis)	156	13.0
Stage 5 (Dialysis)	310	25.8

Advanced CKD stages (4 and 5) accounted for over 60% of participants, reflecting greater dermatologic involvement.

Cutaneous Manifestations: A total of 1044 patients (87%) had one or more dermatologic manifestations. The most common were xerosis (66.7%), pruritus (58.2%), hyperpigmentation (42.4%), and pallor (39.1%).

Table 3: Frequency of Cutaneous Manifestations (n = 1200)

Cutaneous Manifestation	Frequency (n)	Percentage (%)
Xerosis (dry skin)	800	66.7
Pruritus	698	58.2
Hyperpigmentation	509	42.4
Pallor	469	39.1
Nail changes	322	26.8
Hair changes	286	23.8
Uremic frost	84	7.0
Ecchymosis/Purpura	76	6.3
Fungal infections	192	16.0
Bacterial infections	98	8.2
Other (lichenification, calciphylaxis, etc.)	144	12.0

Xerosis and pruritus were the most prevalent features, especially in patients undergoing dialysis or in late-stage CKD.

Biochemical Correlation: Significant correlations were observed between selected biochemical parameters and certain skin changes. For instance, pruritus was strongly associated with high serum urea (>100 mg/dL) and serum phosphate (>6 mg/dL) ($p<0.001$).

Table 4: Correlation of Pruritus with Biochemical Parameters

Parameter	Pruritus Present (n=698)	Pruritus Absent (n=502)	p-value
Serum Urea (mg/dL)	106.2 ± 20.1	91.4 ± 17.5	<0.001
Serum Phosphate (mg/dL)	6.8 ± 1.2	5.6 ± 1.1	<0.001
Serum Calcium (mg/dL)	8.2 ± 0.6	8.6 ± 0.5	0.02
Hemoglobin (g/dL)	9.1 ± 1.3	10.2 ± 1.5	<0.05

Higher levels of uremic toxins and phosphate were statistically associated with pruritus and xerosis, suggesting a biochemical basis for these symptoms.

CKD Stage vs. Cutaneous Manifestations: Advanced stages showed a higher frequency and complexity of cutaneous findings. For example, uremic frost and calciphylaxis were seen almost exclusively in Stage 5 patients on dialysis.

Table 5: CKD Stage vs. Number of Cutaneous Manifestations

CKD Stage	Avg. Number of Manifestations per Patient	p-value
Stage 1–2	0.7	—
Stage 3	1.3	0.03
Stage 4	2.6	<0.001
Stage 5 ND	2.9	<0.001
Stage 5 D	3.4	<0.001

The number of dermatological symptoms increased significantly with disease progression, particularly in dialysis patients ($p<0.001$).

Summary of Key Findings

- 87% of CKD patients had dermatological manifestations.
- Most common features: xerosis, pruritus, and hyperpigmentation.
- Biochemical abnormalities (e.g., high urea, phosphate) were significantly associated with pruritus and xerosis.
- Patients in Stages 4 and 5 had significantly more and severe cutaneous involvement.
- Dialysis patients had a greater number of cutaneous features compared to non-dialysis CKD patients ($p<0.001$).

Discussion

In this prospective study involving 1,200 patients with (CKD), cutaneous manifestations were found to be highly prevalent, affecting 87% of the cohort. The majority of participants were male (60%), with the mean age being 52.4 years, and the largest subgroup falling in the 51–60-year age group. The study population was primarily composed of patients in advanced stages of CKD, with Stage 4 (30.2%) and Stage 5 (34.1%) comprising over 64% of all cases, indicating a higher burden of disease severity among the subjects.

The most frequently observed dermatological conditions included xerosis (66.7%), pruritus (58.2%), hyperpigmentation (42.4%), and pallor (39.1%), followed by nail and hair changes. These findings are consistent with uremic and metabolic changes typically observed in CKD patients, particularly those undergoing hemodialysis, who represented 25.8% of the cohort. Notably, uremic frost and calciphylaxis—rare but severe manifestations—were predominantly noted in dialysis-dependent patients, underlining the dermatological impact of end-stage renal disease.

Statistical analysis revealed significant associations between biochemical parameters and certain cutaneous features, especially pruritus, which showed strong correlations with elevated serum urea and hyperphosphatemia ($p<0.001$). Patients with pruritus had markedly higher urea (mean 106.2 mg/dL) and phosphate levels, as well as lower hemoglobin and calcium, suggesting a multifactorial etiology involving metabolic toxins, secondary hyperparathyroidism, and anemia. These observations underscore the biochemical underpinnings of dermatological symptoms in CKD and highlight the need for metabolic control in reducing symptom burden.

Further, the number of cutaneous manifestations increased proportionately with CKD stage, with patients in Stage 5 on dialysis experiencing an average of 3.4 dermatologic symptoms compared to fewer than one symptom in early-stage CKD (Stage 1–2). This gradient reflects the cumulative effect of uremia, dialysis-related changes, and chronic inflammation on the skin and its appendages. The findings strongly suggest that dermatologic screening should be an integral part of CKD management, particularly for those in advanced or dialysis-dependent stages.

(CKD) patients commonly present with dermatological symptoms, which significantly affect their quality of life and are often linked with biochemical abnormalities. In a recent review, Escamilla et al. reported that both nonspecific (e.g., pruritus, xerosis, pigmentation disorders) and specific (e.g., perforating dermatoses, calciphylaxis)

skin manifestations are prevalent in advanced CKD, often due to toxin accumulation or chronic inflammation [8]. A study from Ghana revealed a 95.2% prevalence of skin disorders in CKD patients, with pallor, xerosis, and pruritus being the most common findings. Notably, half-and-half nails and scalp hair loss were frequently observed [9].

Blaha et al. emphasized that pruritus, xerosis, pigmentation changes, and nail abnormalities are widespread in end-stage renal disease (ESRD), especially among those undergoing hemodialysis. However, treatment for these symptoms remains challenging due to limited large-scale clinical trial data [10]. In a cross-sectional study from Indonesia, Sartika et al. found xerosis (73.2%) and pruritus (68.6%) to be the leading complaints among both hemodialysis and non-dialysis patients. Nail and hair changes were also reported in over half of the participants [11].

Khare and Gulanikar similarly observed that xerosis (60%), pruritus (43%), and nail changes (82%) were frequently noted in patients undergoing dialysis and post-transplant care, suggesting a strong link between skin changes and the management stage of CKD [12]. In pediatric populations, xerosis (80%) and pruritus (60%) were the leading symptoms among stage 5 CKD patients on regular dialysis, though no significant associations were found between dermatological findings and age or disease etiology [13].

Shaikh et al. highlighted xerosis (87.9%), pruritus (24.1%), and pigmentation (31.9%) as common findings in ESRD patients. Nail changes such as half-and-half nails and alopecia were also significant, indicating systemic biochemical imbalance [14]. Pradhan et al. established a statistically significant relationship between pruritus and serum creatinine and urea levels, underlining the biochemical basis for cutaneous symptoms in CKD [15].

Vudayana et al. conducted a focused study on patients undergoing maintenance hemodialysis and found high rates of xerosis (91%) and pruritus (69%), with a significant number also experiencing nail dystrophies such as onycholysis and half-and-half nails [16]. Lastly, Potthuri and Arun observed pruritus (85.1%) and xerosis (84%) as the most common skin manifestations, supporting the notion that these symptoms are both widespread and distressing in hemodialysis patients [17].

Conclusion:

Cutaneous manifestations are highly prevalent among patients with chronic kidney disease, especially in advanced stages and those on dialysis. Common findings such as xerosis, pruritus, and hyperpigmentation are significantly associated with biochemical abnormalities like elevated urea and phosphate. Early recognition and management of these dermatological changes are essential to improve patient comfort and overall quality of life.

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