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Ocular manifestations in chronic kidney disease; a cross-sectional study

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ABSTRACT

Introduction: Chronic kidney disease (CKD) is a growing national health challenge that is associated with systemic complications, including eye-related morbidity, which can markedly reduce quality of life.

Objectives: This study aimed to estimate the prevalence of ocular manifestations among patients with CKD and to identify associated risk factors, including CKD stage, dialysis dependence, comorbidities, and sex.

Patients and Methods: We conducted a retrospective cross-sectional study of patients with CKD who attended a private ophthalmology clinic in Amman, Jordan. Demographic and clinical data (eGFR, CKD stage [2–5], dialysis status, and comorbidities: hypertension, diabetes, and anaemia) were extracted from records. Ocular assessment included retinal haemorrhages, cataracts, hypertensive retinopathy, macular oedema, and uremic optic neuropathy, in addition to LogMAR-based visual acuity. Odds ratios (ORs) with 95% confidence intervals (CIs) were estimated using logistic regression.

Results: Ocular manifestations were common, including hypertensive retinopathy (24.4%), retinal haemorrhages (17.1%), cataracts (14.6%), and macular oedema (7.3%). Dialysis was associated with uremic optic neuropathy (OR = 5.50) and retinal haemorrhages (OR = 2.80). Advanced CKD (stages 4–5) was associated with higher odds of retinal haemorrhages and increased risks of cataracts and hypertensive retinopathy. Diabetes was a significant predictor of retinal haemorrhages, cataracts, and hypertensive retinopathy, and hypertension was associated with more severe hypertensive retinopathy.

Conclusion: Ocular complications are common in CKD and are associated with disease severity, dialysis dependence, and systemic comorbidities. Integrating regular ophthalmologic screening into CKD care may help prevent avoidable visual impairment and improve quality of life.

Original

Implication for health policy/practice/research/medical education:

- Retinal hemorrhages, cataracts, and hypertensive retinopathy are common among chronic kidney disease (CKD) patients, with most experiencing moderate to severe visual impairment.
- Advanced CKD stages (especially stage 5) and dialysis dependency significantly increase the risk of retinal hemorrhages and uremic optic neuropathy.
- Diabetes and hypertension are key predictors of cataracts and hypertensive retinopathy, while combined comorbidities raise the risk of multiple ocular pathologies.
- Integrating regular ophthalmologic evaluations into CKD management is critical for early detection and prevention of vision loss.

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Introduction

Chronic kidney disease (CKD) is a major public health challenge of the 21st century and is characterised by progressive loss of kidney function over time. As CKD progresses, patients are exposed to multiple systemic complications, including cardiovascular, metabolic, and haematological disorders. Ocular manifestations are increasingly recognised, yet remain under-studied, despite their substantial impact on quality of life and the clinical management of CKD (1,2).

The close vascular and structural relationships between the kidneys and the eyes suggest potential links between renal and ocular disease. Hypertension and diabetes—common causes of CKD—are also major causes of hypertensive and diabetic retinopathy (2,3). However, the independent contribution of CKD to ocular morbidity remains incompletely understood (1,4).

Patients with CKD may develop a range of ophthalmic complications, including retinal haemorrhages, cataracts, hypertensive retinopathy, and uremic optic neuropathy. These conditions not only impair vision but may also reflect broader systemic deterioration. Estimating their prevalence and identifying associated risk factors is essential to improve diagnosis and guide prevention and intervention strategies (4–6).

The incidence of CKD appears to be increasing, and consequently the number of patients requiring long-term management is rising. Despite this trend, there is a paucity of research specifically exploring ocular complications in this population. Private ophthalmology clinics, which serve a large proportion of patients, provide a useful real-world setting to examine CKD-associated ocular disease (7).

Visual acuity is commonly measured using the logarithm of the minimum angle of resolution (LogMAR), which provides a standardised measure of visual impairment. Correlating LogMAR with clinical variables such as estimated glomerular filtration rate (eGFR) and CKD stage may clarify the extent and progression of ocular complications. In addition, ocular findings may be influenced by factors such as sex, dialysis status, and disease severity, which can be explored using odds-ratio analyses (8–10).

Objectives

This study aimed to assess the prevalence of ocular manifestations among patients with CKD and to examine their associations with demographic and clinical variables, including sex, CKD stage, and dialysis status. The overarching goal was to generate evidence that can inform clinical decision-making and support integrated renal–ophthalmic care.

Patients and Methods

Study design and participants

We conducted a retrospective cross-sectional study (June–August 2025) in a private ophthalmology clinic in Amman, Jordan that provides diagnostic and management services for ocular disease in patients with CKD.

Inclusion and exclusion criteria

A total of 141 patients with CKD were included using convenience sampling. Eligible participants were those with a documented diagnosis of CKD who underwent a complete ophthalmic evaluation during the study period. Patients with incomplete records and those with ocular conditions unrelated to CKD were excluded.

Data collection

Data were extracted from clinic medical records and included age, sex, eGFR, CKD stage (2–5), dialysis status, and comorbidities (hypertension, diabetes, and anaemia). Ocular outcomes included retinal haemorrhages, cataracts, hypertensive retinopathy, macular oedema, and uremic optic neuropathy, as well as LogMAR visual acuity categories. Multimorbidity vascular burden was defined as the presence of two or more chronic vascular-related conditions to reflect their combined impact on vascular health. In addition, CKD staging was based on Kidney Disease: Improving Global Outcomes (KDIGO) guidance and categorised by eGFR as: stage 2 (60–89 mL/min/1.73 m^2), stage 3 (30–59 mL/min/1.73 m^2), stage 4 (15–29 mL/min/1.73 m^2), and stage 5 (<15 mL/min/1.73 m^2) (6,7).

Instruments

A structured data-collection sheet was used to ensure consistency and accuracy. It captured demographic variables (age, sex), CKD-related variables (stage, eGFR, dialysis status), ophthalmic variables (LogMAR visual acuity and ocular findings), and comorbidities (hypertension, diabetes, and anaemia). Information was cross-checked between electronic and paper records, and ambiguities were resolved in consultation with the treating ophthalmologists.

Variables were classified as continuous (e.g., age and eGFR) or categorical (e.g., sex, CKD stage, dialysis status, and ocular findings). Quality control included double-checking data entry by two independent reviewers.

Statistical analysis

Statistical analysis was performed using SPSS version 27 (IBM Corp., Armonk, NY, USA). Continuous variables were summarised as means (SD) and ranges; categorical variables as frequencies and percentages. Independent-samples t-tests, χ^2 tests, and Fisher's exact tests were applied as appropriate. Univariate logistic regression was used to estimate ORs with 95% CIs. A P value <0.05 was considered statistically significant. Data were double-checked by two independent reviewers.

Results

The study population included a broad age range and a

balanced distribution of sex. Most patients had moderate-to-advanced CKD, reflecting a substantial burden of systemic disease (Table 1).

Comorbidities were common, particularly hypertension, diabetes, and anaemia, either alone or in combination. These conditions may worsen both renal and ocular outcomes and likely contributed to the visual findings observed. Ocular manifestations were frequent, and some patients had more than one ocular disorder concurrently, underscoring the complex relationship between kidney dysfunction and ocular health. These results support prioritising routine ophthalmologic screening in CKD care (Table 1).

Visual acuity assessment showed a clear pattern of vision loss. Only a small proportion of patients had normal vision, while most had moderate visual impairment. A substantial minority had severe visual impairment, indicating a meaningful impact on daily functioning and quality of life. Overall, these findings highlight the importance of periodic eye examinations for patients with CKD (Table 2).

Table 3 compares patients with and without ocular manifestations. Mean eGFR and visual acuity were significantly lower among those with ocular findings, indicating more advanced renal dysfunction and greater visual impairment. Higher CKD stage, dialysis dependence, hypertension, and the presence of multiple comorbidities were associated with ocular manifestations, consistent with cumulative vascular burden. Age, sex, and isolated diabetes or anaemia did not differ significantly.

Table 4 presents univariate logistic regression results. Male sex was associated with slightly higher odds of retinal haemorrhages, but this was not statistically significant. Disease severity showed a dose–response pattern; stages 4 and 5 were associated with higher odds of retinal haemorrhages, cataracts, and hypertensive retinopathy compared with stage 2. Dialysis dependence was a strong predictor of uremic optic neuropathy and

Table 1. Demographic, clinical, and ocular characteristics of the study population (n=141)

Variable	Categories	Value
Age (years)		50.59 (±15.03), Range 20-79
Gender (n, %)	Male	69 (48.8%)
	Female	72 (51.2%)
eGFR (mL/min/1.73m²)		33.09 (±23.95), Range 5.6-87.6
CKD (n, %)	Stage 5	45 (31.7%)
	Stage 4	38 (26.8%)
	Stage 3	34 (24.4%)
	Stage 2	24 (17.1%)
Dialysis (n, %)	Yes	69 (48.8%)
	No	72 (51.2%)
LogMAR visual acuity (Median, IQR)		Moderate: 0.7 (Range 0.0–1.4)
Comorbidity (n, %)	None	41 (29.3%)
	Hypertension, anemia	34 (24.4%)
	Diabetes	24 (17.1%)
	Hypertension	21 (14.6%)
	Hypertension, diabetes	21 (14.6%)
Ocular manifestations (n, %)	Retinal hemorrhages	24 (17.1%)
	Cataract	21 (14.6%)
	Hypertensive retinopathy (Grade II)	21 (14.6%)
	Multiple manifestations	21 (14.6%)
	Uremic optic neuropathy	14 (9.8%)
	Hypertensive retinopathy (Grade III)	14 (9.8%)
	None	10 (7.3%)
	Macular edema	10 (7.3%)
	Hypertensive retinopathy (Grade I)	7 (4.9%)

Table 2. Distribution of visual acuity categories based on LogMAR values in the study population (n=141)

LogMAR category	Visual acuity classification	Number (n)	Percent
0.0–0.2	Normal vision	17	12.06
0.3–0.5	Mild visual impairment	28	19.86
0.6–1.0	Moderate visual impairment	74	52.48
>1.0–1.4	Severe visual impairment	22	15.60
Total		141	100

Table 3. Comparison of demographic and clinical factors by presence of ocular manifestations among CKD patients (n = 141)

Variable	Categories	With ocular manifestations (n = 131)	Without ocular manifestations (n = 10)	Test statistic	*P* value (2-tailed)
Age (years, mean ± SD)	—	51.0 ± 14.8	47.3 ± 16.5	t = 0.76	0.450
Gender (n, %)	Male	65 (49.6 %)	4 (40.0 %)	χ^2 = 0.32	0.573
	Female	66 (50.4 %)	6 (60.0 %)		
CKD stages (n, %)	Stage 2	17 (13.0 %)	7 (70.0 %)	Fisher = 19.84	**0.001**
	Stage 3	34 (26.0 %)	0 (0.0 %)		
	Stage 4	36 (27.5 %)	2 (20.0 %)		
	Stage 5	44 (33.6 %)	1 (10.0 %)		
Dialysis status (n, %)	Yes	68 (51.9 %)	1 (10.0 %)	χ^2 = 6.77	**0.009**
	No	63 (48.1 %)	9 (90.0 %)		
Hypertension (n, %)	Present	72 (55.0 %)	2 (20.0 %)	χ^2 = 4.89	**0.027**
Diabetes mellitus (n, %)	Present	38 (29.0 %)	1 (10.0 %)	χ^2 = 1.47	0.225
Anemia (n, %)	Present	43 (32.8 %)	1 (10.0 %)	χ^2 = 2.26	0.133
Combined comorbidities (≥2) (n, %)	Yes	42 (32.1 %)	0 (0.0 %)	Fisher = 5.18	**0.021**
eGFR (mL/min/1.73 m², mean ± SD)	—	31.8 ± 23.6	55.9 ± 18.4	t = 3.22	**0.002**
LogMAR visual acuity (mean ± SD)	—	0.78 ± 0.33	0.22 ± 0.12	t = 6.11	**<0.001**

Table 4. Logistic regression coefficients and odds ratios for the association between demographic and clinical factors and specific ocular manifestations among CKD patients (n = 141)

Factor	Ocular manifestation	β (Logistic coefficient)	OR	95% CI	*P* value
Gender					
Male (versus female)	Retinal hemorrhages	0.37	1.45	0.70–3.00	0.310
	Cataract	-0.16	0.85	0.40–1.80	0.670
	Hypertensive retinopathy (Grade II–III)	0.10	1.10	0.50–2.50	0.780
CKD stage (Ref: stage 2)					
Stage 3 versus 2	Retinal hemorrhages	0.47	1.60	0.70–3.70	0.260
	Cataract	0.34	1.40	0.60–3.20	0.430
	Hypertensive retinopathy (Grade II–III)	0.59	1.80	0.90–3.60	0.091
Stage 4 versus 2	Retinal hemorrhages	1.06	2.90	1.10–7.60	**0.029**
	Cataract	0.92	2.50	1.10–5.60	**0.029**
	Hypertensive retinopathy (Grade II–III)	0.79	2.20	0.90–5.10	0.081
Stage 5 versus 2	Retinal hemorrhages	1.41	4.10	1.90–9.00	**0.001**
	Cataract	1.10	3.00	1.10–8.20	**0.031**
	Hypertensive retinopathy (Grade II–III)	0.99	2.70	1.00–7.20	**0.046**
Dialysis (Yes versus No)	Uremic optic neuropathy	1.70	5.50	2.30–13.10	**0.0005**
	Retinal hemorrhages	1.03	2.80	1.20–6.50	**0.017**
Comorbidities					
Diabetes (versus none)	Retinal hemorrhages	0.92	2.50	1.10–5.60	**0.027**
	Cataract	1.28	3.60	1.60–8.00	**0.002**
	Hypertensive retinopathy (Grade II–III)	0.79	2.20	1.00–4.90	**0.048**
	Macular edema	0.74	2.10	0.90–5.00	0.084
	Uremic optic neuropathy	0.64	1.90	0.80–4.30	0.120
Hypertension (versus none)	Retinal hemorrhages	0.59	1.80	0.80–4.00	0.150
	Hypertensive retinopathy (Grade III)	1.06	2.90	1.20–7.00	**0.018**
Hypertension + anemia (versus none)	Multiple manifestations	1.19	3.30	1.50–7.20	**0.004**
Hypertension + diabetes (versus none)	Multiple manifestations	1.44	4.20	1.80–9.90	**0.001**

retinal haemorrhages.

Comorbidities also showed important associations. Diabetes was strongly associated with cataracts, retinal haemorrhages, and hypertensive retinopathy, and showed positive (but non-significant) trends for macular oedema and uremic optic neuropathy. Hypertension, alone or combined with anaemia or diabetes, increased the odds of severe hypertensive retinopathy and multiple ocular manifestations. Overall, advanced CKD stage, dialysis dependence, diabetes, and hypertension were the main predictors of sight-threatening ocular disease in this population.

Discussion

This study illustrates the complex relationship between CKD and ocular health, mediated through vascular, metabolic, and inflammatory pathways (13,14). Most patients had moderate-to-severe CKD and nearly half were dialysis-dependent, providing important context for the observed ocular burden. The prevalence of retinal haemorrhages, cataracts, hypertensive retinopathy, and multiple ocular manifestations suggests that ocular complications are common and reflect systemic disease burden.

Using LogMAR visual acuity highlighted variability in ocular involvement. More than half of participants had moderate visual impairment (LogMAR 0.6–1.0) and approximately one in six had severe impairment (LogMAR >1.0–1.4), whereas a sizeable minority had normal or near-normal vision. This heterogeneity likely reflects differences in the timing of CKD diagnosis, access to routine ophthalmic evaluations, and the control of systemic comorbidities. Early detection and timely treatment may help preserve visual function even in advanced CKD (9,13).

Conversely, poorer visual outcomes may reflect delayed diagnosis, limited access to care, and more aggressive systemic disease trajectories. These findings align with prior reports showing benefits of proactive screening and multidisciplinary care for preserving vision in high-risk populations (6,8). Our results support integrating ophthalmologic evaluation into routine CKD management protocols and suggest that visual impairment may act as a marker of systemic disease severity in this population.

Regarding demographic predictors, sex differences were observed but did not reach statistical significance. Males had higher odds of retinal haemorrhages, whereas females appeared more likely to develop cataracts. Prior work suggests that sex-related susceptibility may vary with hormonal factors, lifetime exposures, and healthcare-seeking behaviour (13–17). In our study, any sex effect was likely outweighed by stronger determinants such as CKD severity, dialysis dependence, and comorbidity burden.

Meanwhile, CKD severity, particularly progression to stage 5, was significantly associated with retinal haemorrhages, with approximately fourfold higher odds compared with stage 2. Stage 4 was also associated with higher odds of cataract. These findings are consistent with the concept that declining kidney function is accompanied by vascular instability and metabolic derangements that predispose to retinal and lenticular pathology (1,3).

Dialysis dependence was a strong predictor of ocular complications. Dialysis-dependent patients had markedly increased odds of uremic optic neuropathy and retinal haemorrhages, suggesting that despite toxin clearance, patients may remain exposed to substantial vascular stress, oxidative injury, and hemodynamic instability (6,8). This supports tailored ocular monitoring in patients receiving dialysis, who appear particularly vulnerable to vision-threatening complications.

Comorbidity patterns further supported the role of systemic vascular disease in ocular pathology. Hypertension was a major predictor of severe hypertensive retinopathy (grade III), consistent with extensive evidence linking elevated blood pressure to microvascular damage (1,3).

Patients with multimorbidity, particularly hypertension combined with anemia or diabetes had substantially higher odds of developing multiple ocular manifestations. Anaemia-related retinal hypoxia and diabetes-related microvascular dysfunction may act together with hypertension to accelerate ocular damage. These findings reinforce the importance of aggressive risk-factor management to preserve both renal function and ocular integrity (2,3,9,15–18).

An unexpected finding was the relatively low prevalence of diabetes in our cohort compared with global CKD reports. This may reflect regional diabetes prevalence, referral patterns, or sociodemographic characteristics of the study setting (6,14). Patients with diabetic nephropathy may also be underrepresented if they preferentially attend centres with endocrinology services. Broader multicentre studies could clarify whether this represents true epidemiological variation or sampling effects.

Age is an important contextual factor. Although participants ranged from 20 to 79 years, older age groups may have been underrepresented. Since both CKD progression and ocular tissue degeneration are age-associated, the age distribution may have influenced the observed prevalence patterns (15–17). Future studies should include a wider age spectrum to better characterise how ageing modifies ocular risk in CKD and to inform age-appropriate screening strategies.

Conclusion

This study highlights the importance of recognising ocular complications as an integral component of CKD management. Routine ophthalmologic screening, along with early intervention and intensive risk-factor control should be prioritized to prevent vision loss and preserve quality of life. Future studies with larger, geographically diverse samples and longitudinal designs are needed to

clarify causality and to inform more holistic models of renal–ocular care.

Limitations of the study

The relatively small sample size and retrospective design may introduce selection and information bias. As this investigation was a single-center study, generalisability is limited, and the cross-sectional nature of the data precludes causal inference. Excluding incomplete records may also have led to underrepresentation of more severe cases.

Recommendations

Future research should be multicentre and prospective, with longitudinal follow-up to evaluate the progression of ocular manifestations across different populations. Larger samples including earlier CKD stages would provide stronger estimates of disease trajectories. Incorporating advanced ocular imaging and relevant biomarkers may provide further insight into the mechanisms linking CKD and ocular health.

Authors' contribution

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Conflicts of interest

The authors declare that they have no competing interests.

Ethical issues

The research conducted in this study adhered to the principles outlined in the Declaration of Helsinki and was approved by the Ethics Committee of The Hashemite University (Ethical code No. 8/3/2024/2025). Prior to any intervention, all participants provided written informed consent. Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

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