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Research Article

Renal Health Status in Individuals Living in Camps of Duhok, Kurdistan Region – Iraq

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ABSTRACT

Background: Internally displaced persons (IDPs) living in camps often face substandard living conditions that may adversely affect renal health. This study aimed to assess and compare the renal function biomarkers between IDPs residing in camps and healthy individuals living outside camps in Duhok, Kurdistan Region, Iraq.

Subjects and Methods: A cross-sectional study was conducted involving 300 participants (150 IDPs and 150 controls), aged 18–65 years. Individuals with chronic diseases, smokers, alcohol consumers, or other potential confounders (such as pregnancy, recent acute illness, use of nephrotoxic medications, or history of kidney surgery) were excluded. Blood and urine samples were collected to evaluate serum albumin, creatinine, and urea, urine albumin and creatinine, albumin/creatinine ratio (ACR), and microscopic urine examination. The estimated glomerular filtration rate (eGFR) was calculated. The data were analyzed across demographic variables, including age, gender, body mass index, drinking water amount, and biochemical parameters.

Results: IDPs exhibited significantly lower serum albumin and creatinine levels and higher ACR compared to controls ($p < 0.05$). No significant differences were found in urea or eGFR. Microalbuminuria prevalence was higher in IDPs (5.3%) than in controls (2%), and this difference was statistically significant ($p = 0.006$). ACR was elevated in the IDPs across all subgroups. Microscopic urine examination revealed uric acid crystals in the IDP group; these crystals were not observed in the control participants. Most participants were classified as CKD stage 1 or 2; comparisons at stages 3a and 3b were limited due to small sample sizes.

Conclusions: IDPs living in camps showed early signs of renal dysfunction, with altered albumin, creatinine, and ACR levels. These findings underscore the need for improved renal health surveillance and targeted interventions focused on hydration, nutrition, and living conditions in displacement settings.

Introduction

The ongoing humanitarian crisis in the Middle East has led to the displacement of millions of individuals **1**. As a result of the conflict with the Islamic State in Iraq and Syria (ISIS) in 2014 and regional instability, the Kurdistan Region of Iraq saw a large influx of internally displaced persons (IDPs), leading to the establishment of camps such as Khanke, Shariya, and Garbarto [2,3]. Initially designed as temporary shelters, these camps have become long-term settlements marked by overcrowding, limited infrastructure, restricted healthcare access, and reliance on humanitarian aid [4]. Key challenges include inconsistent access to clean water, poor sanitation, insufficient nutrition, and chronic stress—all of which may adversely affect kidney function [2]. Despite these known risks, renal health remains a critical yet under-researched concern among IDPs in the Kurdistan Region [5,6]. The University of Duhok (UoD) plays a key role in supporting the health of displaced populations in the Kurdistan Region of Iraq through medical care, research, and public health initiatives, including dental clinics, water and sanitation, nutrition programs, and mental health services [5]. The effects of the 2014 ISIS genocide on Yazidi IDPs, particularly women and children, revealed high rates of post-traumatic stress disorder (PTSD), depression, and trauma-related disorders [7-10]. Yazidis, in particular, suffer from long-term psychological harm and increased physical health risks such as high BMI and blood pressure [11]. These findings highlight the urgent need for early diagnosis, ongoing mental health care, and social support for survivors [8]. Chronic Kidney Disease (CKD) is a progressive condition marked by persistent kidney damage and reduced function (glomerular filtration rate (GFR) <60 mL/min/1.73 m²) or structural changes, such as albuminuria [12]. CKD progression involves nephron loss, inflammation, and fibrosis, with some cases linked to environmental factors [13,14].

Subjects and Methods

Study Design and Subjects

This cross-sectional study was conducted in Duhok city from October 2024 to October 2025, with sample collection taking place from October to December 2024 to assess renal health status among IDPs living in camps. A total of 300 apparently healthy individuals aged 18–65 years were enrolled and divided into two equal age- and gender-matched groups: 150 IDPs living in camps since the ISIS attack in 2014 and 150 individuals living outside the camps as controls. The IDP participants were recruited from three camps: Gabarto 1 (34 participants; total population ~14,012), Gabarto 2 (91 participants; total population ~13,952), and Khanke (25 participants; total population ~16,115). Kabarto 1 and 2 Camps are located approximately 13 km southwest of Duhok city, while Khanke Camp is situated about 20 km west of the city. These camps rely mainly on external aid and specialized infrastructure for essential needs such as water supply, which differs in quality and reliability from the urban water system of Duhok. A simple random sampling technique was used to select participants from both the IDP camps and the control population. The control group included individuals from various urban and suburban areas of Duhok city. These participants were selected to provide a representative estimate of renal health status among the camp population, with 95% confidence in the measured outcomes. Inclusion criteria included apparently healthy adults aged 18–65 years with no known history of CKD prior to participation. Exclusion criteria included a history of kidney impairment, acute infections, pregnancy, smoking, alcohol consumption, chronic diseases (e.g., diabetes mellitus, cancer, liver, or heart disorders), or the use of any medications or supplements within at least six months prior to sampling. Ethical approval was granted by the Ethics Committee of the College of Health Sciences and the Directorate of Health in Duhok on 25 September 2024 (reference number: 25092024-8-25). Written informed consent was obtained from each participant after the study objectives were explained.

Data Collection

Participants were interviewed and completed a pre-designed questionnaire covering demographic data, medical and family history, duration of displacement, and water intake habits. Participants reported their total water consumption over the previous 24 hours in milliliters (ml). To standardize intake despite variations in glass sizes, 1 cup was defined as 180 ml. Information on the type of water consumed (tap, bottled, or other sources) was also recorded.

Anthropometric Measurements

• Height and weight were measured using standardized procedures, and body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m²) [15]. According to their BMI, the participants were classified based on National Institutes of Health (NIH) criteria [16] into four categories: underweight (<18.5 kg/m²), normal weight (18.5–24.9 kg/m²), overweight (25–29.9 kg/m²), and obese (≥30 kg/m²).

• Systolic and diastolic blood pressure (SBP and DBP) were measured using an electronic blood pressure monitor after participants had rested for at least 5 minutes in a seated position.

• Waist circumference was measured at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest using a non-stretchable measuring tape, with participants standing and breathing normally.

Collection of blood and urine samples

Venous blood samples (5 mL) and midstream urine samples were collected from all participants under aseptic conditions. Blood samples were collected in gel-containing tubes, left for 30 minutes, then centrifuged for 10 minutes at 3000 rpm to obtain the serum. Random urine samples were collected in two plain tubes; one was analyzed immediately for microscopic examination at the health centers of the camps and the College of Health Sciences. The remaining urine samples and serum were transported in a portable medical cooler with ice packs to a freezer at the College of Health Science at the University of Duhok at (–40 °C), used exclusively for biological sample storage, where they were kept frozen until analysis.

• Serum Albumin: Was measured using the bromocresol green (BCG) colorimetric method with a commercially available kit (Catalog No. 80002, Biolab Diagnostics, France).

• Serum Urea: Was measured using the enzymatic colorimetric method with a commercially available kit (Catalog No. 92021, Biolab Diagnostics, France).

• Serum Creatinine: Was measured using the kinetic Jaffe reaction method with a commercially available kit (Catalog No. 80107, Biolab Diagnostics, France).

• eGFR was calculated using Cockcroft-Gault equation [17]:

$$eGFR= \{(140–age) \times \text{weight in Kg})/ (72 \times SCr)\} \times 0.85 \text{ (if female)}$$

• Urine Albumin: Was measured by immunoturbidimetric assay (ALB-T TQ Gen. 2 kit)

• Urine Creatinine: Was analyzed using the kinetic colorimetric Jaffe method (CREAJ Gen. 2 kit).

• Serum albumin, urea, and creatinine were performed on the Kenza® 240TX analyzer at the College of Health Sciences, University of Duhok. Urine albumin and creatinine were measured on the Cobas c 311 analyzer (Roche Diagnostics, Germany) at an Awny private laboratory in Duhok.

• Albumin-to-Creatinine Ratio (ACR) was calculated using the formula [18]:
ACR (mg/g) = ((urine albumin (mg/dL)/ urine creatinine (mg/dL)) * 100
• Microscopic Urine Examination involved microscopic evaluation of pus, red blood cells (RBCs), amorphous, calcium oxalate, uric acid, crystals, epithelial and bacteria, and other abnormalities. All microscopic findings were semi-quantitatively graded based on their abundance under the microscope:
O 1+: few cells or crystals observed per high-power field (HPF)
O 2+: moderate number per HPF
O 3+: large number per HPF
All biochemical assays were performed according to the manufacturer's instructions with internal quality controls.
Chronic Kidney Disease (CKD) Assessment
Chronic kidney disease (CKD) was classified into five stages based on glomerular filtration rate (GFR) and into three stages based on albuminuria, 19, as shown in Tables 1 and 2, respectively.

Table 1: Chronic kidney disease (CKD) stages based on glomerular filtration
Rate (GFR)

Stages of CKD	GFR value ml/ min/1.73m^2	Classification
1	>90	Normal or High
2	60-89	Mild decrease
3a	45-59	Mild to moderate decrease
3b	30-44	Moderate to severe decrease
4	15-29	Severe decrease
5	<15	Kidney failure

*Abbreviations: CKD – Chronic Kidney Disease; GFR – Glomerular Filtration Rate; mL/min/1.73 m² – milliliters per minute per 1.73 square meters.

Table 2: Chronic kidney disease (CKD) stages based on albuminuria

Stages of CKD	(ACR) mg/g	Classifications
1	<30	Normal to discrete
2	30 – 300	Moderate
3	>300	Severe

*Abbreviations: CKD – chronic kidney disease; ACR – Albumin-to-Creatinine Ratio; mg/g – milligrams per gram

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 22 and Microsoft Excel. Continuous variables are presented as mean ± standard deviation (SD). Group comparisons were performed using independent t-tests. Statistical significance was set at $p \leq 0.05$.

Results

Characteristic Features of the Participants (IDP and control)
As shown in Table 3, participants were subdivided into groups based on study characteristics:
• BMI Categories: Most participants (43%) had normal weight, followed by overweight (32%) and obese (20%).
• Water Intake: The majority of participants drank filtered water (54% of IDPs, 48% of controls), followed by tap water, which was more prevalent among IDPs (44%) than controls (34.6%). Daily water consumption was recorded in milliliters: the majority of both groups (54%) of the IDPs and (60%) of the controls drank (900 – 1,800 mL/day) followed by (38%) of the IDPs versus (32%) of the controls drank (< 900 mL/day).

Table 3: Percentage distribution of the participants

Demographic and lifestyle characteristics	Total n (%)	IDP n (%)	Controls (%)
Number of respondents	300	150 (50)	150 (50)
Age groups			
<25	93 (31)	40 (26.66)	53 (35.33)
25 – 45	136 (45.33)	71 (47.33)	65 (43.33)
>45	71 (23.66)	39 (26)	32 (21.33)
Gender			
Females	171 (57)	84 (56)	87 (58)
Males	129 (43)	66 (44)	63 (42)
BMI			
Underweight	12 (4)	6 (4)	6 (4)
Normal weight	130 (43)	66 (44)	64 (42.67)
Over weight	96 (32)	40 (26.67)	56 (37.33)
Obese	62 (20)	38 (25.33)	24 (16)
Type of drinking water			
Tap water	118 (39.30)	66 (44)	52 (34.64)
Filtered water	153 (51)	81 (54)	72 (48)
Bottled water	29 (9.70)	3 (2)	26 (17.33)
Amount of drinking water (ml/day)			
<900	96 (32)	57 (38)	39 (26)
900 – 1800	171 (57)	81(54)	90 (60)
>1800	33(11)	12 (8)	21 (14)

Comparison of the variables between the studied groups
Statistically significant differences were found between IDPs and the controls in diastolic blood pressure (DBP), serum albumin, serum creatinine, and ACR in urine, but no significant differences were seen in systolic blood pressure (SBP), waist circumference, urea, eGFR, age, and BMI, according to Table 4
Comparison of the studied groups by age.
Participants were categorized into three categories (<25, 25-45, >45) as shown in Table 5. The study revealed that, across all age categories, serum albumin and creatinine levels were lower, whereas urine ACR was higher in the IDP group than in the control group ($p<0.05$). Furthermore, both SBP and DBP were significantly lower in the IDP group within the younger group as compared to the control group

Table 4: Mean values of the investigated variables in the studied groups

Variables	IDP (mean ± SD)	Control (mean ± SD)	*p** Value
BMI (Kg/m^2)	26.57 ± 5.31	25.63 ± 3.95	0.259
SBP (mmHg)	115.03 ± 10.84	115.01 ± 10.97	0.992
DBP (mmHg)	72 ± 9.41	74.6 ± 11.27	0.031*
Waist Circumference	90.14 ± 14.71	90.94 ± 14.28	0.633
Serum albumin (g/dL)	4.71 ± 0.35	4.93 ± 0.32	<0.001*
Serum creatinine (mg/dL)	0.87 ± 0.21	0.96 ± 0.23	<0.001*
Serum urea (mg/dL)	38.1 ± 11.06	39.05 ± 9.54	0.425
eGFR (mL/min/1.73m²)	105.97 ± 25.82	104.44 ± 25.29	0.604
Urine ACR (mg/g)	6.16 ± 2.74	4.37 ± 2.26	<0.001*

*Significant results According to Independent t- test
*Abbreviations: BMI – Body Mass Index; SBP – Systolic Blood Pressure; DBP – Diastolic Blood Pressure; eGFR – Estimated Glomerular Filtration Rate; ACR – Albumin-to-Creatinine Ratio; SD – Standard Deviation. $p < 0.05$ considered statistically significant.

Table 5: Comparison between the studied groups according to their ages

Variables	Age (in year)	IDPs mean± SD (N)	Control mean±SD (N)	*p** value
Serum Albumin (g/dL)	<25	4.93 ±0.34 (40)	5.12 ± 0.3 (53)	0.006*
	25 – 45	4.68 ±0.35 (71)	4.87 ± 0.28 (65)	<0.001*
	>45	4.54 ±0.24 (39)	4.75 ± 0.3 (32)	0.002*
Serum creatinine (mg/dL)	<25	0.85 ±0.18 (40)	0.98 ± 0.18 (53)	0.001*
	25 – 45	0.83 ± 0.2 (71)	0.93 ± 0.24 (65)	0.009*
	>45	0.95 ±0.23 (39)	1.02 ± 0.29 (32)	0.310
Serum urea (mg/dL)	<25	34.65±11.22(40)	36.57±10.36(53)	0.396
	25 – 45	36.91± 9.98 (71)	39.34 ±8.81 (65)	0.135
	>45	43.8 ±10.88 (39)	42.56 ±8.61 (32)	0.603
eGFR (mL/min/1.73m²)	<25	107.08±22.89(40)	108.72±23.02(53)	0.734
	25 – 45	112.55±23.35(71)	105.28±25.53(65)	0.085
	>45	92.85± 28.53 (39)	95.63± 26.99 (32)	0.676
Urine ACR (mg/g)	<25	6.51 ± 2.59 (40)	4.64± 2.61 (53)	<0.001*
	25 – 45	6.23 ± 2.75 (71)	4.42 ± 2.03 (65)	<0.001*
	>45	5.69 ± 2.83 (39)	3.82 ± 2.04 (32)	0.003*
SBP (mmHg)	<25	109.75 ±6.59 (40)	113.58± 6.82 (53)	0.008*
	25 – 45	111.75 ±7.73 (71)	113.09 ±12.1 (65)	0.437
	>45	126.41±11.11(39)	121.28±12.08(32)	0.067
DBP (mmHg)	<25	68.75 ± 8.22 (40)	74.53 ± 7.73 (53)	<0.001*
	25 – 45	70.85 ± 8.9 (71)	72.15 ±11.65 (65)	0.461
	>45	77.44 ± 9.38 (39)	79.69 ±13.79 (32)	0.417

*Significant results According to Independent t- test
*Abbreviations: SD – Standard Deviation; SBP – Systolic Blood Pressure; DBP – Diastolic Blood Pressure; eGFR – Estimated Glomerular Filtration Rate; ACR – Albumin-to-Creatinine Ratio; BMI – Body Mass Index. $p < 0.05$ considered statistically significant.

Comparison between the studied groups based on their body mass index (BMI)

Serum albumin levels decreased with increasing BMI in both groups. The IDP group consistently had significantly lower serum albumin and creatinine levels than the control group across all BMI subcategories, except for normal weight, where no significant difference in creatinine was observed. Urine ACR values decreased with increasing BMI in both groups; however, IDPs had consistently higher urine ACR levels than controls at the same BMI. Lastly, a significant reduction in SBP and DBP was observed in underweight participants, while no significant differences were found in the other BMI categories, as shown in Table 6.

Table 6: Comparison between the studied groups according to their body mass index (BMI)

Variables	BMI (Kg/m^2)	IDPs mean± SD (N)	Control mean±SD (N)	*p** value
Serum albumin (g/dL)	Underweight	4.98 ± 0.38 (6)	5.08 ± 0.29 (6)	0.624
	Normal weight	4.81 ± 0.38 (66)	5.05 ± 0.31 (64)	<0.001*
	Overweight	4.62 ± 0.31 (40)	4.88 ± 0.3 (56)	0.001*
	Obese	4.59 ± 0.25 (38)	4.71 ± 0.28 (24)	0.084
Serum creatinine (mg/dL)	Underweight	0.87 ± 0.11 (6)	1.02 ± 0.13 (6)	0.059
	Normal weight	0.87 ± 0.2 (66)	0.93 ± 0.23 (64)	0.138
	Overweight	0.87 ± 0.25 (40)	0.98 ± 0.24 (56)	0.037*
	Obese	0.86 ± 0.20 (38)	1.02 ± 0.24 (24)	0.005*
Serum urea (mg/dL)	Underweight	36.95 ± 8.19 (6)	31.7 ± 6.93 (6)	0.259
	Normal weight	37.38±11.30 (66)	38.5 ± 10.4 (64)	0.558
	Overweight	39.36±11.99 (40)	39.68 ± 9.23 (56)	0.882
	Obese	38.2 ± 10.23 (38)	40.87 ± 7.67 (24)	0.246
eGFR (mL/min/1.73m²)	Underweight	36.95 ± 8.19 (6)	31.7 ± 6.93 (6)	0.259
	Normal weight	89.45 ± 23.03 (6)	75.67 ± 13.21 (6)	0.233
	Overweight	103.46±23.86(66)	102.22±24.02(64)	0.768
	Obese	108.68 ±28.16 (40)	106.29±24.35(56)	0.658
Urine ACR (mg/g)	Underweight	7.24 ± 1.54 (6)	2.83 ± 1.6 (6)	<0.001*
	Normal weight	6.14 ± 2.83 (66)	4.59 ± 2.43 (64)	0.001*
	Overweight	6.42 ± 2.84 (40)	4.62 ± 2.1 (56)	<0.001*
	Obese	5.76 ± 2.63 (38)	3.57 ± 2.02 (24)	<0.001*
SBP (mmHg)	Underweight	106.67 ± 5.16 (6)	113.33 ± 5.16 (6)	0.049*
	Normal weight	112.14 ±7.94 (66)	112.66±10.27(64)	0.747
	Overweight	117.55±12.93(40)	115.38± 9.89 (56)	0.353
	Obese	118.71±11.64(38)	120.88±14.08(24)	0.514
DBP (mmHg)	Underweight	63.33 ± 5.16 (6)	80 ± 6.32 (6)	<0.001*
	Normal weight	70.3 ± 7.83 (66)	72.5 ± 10.38 (64)	0.175
	Overweight	72.5 ± 10.31 (40)	74.29 ± 9.88 (56)	0.394
	Obese	75.79 ±10.03 (38)	79.58 ±15.45 (24)	0.245

* Significant results According to Independent t- test
*Abbreviations: SD – Standard Deviation; BMI – Body Mass Index; SBP – Systolic Blood Pressure; DBP – Diastolic Blood Pressure; eGFR – Estimated Glomerular Filtration Rate; ACR – Albumin-to-Creatinine Ratio.
$p < 0.05$ considered statistically significant.

Comparison between the studied groups according to the amount of drinking water in mL/day

The data were analyzed according to daily water intake (<900, 900–1,800, and >1,800 mL/day). Serum albumin and serum creatinine levels were significantly lower, while ACR was higher in the IDP group compared to the control group among participants who consumed <900 mL/day and 900–1,800 mL/day. No significant differences in serum albumin, serum creatinine, or urine ACR were observed in participants who consumed >1,800 mL/day, as shown in Table 7.

Comparison between the studied groups according to the type of drinking water:

Participants were also categorized into three categories according to the type of drinking water (tap water, filtered water and bottled water), significantly lower serum albumin and serum creatinine levels and higher urine ACR levels were recorded in IDPs compared to controls among those who drank tap or filtered water, while no significant differences were observed in participants consuming bottled water as shown in Table 8. In general, serum albumin and serum creatinine levels increased in both groups as the source of drinking water shifted from tap to filtered to bottled, as shown in Table 8. No significant differences in serum urea or eGFR levels were observed across water types.

Table 7: Comparison between the studied groups according to the amount of drinking water mL/day

Variables	Amount of drinking water (mL/day)	IDPs mean± SD (N)	Control mean±SD (N)	*p** value
Serum albumin (g/dL)	<900	4.67 ± 0.36 (57)	5.01 ± 0.39 (39)	<0.001*
	900 – 1,800	4.74 ± 0.35 (81)	4.91 ± 0.3 (90)	<0.001*
	>1,800	4.69 ± 0.28 (12)	4.87 ± 0.25 (21)	0.067
Serum creatinine (mg/dL)	<900	0.86 ± 0.2 (57)	0.94 ± 0.24 (39)	0.072*
	900 – 1,800	0.86 ± 0.21 (81)	0.97 ± 0.23 (90)	0.002*
	>1,800	0.96 ± 0.23 (12)	1.01 ± 0.23 (21)	0.563
Serum urea (mg/dL)	<900	37.73 ±11.48 (57)	37.4 ± 10.3 (39)	0.886
	900 – 1,800	38.42±11.55 (81)	40.61 ± 9.04 (90)	0.166
	>1,800	37.69 ± 3.75 (12)	35.41 ± 9.11 (21)	0.417
eGFR (mL/min/1.73m²)	<900	103.99±27.96(57)	105.56±23.38(39)	0.774
	900 – 1,800	108.02±23.93(81)	105.22 ±27.3 (90)	0.479
	>1,800	101.54 ±28.6 (12)	99 ± 19.39 (21)	0.763
Urine ACR (mg/g)	<900	6.25 ± 2.52 (57)	4.68 ± 1.9 (39)	0.001*
	900 – 1,800	6.25 ± 2.9 (81)	4.32 ± 2.5 (90)	<0.001*
	>1,800	5.14 ± 2.6 (12)	4.03 ± 1.76 (21)	0.153
SBP (mmHg)	<900	113.89 ± 9.19(57)	113.85 ± 10.41(39)	0.981
	900 – 1,800	114.59±11.39(81)	115.24 ±10.71 (90)	0.7
	>1,800	123.33 ±11.54 (12)	116.19 ±13.22 (21)	0.129
DBP (mmHg)	<900	71.4 ± 9.34 (57)	74.1 ± 10.69 (39)	0.193
	900 – 1,800	71.98 ± 9.41 (81)	74.78 ± 11.14 (90)	0.079
	>1,800	75 ± 10 (12)	74.46 ± 13.27 (21)	0.957

* Significant results. According to the Independent t- test

*Abbreviations: SD – Standard Deviation; SBP – Systolic Blood Pressure; DBP – Diastolic Blood Pressure; eGFR – Estimated Glomerular Filtration Rate; ACR – Albumin-to-Creatinine Ratio.

$p < 0.05$ is considered statistically significant.

Table 8: Comparison between the studied groups according to the type of drinking water

Variables	Type of drinking water	IDPs mean± SD (N)	Control mean±SD (N)	*p** value
Serum albumin (g/dL)	Tap water	4.65 ± 0.35 (66)	4.88 ± 0.29 (52)	<0.001*
	Filtered water	4.75 ± 0.34 (81)	4.91 ± 0.31 (72)	0.003*
	Bottled water	4.93 ± 0.43 (3)	5.08 ± 0.39 (26)	0.54
Serum creatinine (mg/dL)	Tap water	0.85 ± 0.19 (66)	0.96 ± 0.2 (52)	0.002*
	Filtered water	0.87 ± 0.22 (81)	0.95 ± 0.27 (72)	0.049*
	Bottled water	1.03 ± 0.4 (3)	1.01 ± 0.22 (26)	0.856
Serum urea (mg/dL)	Tap water	37.40 ± 9.44 (66)	38 ± 9.43 (52)	0.736
	Filtered water	38.85 ± 12.3 (81)	39.55 ± 9.28 (72)	0.696
	Bottled water	33 ± 9.44 (3)	39.78 ±10.64 (26)	0.302
eGFR (mL/min/1.73m²)	Tap water	105.23 ±27.2 (66)	107.13±24.65(52)	0.696
	Filtered water	107.1 ±24.54 (81)	103.02±26.22(72)	0.322
	Bottled water	91.73 ± 34.28 (3)	102.98±24.46(26)	0.472
Urine ACR (mg/g)	Tap water	6.19 ± 2.58 (66)	4.77 ± 2.41 (52)	0.003*
	Filtered water	6.25 ± 2.86 (81)	4.31 ± 2.18 (72)	<0.001*
	Bottled water	3.32 ± 1.68 (3)	3.73 ± 2.11 (26)	0.747
SBP (mmHg)	Tap water	114.44±10.95(66)	113.29±10.79(52)	0.57
	Filtered water	115.07±10.73(81)	116.4 ±12.01 (72)	0.471
	Bottled water	126.67 ± 5.77 (3)	114.62 ± 7.6 (26)	0.014*
DBP (mmHg)	Tap water	71.97 ± 9.15 (66)	73.27 ±12.32 (52)	0.512
	Filtered water	71.73 ± 9.72 (81)	75.14 ±11.38 (72)	0.047*
	Bottled water	80 ± 0 (3)	75.77 ± 8.56 (26)	0.407

* Significant results. According to the Independent t- test
*Abbreviations: SD – Standard Deviation; SBP – Systolic Blood Pressure; DBP – Diastolic Blood Pressure; eGFR – Estimated Glomerular Filtration Rate; ACR – Albumin-to-Creatinine Ratio.
$p < 0.05$ is considered statistically significant.

Comparison of the variables between the studied groups according to their gender:
A statistically significant decrease in serum albumin and serum creatinine, and an increase in urine ACR, were observed in the IDP group compared with the control group in both genders. Meanwhile, urea levels were significantly lower in males of the IDP group, but no significant difference was observed in females compared with the control group. (Table 9).

Table 9: Mean values of the studied variables according to their gender

Variables	Male			Female		
	IDPs mean ± SD (N)	Control mean ± SD (N)	*p** value	IDPs mean ± SD (N)	Control mean ± SD (N)	*p** value
BMI (Kg/m²)	26.57 ± 5.31 (66)	25.63 ± 3.95 (63)	0.259	25.51 ± 4.33 (84)	25.11 ± 5.06 (87)	0.577
SBP (mmHg)	118.23 ± 10.62 (66)	119.84 ± 8.32 (63)	0.34	112.51 ± 10.39 (84)	111.52 ± 11.36 (87)	0.552
DBP (mmHg)	74.85 ± 8.81 (66)	77.87 ± 9.06 (63)	0.065	69.76 ± 9.31 (84)	72.3 ± 12.17 (87)	0.129
Waist circumference (cm)	92.57 ± 15.78 (66)	93.55 ± 12.05 (63)	0.694	88.22 ± 13.6 (84)	89.04 ± 15.49 (87)	0.714
Serum albumin (g/dL)	4.74 ± 0.35 (66)	5 ± 0.33 (63)	<0.001*	4.68 ± 0.35 (84)	4.88 ± 0.31 (87)	<0.001*
Serum creatinine (mg/dL)	0.92 ± 0.2 (66)	1.07 ± 0.23 (63)	<0.001*	0.82 ± 0.2 (84)	0.89 ± 0.21 (87)	0.049*
Serum urea (mg/dL)	39.2 ± 9.58 (66)	42.92 ± 8.61 (63)	0.022*	37.23 ± 12.08 (84)	36.24 ± 9.24 (87)	0.549
eGFR (mL/min/1.73m²)	104.48 ± 25.48 (66)	104.3 ± 25.03 (63)	0.966	107.14 ± 26.18 (84)	104.54 ± 25.63 (87)	0.513
Urine ACR (mg/g)	6.3 ± 2.92 (66)	4.13 ± 2.11 (63)	<0.001*	6.06 ± 2.59 (84)	4.54 ± 2.36 (87)	<0.001*

* Significant results. According to the Independent t- test
*Abbreviations: SD – Standard Deviation; BMI – Body Mass Index; SBP – Systolic Blood Pressure; DBP – Diastolic Blood Pressure; eGFR – Estimated Glomerular Filtration Rate; ACR – Albumin-to-Creatinine Ratio. $p < 0.05$ is considered statistically significant.

Comparison between chronic kidney disease (CKD) Stages Among the Studied Groups:

According to Table 10, there were no statistically significant differences between the studied groups according to CKD stages

Comparison between the studied groups according to Albuminuria:

According to Table 11, there were statistically significant differences between the studied groups in stages 1 and 2 based on albuminuria

Table 10: Comparison between the studied groups according to CKD Stages

CKD stages	eGFR (mL/min/1.73m²)	IDPs mean ± SD (N)	Control mean ± SD (N)	*p** value
Stage 1 Normal or high	≥ 90	117.20 ± 18.90 (111)	116.49 ± 18.69 (106)	0.779
Stage 2 Mild decrease	60 – 89	78.65 ± 8.32 (32)	79.26 ± 8.69 (37)	0.767
Stage 3a Mild to moderate decrease	45 – 59	54.11 ± 5.51 (6)	55.04 ± 2.59 (7)	0.699
Stage 3b Moderate to severe decrease	30 – 44	(1)	0	Statistical comparison could not be performed due to insufficient sample size in this category

* Significant results According to Independent t- test

*Abbreviations: CKD – Chronic Kidney Disease; eGFR – Estimated Glomerular Filtration Rate; SD – Standard Deviation.

$p < 0.05$ considered statistically significant.

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Table 11: Comparison between the studied groups according to albuminuria

Stages of ACR (mg/g)	Classification	IDPs mean ± SD (N)	Control mean± SD(N)	*p** value
1	Normal	6.07± 2.76 (142)	4.37±2.28 (147)	<0.001*
2	Microalbuminuria	7.78± 1.5 (8)	4.5±0.0 (3)	0.006*
3	Macroalbuminuria	0	0	Statistical comparison could not be performed due to insufficient sample size in this category

* Significant results According to Independent t- test

Abbreviations: ACR – Albumin-to-Creatinine Ratio; SD – Standard Deviation.

$p < 0.05$ considered statistically significant.

Microscopic Urine Examination

The microscopic examination was performed to look for pus, red blood cells (RBCs), amorphous calcium oxalate, uric acid, epithelial cells, and bacteria. Similar results were found in both groups in all the microscopic tests, with the exclusion of uric acid; 23 participants showed 1+ in the IDPs group, whereas no cases were observed in the control group.

Discussion

This study aimed to evaluate and compare renal health markers among IDPs living in camps and healthy individuals living outside the camps in Duhok, Kurdistan Region, Iraq. Our findings revealed significant alterations in renal biomarkers between the two groups, indicating potential renal health challenges among IDPs residing in displacement camps.

The significantly lower serum albumin and creatinine levels observed in the IDP group compared to controls align with previous studies demonstrating nutritional and metabolic disturbances among displaced populations [20]. For instance, a study conducted in Debark refugee camp in Ethiopia found that low serum albumin, total protein, and folate were significant determinants of malnutrition among IDPs [21]. Similarly, research among children in IDP camps in Maiduguri, Nigeria, reported low albumin and total protein levels, reflecting poor nutritional status and increased vulnerability to infectious and metabolic complications [22]. These studies, along with our findings, indicate that displacement is consistently associated with compromised nutritional and biochemical status across populations. Albumin, a marker of nutritional status and liver function, is also sensitive to inflammation and protein loss [23]. The reduced albumin levels in IDPs may reflect the combined effects of poor nutrition, chronic stress, and potential low-grade inflammation, all common in displacement settings due to limited food security and suboptimal living conditions [24]. This hypoalbuminemia can adversely impact renal function and overall health [25].

Similarly, the lower serum creatinine levels in the IDPs likely reflect reduced muscle mass or malnutrition rather than improved renal clearance, as creatinine production is directly linked to muscle metabolism in addition to kidney function (6)[26]. Evidence from studies on muscle wasting and malnutrition indicates that serum creatinine is an unreliable marker of renal function in populations with sarcopenia or chronic nutritional deficits, as it may underestimate kidney dysfunction and overestimate eGFR [27]. This is particularly relevant for our IDPs, where chronic stress, limited nutrition, and reduced physical activity could contribute to decreased muscle mass [28] (5).

Despite these reductions in albumin and creatinine, the eGFR did not differ significantly between groups. This may be explained by the fact that creatinine-based eGFR equations, such as Cockcroft-Gault, can overestimate kidney function in individuals with low muscle mass [29] [17]. Notably ACR, a sensitive marker for early kidney damage, was significantly elevated in the IDP group. This finding is consistent across age groups, BMI categories, and drinking water types, indicating persistent subclinical renal injury despite apparently normal eGFR. Microalbuminuria is a known early indicator of glomerular injury and has been associated with increased risk for progression to CKD and cardiovascular morbidity [18.]

The prevalence of microalbuminuria was more than double in IDPs (5.3%) compared to controls (2%), highlighting the increased renal vulnerability in displaced populations. This finding is critical given the high prevalence of CKD risk factors in such settings, including exposure to environmental toxins, infections, dehydration, and psychological stress [18].

Since the majority of participants in both groups fall into stages 1 (normal kidney function) and 2 (mild decrease in kidney function), the comparison between IDPs and controls in the more advanced CKD stages (3a and 3b) is limited by the small sample sizes in these subsets. This limits the statistical power to draw definitive conclusions about differences in moderate-to-severe kidney impairment between the groups.

Interestingly, no significant differences in serum urea levels were found between groups. Urea is influenced by protein intake and catabolism, so the similar values may reflect comparable protein metabolism despite differences in albumin and creatinine [30].

Additionally, no significant changes in blood pressure were detected in most categories except lower DBP among IDPs in younger age groups and underweight participants. This could be related to differences in cardiovascular status [31].

Water intake and source showed important effects on renal markers. Lower albumin and creatinine levels in IDPs drinking tap or filtered water compared to controls suggest potential exposure to suboptimal water quality or quantity, which can impact hydration status and renal function [32]. The higher ACR in these groups further supports possible renal stress linked to water source. However, these differences diminished among participants who consumed bottled water, suggesting that better water quality may mitigate some renal risks.

Gender comparisons showed patterns similar to the overall findings: both males and females in the IDP group had lower albumin and creatinine levels but higher ACR than controls. The changes were more marked in males, who showed a greater decline in creatinine and higher ACR. This likely reflects their higher baseline muscle mass and protein turnover, making them more sensitive to nutritional deficiencies and catabolic stress. In addition, the significant decrease in urea among IDP males may point to reduced protein intake or impaired protein metabolism under chronic stress. These differences indicate that sex-specific physiology should be considered when interpreting renal biomarkers in displaced populations. [33].

Microscopic urine examination revealed the presence of uric acid crystals exclusively in the IDP group. Uric acid crystalluria can be a marker of dehydration, metabolic disturbances, or increased cell turnover linked to stress and poor nutrition [34]. The absence of these crystals in controls further highlights environmental and physiological stressors faced by displaced populations that may predispose to kidney stone formation or renal injury **35**.

Overall, these findings indicated that IDPs in camps exhibited subtle but significant impairments in renal biomarkers, which may reflect early kidney damage driven by multifactorial stressors including malnutrition, dehydration, poor water quality, and psychosocial stress.

This study has several limitations. The cross-sectional nature of the study limits the ability to infer causal relationships or determine the temporal sequence between potential risk factors and renal outcomes. Amount and type of water intake was self-reported, which may introduce recall bias. Physical activity levels and detailed nutritional intake were not systematically collected. The exclusion of participants with known chronic diseases, while necessary for internal validity, may underestimate the true burden of renal dysfunction in camps A potential limitation of this study is that the control group, consisting of individuals living outside the camps, may not be fully homogeneous in infrastructure quality, socioeconomic status, and living conditions. Finally, urine specific gravity, pH, and protein were not measured, which limited the ability to comprehensively interpret hydration status and urinary abnormalities alongside microscopic findings.

Conclusion

In conclusion, displaced persons living in camps in Duhok are at increased risk of early renal dysfunction, as evidenced by lower serum albumin and creatinine levels and elevated ACR compared to healthy controls. These findings highlight the need for targeted healthcare interventions focused on improved nutrition, safe access to water, and routine renal monitoring for displaced populations. Future research should employ prospective designs and systematically assess nutritional status, hydration, and physical activity, as these unmeasured lifestyle factors may critically influence kidney outcomes. Addressing these gaps will strengthen causal inference and better guide preventive strategies and healthcare planning.

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Conflict of Interest

The author declares no conflicts of interest related to this work.

Data availability

Data are available upon reasonable request.

Author Contributions

BSY. contributed to conception, study design, data acquisition, data analysis, interpretation of results, drafting of the manuscript, and revision and proofreading. SYA contributed to conception, study design, interpretation of results, and revision and proofreading of the manuscript. All authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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References

[1] Mizzouri NS, Kochary SA, Barwari N. Decentralized sanitation solutions for temporal Internally Displaced people (IDPs) and refugees camps and residential complexes in Duhok province–Case study. Ain Shams Engineering Journal. 2022 Jun 1;13(4):101706. https://doi.org/10.1016/j.asej.2022.101706

[2] Cengiz M, Karademir K, Cinoglu H. The ISIS Model and its Influence Over Global Terrorism. European Scientific Journal. 2022;18(7):14-35. https://doi.org/10.19044/esj.2022.v18n7p14

[3] Qahar JA. The coping mechanism by Yazidi female survivors and their problems inside camps-Duhok. Holistic Economics. 2023 Apr 25;2(1):11-9. https://doi.org/10.55094/hoec.1957

[4] Denkinger JK, Rometsch C, Engelhardt M, Windthorst P, Graf J, Pham P, Gibbons N, Zipfel S, Junne F. Longitudinal changes in posttraumatic stress disorder after resettlement among Yazidi female refugees exposed to violence. JAMA network open. 2021 May 3;4(5):e2111120-. https://doi.org/10.1001/jamanetworkopen.2021.11120

[5] Borkowska K, Aziz Ketuly K, Osborne M, Abid Mohammed S, Azizi N. Embedding the Third Mission of universities in humanitarian crisis response: Profiling the role of the University of Duhok in addressing health needs of internally displaced people and refugees. Journal of Adult and Continuing Education. 2025 Mar;31(1):160-79. https://doi.org/10.1177/14779714241290658

[6] Cantor D, Swartz J, Roberts B, Abbara A, Ager A, Bhutta ZA, Blanchet K, Bunte DM, Chukwuorji JC, Daoud N, Ekezie W. Understanding the health needs of internally displaced persons: a scoping review. Journal of migration and health. 2021 Jan 1;4:100071. https://doi.org/10.1016/j.jmh.2021.100071

[7] Jasim KH, Alkass SY, Persike DS. Long-lasting effects of post-traumatic stress disorder in Yazidi women living in Northern Iraqi camps. Journal of Taibah University Medical Sciences. 2024 Oct 1;19(5):919-33. https://doi.org/10.1016/j.jtumed.2024.08.028

[8] Ahmed DR. A systematic review of Yazidi children and adolescents reveals high rates of mental and psychiatric disorders after the ISIS invasion in 2014. Global Psychiatry Archives. 2022 Jul 4;5(02):119-26.

[9] Hasan HM, Alkass SY, Persike DS, Alkass SY, de Oliveira DS. Post-traumatic Stress Disorder: The Influence of the Environmental Context and Analysis of Oxidative Stress and Inflammatory and Glycemic Markers in Women Living in Kurdistan Regional Government-Iraq. Cureus. 2024 Mar 21;16(3). 10.7759/cureus.56661 https://doi.org/10.7759/cureus.56661

[10] Goodman A, Bergbower H, Perrotte V, Chaudhary A. Survival after sexual violence and genocide: Trauma and healing for Yazidi women in Northern Iraq. Health. 2020 Jun 18;12(06):612. https://doi.org/10.4236/health.2020.126046

[11] Alsaeed HA, Khleel RI. Post-Traumatic Stress Disorder among Yazidi Adolescents Survivors at Refugee Camps in Duhok City, Kurdistan Region of Iraq. Journal of Global Scientific Research. 2022;7(5):2302-8.

[12] Chen TK, Knicely DH, Grams ME. Chronic kidney disease diagnosis and management: a review. Jama. 2019 Oct 1;322(13):1294-304. https://doi.org/10.1001/jama.2019.14745

[13] Torra R, Furlano M, Ortiz A, Ars E. Genetic kidney diseases as an underrecognized cause of chronic kidney disease: the key role of international registry reports. Clinical kidney journal. 2021 Aug 1;14(8):1879-85. https://doi.org/10.1093/ckj/sfab056

[14] Chapman E, Haby MM, Illanes E, Sanchez-Viamonte J, Elias V, Reveiz L. Risk factors for chronic kidney disease of non-traditional causes: a systematic review. Revista Panamericana de Salud Pública. 2019 Mar 14;43:e35. https://doi.org/10.26633/RPSP.2019.35

[15] Mahat RK, Singh N, Rathore V, Gupta A, Shah RK. Relationship between atherogenic indices and carotid intima-media thickness in prediabetes: a cross-sectional study from Central India. Medical Sciences. 2018 Jul 5;6(3):55. https://doi.org/10.3390/medsci6030055

[16] Buchholz AC, Bugaresti JM. A review of body mass index and waist circumference as markers of obesity and coronary heart disease risk in persons with chronic spinal cord injury. Spinal cord. 2005 Sep;43(9):513-8. https://doi.org/10.1038/sj.sc.3101744

[17] Michels WM, Grootendorst DC, Verduijn M, Elliott EG, Dekker FW, Krediet RT. Performance of the Cockcroft-

Gault, MDRD, and new CKD-EPI formulas in relation to GFR, age, and body size. Clinical Journal of the American Society of Nephrology. 2010 Jun 1;5(6):1003-9 https://doi.org/10.2215/cjn.06870909

[18] Weaver RG, James MT, Ravani P, Weaver CG, Lamb EJ, Tonelli M, Manns BJ, Quinn RR, Jun M, Hemmelgarn BR. Estimating urine albumin-to-creatinine ratio from protein-to-creatinine ratio: development of equations using same-day measurements. Journal of the American Society of Nephrology. 2020 Mar 1;31(3):591-601 https://doi.org/10.1681/asn.2019060605

[19] Chawla LS, Eggers PW, Star RA, Kimmel PL. Acute kidney injury and chronic kidney disease as interconnected syndromes. New England Journal of Medicine. 2014 Jul 3;371(1):58-66. https://doi.org/10.1056/nejmra1214243

[20] Gameiro J, Fonseca JA, Outerelo C, Lopes JA. Acute kidney injury: from diagnosis to prevention and treatment strategies. Journal of clinical medicine. 2020 Jun 2;9(6):1704. https://doi.org/10.3390/jcm9061704

[21] Girma M, Werede A, Chane E, Fentie A, Eshetu B. Assessment of Nutritional Status and Associated Factors Using Anthropometric Measurement and Selected Biochemical Parameters among Internally Displaced Individuals at Debark Refugee Camp, North Gondor, North West Ethiopia: A Cross-Sectional Study, 2022 GC. J Nutri Med Diet Care. 2023;9:065. https://doi.org/10.23937/2572-3278/1510065

[22] Musa AH, Abubakar AA, Fatima ZA, Mamza YP, Umar AM. Evaluation of Nutritional Status using MUAC, BMI Percentile and Biochemical indicators among Internally Displaced Children attending IDPs Clinic within Maiduguri/Jere, Borno State, Nigeria: An impact of the Boko Haram insurgency. Sokoto Journal of Medical Laboratory Science. 2022 Aug 27;7(2). https://sokjmls.com.ng/index.php/SJMLS/article/view/66

[23] Johnson RJ, Sánchez-Lozada LG, Newman LS, Lanaspa MA, Diaz HF, Lemery J, Rodriguez-Iturbe B, Tolan DR, Butler-Dawson J, Sato Y, Garcia G. Climate change and the kidney. Annals of Nutrition and Metabolism. 2019 Jun 14;74(Suppl. 3):38-44. https://doi.org/10.1159/000500344

[24] De Simone G, di Masi A, Ascenzi P. Serum albumin: a multifaced enzyme. International journal of molecular sciences. 2021 Sep 18;22(18):10086. https://doi.org/10.3390/ijms221810086

[25] Tabata F, Wada Y, Kawakami S, Miyaji K. Serum albumin redox states: more than oxidative stress biomarker. Antioxidants. 2021 Mar 24;10(4):503. https://doi.org/10.3390/antiox10040503

[26] Kameda T, Horikoshi K, Kumagai S, Saito Y, Yoshioka T. Adsorption of urea, creatinine, and uric acid onto spherical activated carbon. Separation and Purification Technology. 2020 Apr 15;237:116367. https://doi.org/10.1016/j.seppur.2019.116367

[27] De Rosa S, Greco M, Rauseo M, Annetta MG. The good, the bad, and the serum creatinine: exploring the effect of muscle mass and nutrition. Blood Purification. 2023 Nov 1;52(9-10):775-85. https://doi.org/10.1159/000533173

[28] Taha PH, Taib NI, Sulaiman HM. Posttraumatic stress disorder correlates among internally displaced Yazidi population following Islamic state of Iraq and Syria attacks in Iraq. BMC psychiatry. 2021 Jun 3;21(1):290. https://doi.org/10.1186/s12888-021-03299-8

[29] Ebert N, Bevc S, Bökenkamp A, Gaillard F, Hornum M, Jager KJ, Mariat C, Eriksen BO, Palsson R, Rule AD, van Londen M. Assessment of kidney function: clinical indications for measured GFR. Clinical kidney journal. 2021 Aug 1;14(8):1861-70. https://doi.org/10.1093/ckj/sfab042

[30] Botewad SN, Gaikwad DK, Girhe NB, Thorat HN, Pawar PP. Urea biosensors: A comprehensive review. Biotechnology and Applied Biochemistry. 2023 Apr;70(2):485-501. https://doi.org/10.1002/bab.2168

[31] Zhou D, Feng X, Wu S, Yan M, Wang J, Nie Z, Feng Y. Early Famine Exposure Results in Left Ventricular Remodeled, Diastolic Dysfunction and Systolic Function Preserved in Adults. Annals of Nutrition and Metabolism. 2024 Apr 2;80(2):74-86. https://doi.org/10.1159/000533659

[32] Ahmed DR, Heun R. The prevalence of psychiatric disorders among Yazidi people results from ISIS invasion and consecutive trauma: A systematic review. Asian journal of psychiatry. 2023 Oct 1;88:103703. https://doi.org/10.1016/j.ajp.2023.103703

[33] Chen L, Yin L. Sex-specific associations between blood urea nitrogen and risk of hyperuricemia in US adults: the NHANES 1999-2020. Frontiers in Endocrinology. 2025 Jun 5;16:1560738. https://doi.org/10.3389/fendo.2025.1560738

[34] Gherghina ME, Peride I, Tiglis M, Neagu TP, Niculae A, Checherita IA. Uric acid and oxidative stress—relationship with cardiovascular, metabolic, and renal impairment. International Journal of Molecular Sciences. 2022 Mar 16;23(6):3188. https://doi.org/10.3390/ijms23063188

[35] Tamborino F, Cicchetti R, Mascitti M, Litterio G, Orsini A, Ferretti S, Basconi M, De Palma A, Ferro M, Marchioni M, Schips L. Pathophysiology and main molecular mechanisms of urinary stone formation and recurrence. International journal of molecular sciences. 2024 Mar 6;25(5):3075. https://doi.org/10.3390/ijms25053075