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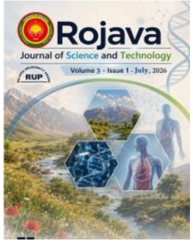

Kidney Disease in Conflict Settings: Prevalence and Risk Factors Among Syrian Adults Living in North and East Syria

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ABSTRACT

Background: Chronic kidney disease (CKD) is a major global public health problem associated with substantial morbidity, mortality, and healthcare costs. In Syria, prolonged conflict has disrupted healthcare services and may have increased exposure to environmental and lifestyle-related risk factors for kidney disease. However, epidemiological data on CKD in Syrian populations remain limited. This study aimed to assess the prevalence of CKD and identify associated risk factors among adults living in North and East Syria. Methods: A cross-sectional study was conducted between December 2023 and June 2024 among 150 adults recruited from outpatient clinics and internal medicine departments in North and East Syria. Sociodemographic characteristics, medical history, lifestyle factors, anthropometric measurements, blood pressure, fasting blood glucose, serum creatinine, and blood urea were assessed. Estimated glomerular filtration rate (eGFR) was calculated using the CKD Epidemiology Collaboration (CKD-EPI) equation. CKD was defined as eGFR <60 mL/min/1.73 m². Associations between CKD and potential risk factors were evaluated using correlation and chi-square analyses. Results: The mean eGFR was 40.4 ± 27.0 mL/min/1.73 m², and 72.67% of participants met the study definition of CKD. Advanced disease stages (CKD stages 3b–5) accounted for a substantial proportion of cases. CKD prevalence increased significantly with age ($p < 0.001$) and was higher among males than females ($p < 0.001$). Elevated mean arterial pressure (MAP) ($p < 0.001$), hyperglycemia ($p = 0.009$), a history of hypertension ($p = 0.004$), and cardiovascular disease ($p < 0.001$) were significantly associated with CKD. eGFR was negatively correlated with MAP ($r = -0.263$, $p = 0.001$). Reliance on Euphrates River water ($p < 0.001$) and long-term analgesic use ($p = 0.017$) were also significantly associated with CKD. No significant associations were observed for BMI category, smoking status, physical activity, or dietary pattern. Conclusions: A high prevalence of eGFR-defined CKD was observed among adults attending healthcare facilities in North and East Syria. Older age, male sex, elevated blood pressure, hyperglycemia, cardiovascular disease, long-term analgesic use, and reliance on Euphrates River water were associated with CKD. These findings highlight the need for enhanced screening and management of cardiometabolic risk factors and further investigation of environmental determinants of kidney disease in conflict-affected populations.

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1. Introduction

The kidneys play a central role in maintaining physiological homeostasis through regulation of fluid balance, electrolyte composition, acid–base equilibrium, endocrine signaling, and metabolic waste excretion. In addition to filtering blood and eliminating toxins, the kidneys contribute to blood pressure regulation through the renin–angiotensin–aldosterone system, stimulate erythropoiesis via erythropoietin secretion, and participate in calcium and phosphate homeostasis through activation of vitamin D metabolites (Terashita et al., 2026). Consequently, impairment of renal function has widespread systemic effects that influence cardiovascular, metabolic, hematological, and endocrine health. (National Institute of Diabetes and Digestive and Kidney Diseases 2018). Kidney disease (nephropathy) involves kidney damage that can lead to kidney failure, which is known as the end stage of kidney disease (ESKD). Chronic kidney disease (CKD) is a progressive condition marked by declining glomerular filtration rate, commonly caused by diabetes, hypertension, glomerulonephritis, and polycystic kidney disease (Murray et al. 2015). Importantly, CKD is strongly associated with cardiovascular disease (CVD), which remains the leading cause of death among patients with impaired renal function. Reduced kidney function contributes to endothelial dysfunction, chronic inflammation, vascular calcification, oxidative stress, and dysregulation of mineral metabolism, thereby increasing the risk of hypertension, ischemic heart disease, heart failure, and stroke (Lodi et al., 2026). This bidirectional relationship between CKD and CVD has led to the recognition of the cardiorenal syndrome as a major clinical entity. Furthermore, CKD imposes considerable socioeconomic burdens through increased hospitalization rates, reduced quality of life, loss of productivity, and escalating healthcare expenditures associated with dialysis and transplantation (Liao et al. 2012). Early intervention, lifestyle modifications, and medications can slow progression, while advanced stages require dialysis or transplantation (Lodi et al., 2026). Globally, the prevalence of CKD has risen steadily over recent decades, driven by population aging, urbanization, sedentary lifestyles, obesity, and the growing incidence of diabetes and hypertension. According to global epidemiological estimates, approximately 753 million individuals were living with CKD in 2016, highlighting the enormous burden of the disease worldwide. The prevalence of CKD varies substantially across regions and populations, with low- and middle-income countries experiencing particularly rapid increases due to limited healthcare infrastructure, inadequate screening programs, and delayed diagnosis (Agboola et aal., 2026). In Africa, the pooled prevalence of CKD stages 1–5 has been estimated at approximately 15.8%, whereas countries in the Middle East report highly variable prevalence rates depending on socioeconomic conditions, healthcare access, and environmental exposures (Bikbov, Perico, and Remuzzi 2018). In the Middle East and North Africa region, CKD represents an emerging public health crisis. Rapid urbanization, nutritional transitions, increasing rates of obesity and diabetes, and widespread hypertension have substantially increased the burden of renal disease. In addition, ongoing conflicts, environmental instability, and weakened healthcare systems in several countries further exacerbate disease progression and limit access to early diagnosis and treatment. Exposure to contaminated water, nephrotoxic substances, infectious diseases, and inappropriate medication use may also contribute to the rising prevalence of kidney dysfunction in vulnerable populations (Alasbahy et al., 2026). Between 2000 and 2016, the overall prevalence of CKD stages 1–5 was 15.8%, and CKD stages 3–5 was 4.6% in Africa (Kaze et al. 2018). The prevalence of ESKD in the Middle East—including Iran, Egypt, Turkey, Tunisia, Yemen, Syria, Lebanon, Qatar, and Iraq—ranged between 55 and 818 per million population. The prevalence of CKD stages 3–5 in Abu Dhabi was 2.8% in females and 4.6% in males (Malekmakan et al. 2018). Syria has experienced prolonged armed conflict and severe disruption of healthcare infrastructure over the past decade, resulting in reduced access to preventive healthcare services, shortages of medications, limited diagnostic capacity, and deterioration of water and sanitation systems. These conditions may significantly increase the risk of chronic diseases, including CKD, while simultaneously limiting opportunities for early detection and disease management. Despite these concerns, epidemiological data regarding CKD prevalence and associated risk factors within the Syrian population remain scarce. The absence of comprehensive screening programs and national renal registries has created substantial gaps in understanding the true burden of kidney disease in the region. Environmental and lifestyle factors may further influence CKD development among populations living in North and East Syria. Reliance on untreated water sources, prolonged use of analgesics and nonsteroidal anti-inflammatory drugs, smoking, poor dietary habits, and inadequate management of metabolic disorders may contribute to progressive renal impairment. However, the relative contribution of these factors has not been adequately investigated in Syrian populations. Identifying modifiable risk factors is essential for developing targeted prevention strategies and reducing disease progression.

2. Subjects and Methods

2.1. Study Design and Setting

This observational cross-sectional study was conducted between December 2023 and June 2024 in North and East Syria. The study aimed to evaluate the prevalence of chronic kidney disease (CKD) and identify associated demographic, clinical, and lifestyle-related risk factors among Syrian adults living in the region. Data collection was performed at outpatient clinics and internal medicine departments of several healthcare centers, including Afrin Hospital (Fafin, Al-Shahba District, Aleppo), Tal Rifaat Hospital (Al-Shahba District, Aleppo), Yassin Hospital (Sheikh Maqsoud neighborhood, Aleppo), Kobani Hospital (Kobani city), and Amal Hospital (Kobani city).

2.2. Study Population and Sample Size

The target population included Syrian adults aged 18 years and older residing in North and East Syria. Participants were recruited using a convenience sampling approach from patients and accompanying individuals attending the participating healthcare facilities during the study period (Farag, Kari, and Singh 2012).

The required sample size was estimated using EPI-INFO version 3 software based on an expected CKD prevalence of 5–6% reported in neighboring Middle Eastern countries due to the absence of national renal registries and limited screening data in Syria. A confidence interval of 95% and an acceptable margin of error of 8–10% were applied, resulting in a minimum required sample size of 150 participants. A total of 150 individuals were ultimately enrolled in the study.

2.3. Inclusion and Exclusion Criteria

Adults aged ≥18 years who were permanent residents of North and East Syria and agreed to participate were eligible for inclusion. Participants were excluded if they were pregnant, critically ill, undergoing dialysis, or unable to provide informed consent. Individuals with incomplete clinical or laboratory data were also excluded from the final analysis.

2.4. Ethical Considerations

The study protocol was approved by the Scientific Ethics Committee of Rojava University (Approval No. 22.06.2022). Official permissions were obtained from the administrations of the participating hospitals and healthcare centers. All procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants prior to enrollment.

2.5. Data Collection and Clinical Assessment

Following informed consent, all participants underwent structured interviews, clinical examinations, anthropometric measurements, and laboratory investigations. Data collection was performed by trained healthcare personnel using standardized procedures.

2.5.1. Questionnaire and Medical History

A structured questionnaire was used to obtain sociodemographic and clinical information, including age, sex, educational level, smoking status, alcohol intake, physical activity, dietary habits, and source of drinking water. Participants were also asked about their medical history, including hypertension, diabetes mellitus, cardiovascular disease (CVD), kidney disease, chronic medication use, and family history of chronic illnesses. Long-term analgesic use was defined as regular analgesic intake for prolonged periods exceeding three months.

2.5.2. Anthropometric Measurements

Body weight was measured to the nearest 0.1 kg using a calibrated digital scale, while height was measured to the nearest 0.5 cm using a non-stretchable measuring tape with participants standing barefoot and wearing light clothing. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Participants were categorized according to World Health Organization criteria as underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), or obese (≥30 kg/m^2).

2.5.3. Blood Pressure Measurement

Blood pressure measurements were obtained using standard mercury sphygmomanometers after participants had rested in a seated position for at least 5 minutes. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were recorded, and mean arterial pressure (MAP) was calculated using the following equation:

$$MAP = DBP + 1/3\ (SBP - DBP)$$

Blood pressure categories were classified according to the 2017 American College of Cardiology/American Heart Association guidelines as normal (<120/80 mmHg), elevated (120–129/<80 mmHg), or hypertensive (≥130/80 mmHg).

2.6. Laboratory Investigations

Venous blood samples were collected after overnight fasting and analyzed at accredited hospital laboratories using standardized laboratory procedures. The following biochemical parameters were assessed:

- Fasting blood glucose (FBG)
- Blood urea
- Serum creatinine

Fasting blood glucose levels were categorized as normal (<100 mg/dL), prediabetes (100–125 mg/dL), or diabetes (≥126 mg/dL). Estimated glomerular filtration rate (eGFR) was calculated using the CKD Epidemiology Collaboration (CKD-EPI) creatinine equation. CKD staging was performed according to Kidney Disease: Improving Global Outcomes (KDIGO) guidelines as follows:

- Stage 1: eGFR ≥90 mL/min/1.73 m^2
- Stage 2: eGFR 60–89 mL/min/1.73 m^2
- Stage 3a: eGFR 45–59 mL/min/1.73 m^2
- Stage 3b: eGFR 30–44 mL/min/1.73 m^2
- Stage 4: eGFR 15–29 mL/min/1.73 m^2
- Stage 5: eGFR <15 mL/min/1.73 m^2

CKD was defined as an eGFR below 60 mL/min/1.73 m².

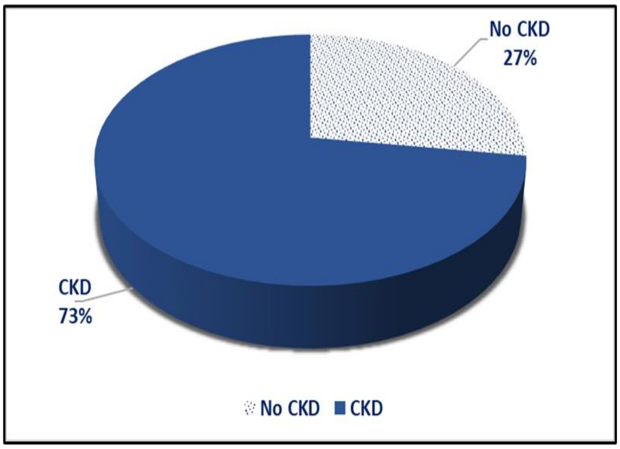
2.7. Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 27. Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were presented as frequencies and percentages. Differences between groups were analyzed using the independent samples t-test or one-way analysis of variance (ANOVA) for continuous variables, as appropriate. Associations between categorical variables were evaluated using Pearson's chi-square test or Fisher's exact test when necessary. Correlation analyses between eGFR and clinical variables were performed using Pearson correlation coefficients. A p-value ≤ 0.05 was considered statistically significant.

3. Results

3.1. eGFR and prevalence of CKD and different CKD stages using CKD-EPI equation:

According to the CKD-EPI equation, the mean estimated glomerular filtration rate (eGFR) was 40.4 mL/min/1.73 m² (SD = 27), and the prevalence of chronic kidney disease (CKD) was 72.67%. The participants were distributed across the five CKD stages: 2.67% in stage 1, 11% in stage 2, 18% in stage 3a, 9% in stage 3b, 10% in stage 4, and 22% in stage 5 (Figure 1).



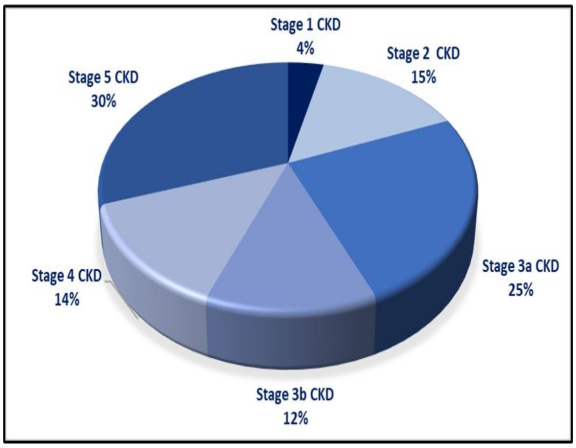


Figure 1: Distribution of chronic kidney disease (CKD) stages and overall CKD prevalence among study participants. The proportion of participants classified according to CKD stage using the CKD Epidemiology Collaboration (CKD-EPI) equation. CKD was defined as an estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m². The overall prevalence of CKD in the study population was 72.67%. Participants were distributed across CKD stages 1–5 according to Kidney Disease: Improving Global Outcomes (KDIGO) criteria.

3.2. The prevalence of some health risks related to CKD:

Hypertension affected 29.3% (44 individuals) of the participants, while hyperglycemia was present in 46.7% (70 individuals). Additionally, 46% (69 individuals) of the participants were classified as overweight or obese. These findings highlight significant risk factors associated with CKD in this population (Figure 2).

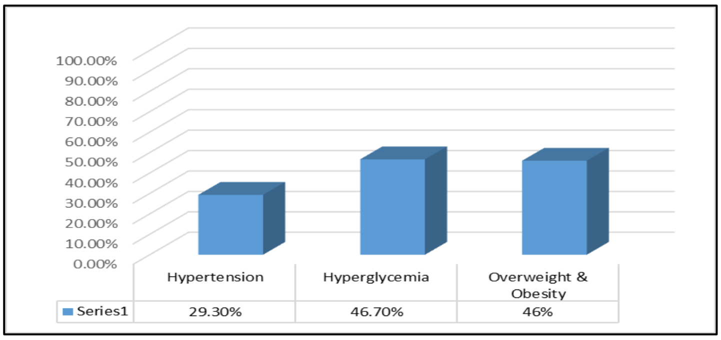


Figure 2: Prevalence of major chronic kidney disease (CKD)-related risk factors among study participants. Hypertension was present in 29.3% of participants, hyperglycemia in 46.7%, and overweight/obesity in 46.0%. These factors represent important clinical conditions associated with impaired kidney function.

3.3. Lifestyle and Clinical Determinants

Correlation between eGFR and various parameters:

Statistical analysis showed a positive correlation between eGFR and BMI, while mean arterial pressure (MAP) was negatively correlated with eGFR (Table 1).

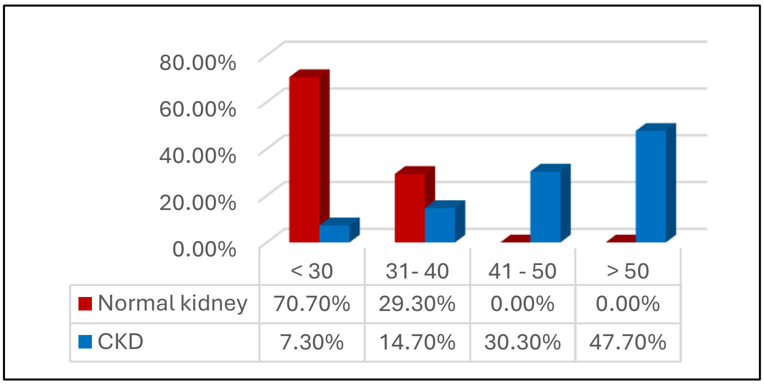
Table 1: Correlation between eGFR and various parameters:

Correlation	eGFR by CKD-EPI equation	
	R	**p-value**
BMI	0.223**	0.007
MAP	-0.263**	0.001
Fasting blood glucose (mg/dl)	-0.146	0.080

eGFR = estimated glomerular filtration rate, BMI = body mass index, MAP = mean arterial pressure. ** Correlation is significant at the 0.01 level (2-tailed).

3.4. Distribution of CKD according to age and sex

Statistical analysis demonstrated a significant association between age groups and CKD ($p < 0.001$). CKD prevalence increased with age, with nearly half of CKD patients being over 50 years old and 30% in the age group of 41 to 50. A significant association was also found between CKD and sex ($p < 0.001$), with 62.4% of CKD patients being male, compared to 37.6% female (Figure 3).



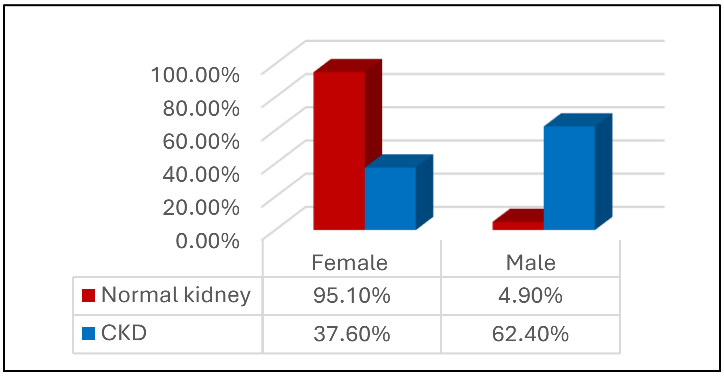


Figure 3: Distribution of chronic kidney disease (CKD) according to age group and sex. CKD prevalence increased significantly with age ($p < 0.001$), with the highest proportion observed among participants older than 50 years. A significant association was also observed between CKD and sex ($p < 0.001$), with males accounting for a greater proportion of CKD cases than females.

3.5. The relation between CKD and some medical risk factors related to CKD

The Body Mass Index (BMI) was not significantly associated with CKD ($p = 0.13$), which suggested no strong link between BMI categories and CKD. However, mean arterial pressure (MAP) demonstrated a significant relationship, with a higher proportion of individuals with elevated MAP having CKD compared to those with normal kidney function ($p < 0.001$). Fasting glucose levels were significantly associated with CKD ($p = 0.009$), indicating that higher glucose levels were more prevalent in individuals with CKD (Table 2). The history of kidney disease ($p = 0.88$), history of diabetes ($p = 0.22$), and family history of diabetes ($p = 0.77$) did not show significant associations with CKD. However, there was a significant relationship between CKD and a history of hypertension ($p = 0.004$), as well as CKD and a history of cardiovascular disease (CVD) ($p < 0.001$). Family history of hypertension ($p = 0.22$) and family history of CVD ($p = 0.37$) were not significantly associated with CKD. These findings

Table 2: The relation between CKD and some medical risk factors related to CKD

		Normal kidney (Number = 41)	**CKD (Number = 109)**	**χ^2 Value (Pearson Chi-Square)**	**p-value**
BMI	Underweight Normal weight Overweight Obese	2 14 20 5	7 58 32 12	5.65	0.13
MAP	Normal High	30 11	34 75	17.85	<0.001*
Fasting glucose	Normal High	29 12	51 58	6.86	0.009*
History of kidney disease	No Yes	19 22	52 57	0.02	0.88
History of diabetes	No Yes	32 9	74 35	1.48	0.22
Family history of diabetes	No Yes	27 14	69 40	0.08	0.77
History of hypertension	No Yes	27 14	43 66	8.35	0.004*
Family history of hypertension	No Yes	15 26	52 57	1.49	0.22
History of CVD	No Yes	40 1	74 35	14.38	<0.001*
Family history of CVD	No Yes	20 21	62 47	0.79	0.37

BMI = body mass index, MAP = mean arterial pressure, CVD = cardiovascular disease p-value ≤ 0.05 is statistically significant

3.6. The relation between CKD and some lifestyle risk factors related to CKD:

The majority of individuals with CKD (100 out of 109) relied on water from the Euphrates River, compared to 22 out of 41 individuals with normal kidney function, showing a highly significant difference ($p < 0.001$). Long-term analgesic use was more common in CKD patients, with 47 individuals reporting use, compared to 9 individuals with normal kidney function, also showing statistical significance ($p = 0.017$) (Table 3). Education level did not significantly affect CKD ($p = 0.69$). Smoking was more common among individuals with CKD (53 out of 109) compared to those with normal kidney function (28 out of 41), but this difference was not statistically significant ($p = 0.31$). Although alcohol consumption was uncommon among the participants, it was significantly associated with CKD ($p = 0.05$). There was no significant difference in physical activity levels between CKD patients and those with normal kidney function ($p = 0.54$). Likewise, there was no significant difference in the type of diet followed or adherence to specific diets between CKD patients and individuals with normal kidney function ($p = 0.30$ and $p = 0.08$, respectively) (Table 3).

Table 3: The relation between CKD and some lifestyle risk factors related to CKD

		Normal kidney (Number = 41)	CKD (Number = 109)	χ^2 Value (Pearson Chi-Square)	p-value
Source of drinking water	Euphrates river Groundwater, wells & springs	22 19	100 9	32.82	**<0.001***
History of long-time analgesic intake	No Yes	32 9	62 47	5.71	**0.017***
Education level	No Low High	15 21 5	35 64 10	0.75	0.69
Smoking	No Yes	13 28	56 53	4.64	**0.31**
Alcohol intake	No Yes	36 5	105 4	3.84	**0.05***
Physical activity	No Yes	35 6	97 12	0.37	0.54
Diet	Healthy Mixed	2 39	2 109	1.06	0.30
Specific diet	No Yes	13 23	20 89	3.09	0.08

p-value ≤ 0.05 is statistically significant

4. Discussion

This cross-sectional study provides important evidence regarding the burden of chronic kidney disease (CKD) among adults residing in North and East Syria. The overall CKD prevalence of 72.67% was substantially higher than estimates reported in most regional and international studies. Furthermore, the mean eGFR of 40.4 mL/min/1.73 m² and the predominance of stages 3b–5 suggest that many participants had moderate-to-severe renal impairment at the time of assessment. Several factors may contribute to this unusually high prevalence. First, participants were recruited from hospital-based settings, which may have increased the likelihood of enrolling individuals with existing health conditions. Second, prolonged disruption of healthcare services during years of armed conflict may have limited opportunities for early diagnosis and management of chronic diseases, allowing progressive kidney dysfunction to remain undetected. These findings emphasize the need for population-based studies to determine the true community prevalence of CKD in Syria. Delayed diagnosis and limited access to healthcare likely contribute to the disease's progression, as seen in other resource-limited settings (Farag, Kari, and Singh 2012; Saeed Al-Ghamdi et al. 2023). Age was strongly associated with CKD in the present study, with prevalence increasing markedly among older participants. This observation is consistent with established evidence demonstrating age-related declines in renal function resulting from nephron loss, vascular changes, and the cumulative effects of chronic comorbidities. Similarly, males exhibited a higher prevalence of CKD than females, in agreement with reports from several epidemiological studies in which biological, behavioral, and healthcare-access factors may contribute to sex-related differences in kidney disease risk. Hyperglycemia was present in 46.7% of participants. Diabetes mellitus is a leading cause of CKD worldwide, particularly when poorly controlled (Zheng, Ley, and Hu 2018). The high prevalence of hyperglycemia in this study suggests that diabetes is a key driver of CKD in Syria, mirroring trends observed in other Middle Eastern populations (Farah et al. 2024). Obesity was another significant CKD risk factor, with 46% of participants classified as overweight or obese. This reflects broader regional trends where dietary shifts and urbanization contribute to increased obesity rates (Syria Obesity - Adult Prevalence Rate - Demographics 2016). Obesity accelerates CKD progression through mechanisms such as glomerular hypertension and fibrosis (Ford, Patel, and Narayan 2017). Studies have also shown that obesity worsens CKD outcomes by increasing proteinuria and renal fibrosis (Wang and Kovesdy 2021). Hypertension emerged as a major contributor to CKD, with a prevalence of 29.3%. This finding aligns with global evidence that hypertension is both a cause and consequence of declining kidney function (kidney disease: Improving Global Outcomes 2021). The high prevalence of hypertension in the Eastern Mediterranean is often attributed to urbanization, economic challenges, and dietary patterns (Abboud and Karam 2021). Certainly, the significant association between a history of hypertension and CVD with CKD highlights the principal role of cardiovascular health in this population's CKD burden. So, controlling hypertension and preventing CVD is an important factor in reducing CKD risk. CVD and CKD are interconnected, often called a "cardiorenal syndrome." CKD accelerates CVD development due to common risk factors such as hypertension, diabetes, and dyslipidemia, while CVD also leads to kidney damage due to poor blood flow. The mechanisms behind this link involve endothelial dysfunction, inflammation, and fibrosis, all of which impair both cardiovascular and kidney functions. Early intervention in managing both conditions together is necessary for better outcomes (Jankowski et al. 2021). The study found a negative correlation between eGFR and age, consistent with previous research demonstrating a gradual decline in kidney function with aging. Metabolic changes and comorbidities such as hypertension and diabetes further compound CKD risk in older populations (Levey et al. 2020). Additionally, men tend to have a higher prevalence of CKD compared to women, although this gap narrows in certain populations as women live longer and are more likely to develop CKD-related complications like diabetes (Hoyos Flight 2019). In studying the relationship between CKD and some lifestyle risk factors, we found that some lifestyle factors also play a critical role in the development and progression of CKD, and the findings of this study reveal several modifiable risk factors that are prevalent in the population. For example, the majority of individuals with CKD relied on water from the Euphrates River. This aligns with global evidence that exposure to water contaminated with nephrotoxins, or heavy metals can exacerbate CKD. Access to drinking water in Syria is severely limited due to various factors, including the ongoing conflict, environmental challenges, and poor infrastructure. In regions under government control, access to piped water is lacking, forcing people to rely on alternatives like trucked water or unsafe coping mechanisms. In areas like Hasakeh and Raqqa, reduced water levels in rivers and reservoirs, compounded by political tensions, further exacerbate the water crisis. This lack of access has led to water contamination and outbreaks of diseases such as cholera, especially in regions reliant on the Euphrates River ("Syria's Water Crisis: Assessing the Intersection of Climate Change and Geopolitical Interests"). Another important CKD risk factor is long-term analgesic use, which showed a statistically significant high prevalence in CKD patients. Studies have demonstrated that prolonged analgesic use, especially without appropriate monitoring, can impair renal function by reducing renal blood flow and GFR. Additionally, opioid use has also been linked to kidney damage, making it necessary to carefully monitor patients receiving chronic pain management (Keen and Aeddula 2020). Globally, the prescription of pain medications, including opioids, is high, but misuse and prolonged use, particularly following surgical procedures, are rising significantly (Lawal et al. 2020). Smoking and alcohol consumption were significantly associated with CKD. This was aligned with studies linking tobacco to renal damage through oxidative stress and endothelial dysfunction (Lang and Schiffl 2024). While no direct association between smoking and CKD was observed, smoking remains a known risk factor for kidney disease progression (Saeed Al-Ghamdi et al. 2023). Smokers with CKD tend to have a faster progression to ESKD compared to non-smokers. Moreover, smoking worsens cardiovascular risk, which is commonly associated with CKD and its complications (Lee et al. 2020). Alcohol consumption, though uncommon, was still significantly associated with CKD, which could suggest that even low levels of alcohol intake may be detrimental to kidney health in a population already loaded with other risk factors (Li et al. 2019). A history of cardiovascular disease was significantly associated with CKD in this population. This finding supports the concept of the cardiorenal continuum, whereby cardiovascular and renal dysfunction frequently coexist and share common pathophysiological pathways, including endothelial dysfunction, chronic inflammation, oxidative stress, and vascular injury. The coexistence of these conditions highlights the importance of integrated cardiovascular and renal risk assessment in vulnerable populations. Several limitations should be acknowledged. The cross-sectional design precludes causal inference and limits assessment of temporal relationships between risk factors and CKD. The hospital-based convenience sample may also limit generalizability to the wider Syrian population. Furthermore, CKD classification was based primarily on a single eGFR assessment without longitudinal confirmation of chronicity. Despite these limitations, the study provides valuable preliminary data from a region where epidemiological evidence on kidney disease remains scarce. Overall, the findings indicate a substantial burden of CKD in North and East Syria and identify several potentially modifiable clinical and lifestyle-related factors associated with impaired renal function. Strengthening screening programs, improving management of hypertension and hyperglycemia, promoting rational analgesic use, and ensuring access to safe drinking water may contribute to reducing the burden of CKD in this vulnerable population.

5. Conclusion

The study reveals a critically high prevalence of chronic kidney disease (CKD) in North and East Syria, with 72.67% of participants affected and an average estimated glomerular filtration rate (eGFR) of 40.4 mL/min/1.73 m², indicating advanced disease stages. This study demonstrates a substantial burden of impaired kidney function among adults attending healthcare facilities in North and East Syria, with a high prevalence of eGFR-defined chronic kidney disease and a predominance of advanced disease stages. Older age, male sex, elevated mean arterial pressure, hyperglycemia, a history of hypertension and cardiovascular disease, reliance on Euphrates River water, and long-term analgesic use were significantly associated with CKD. These findings highlight the combined influence of clinical, environmental, and lifestyle-related factors on kidney health in conflict-affected settings. Given the limited availability of epidemiological data from Syria, this study provides important preliminary evidence that may inform future screening programs and public health strategies. Strengthening early detection of kidney dysfunction, improving the management of hypertension and hyperglycemia, promoting safe medication use, and ensuring access to safe drinking water may help reduce the burden of kidney disease in this vulnerable population. Further large-scale, population-based, and longitudinal studies are required to confirm these findings and clarify the causal pathways linking these risk factors to CKD development and progression in Syria.

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Data Availability Statement:

All data are involved in the article.

Authors' contribution:

This paper is extracted from a MSc. thesis, which Haidar Saify and Eman Elbassuoni were supervisor of the project, chief investigator and responsible for the data analysis. Methodology was performed by Nisreen Nabo Sheikh Bakr as the Master candidate.

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Declarations

Conflicts of interest

The authors declare that they have no known competing interests.

Reference

1. Abboud, Majd, and Sabine Karam. 2021. “Hypertension in the Middle East: Current State, Human Factors, and Barriers to Control.” Journal of Human Hypertension, June. https://doi.org/10.1038/s41371-021-00554-z
2. Agboola, Olayinka J., Jeffrey SK Chan, Jared A. Spitz, Raymond NC Chan, Jaideep Patel, Charles German, Khurram Nasir et al. "The role of inflammation in longitudinal renal function decline and incident chronic kidney disease: the multi-ethnic study of atherosclerosis." European Journal of Preventive Cardiology 33, no. 5 (2026): 718-728.
3. Alasbahy, Afrah, Wadee Abdullah Al-Shehari, Safa Al-Hammadi, Reem Alariqi, Motea Ahmed Aboras, Lina Qasem, and Arafat Alsalami. "Prevalence and Associated Risk Factors of Renal Failure in the Population at the Authority of the Martyr President Saleh Al-Sammad Teaching Hospital in Amran City, Yemen." (2026).
4. Bikbov, Boris, Norberto Perico, and Giuseppe Remuzzi. 2018. “Disparities in Chronic Kidney Disease Prevalence among Males and Females in 195 Countries: Analysis of the Global Burden of Disease 2016 Study.” Nephron 139 (4): 313–18. https://doi.org/10.1159/000489897
5. Carey, Robert M., and Paul K. Whelton. 2018. “Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: Synopsis of the 2017 American College of Cardiology/American Heart Association Hypertension Guideline.” Annals of Internal Medicine 168 (5): 351. https://doi.org/10.7326/m17-3203
6. Lodi, Giada, Domenico Sergi, Anna Dipinto, Francesca Bompan, Paola Secchiero, Rebecca Voltan, and Arianna Romani. "Hyperglycemia-induced endothelial dysfunction: from classical pathogenetic mechanisms to emerging insights into ACE2 protective action." International Journal of Molecular Sciences 27, no. 6 (2026): 2660.
7. Farag, Youssef M.K., Jameela A. Kari, and Ajay K. Singh. 2012. “Chronic Kidney Disease in the Arab World: A Call for Action.” Nephron 121 (3-4): c120–23. https://doi.org/10.1159/000345149
8. Farah, Randa, Abdulrahman Alhajahjeh, Oraib Al-farahid, Hana Abuzaid, Dana Hyassat, Gaith Al-Khuraisat, Rana Al-Shimi, et al. 2024. “Risk Factors for Chronic Kidney Disease in Middle Eastern Patients with Type 2 Diabetes Mellitus: A Cross-Sectional Study Using the KDIGO Classification.” Journal of Diabetes and Its Complications 38 (5): 108740–40. https://doi.org/10.1016/j.jdiacomp.2024.108740
9. Ford, Nicole D., Shivani A. Patel, and K.M. Venkat Narayan. 2017. “Obesity in Low- and Middle-Income Countries: Burden, Drivers, and Emerging Challenges.” Annual Review of Public Health 38 (1): 145–64. https://doi.org/10.1146/annurev-publhealth-031816-044604
10. GBD 2013 Mortality and Causes of Death Collaborators. 2015. “Global, Regional, and National Age–Sex Specific All-Cause and Cause-Specific Mortality for 240 Causes of Death, 1990–2013: A Systematic Analysis for the Global Burden of Disease Study 2013.” The Lancet 385 (9963): 117–71. https://doi.org/10.1016/s0140-6736(14)61682-2

11. Hoyos Flight, Monica. 2019. "Kidney Health Atlas Reveals Burden of Disease in Middle East." Nature Middle East, April. https://doi.org/10.1038/nmiddleeast.2019.57
12. Jankowski, Joachim, Jürgen Floege, Danilo Fliser, Michael Böhm, and Nikolaus Marx. 2021. "Cardiovascular Disease in Chronic Kidney Disease." Circulation 143 (11): 1157–72. https://doi.org/10.1161/circulationaha.120.050686
13. Kaze, Arnaud D., Titilayo Ilori, Bernard G. Jaar, and Justin B. Echouffo-Tcheugui. 2018. "Burden of Chronic Kidney Disease on the African Continent: A Systematic Review and Meta-Analysis." BMC Nephrology 19 (1). https://doi.org/10.1186/s12882-018-0930-5
14. Keen, Mansoor U., and Narothama R. Aeddula. 2020. "Analgesic Nephropathy." PubMed. Treasure Island (FL): StatPearls Publishing. 2020. https://www.ncbi.nlm.nih.gov/books/NBK541101/
15. Lang, Susanne M, and Helmut Schiffl. 2024. "Smoking Status, Cadmium, and Chronic Kidney Disease." Renal Replacement Therapy 10 (1). https://doi.org/10.1186/s41100-024-00533-3
16. Lawal, Oluwadolapo D., Justin Gold, Amala Murthy, Rupam Ruchi, Egle Bavry, Anne L. Hume, Adam K. Lewkowitz, Todd Brothers, and Xuerong Wen. 2020. "Rate and Risk Factors Associated with Prolonged Opioid Use after Surgery." JAMA Network Open 3 (6): e207367. https://doi.org/10.1001/jamanetworkopen.2020.7367
17. Lee, Sangmi, Shinchan Kang, Young Su Joo, Changhyun Lee, Ki Heon Nam, Hae-Ryong Yun, Jung Tak Park, et al. 2020. "Smoking, Smoking Cessation, and Progression of Chronic Kidney Disease: Results from KNOW-CKD Study." Nicotine & Tobacco Research 23 (1): 92–98. https://doi.org/10.1093/ntr/ntaa071
18. Levey, Andrew S, Kai-Uwe Eckardt, Nijsje M Dorman, Stacy L Christiansen, Michael Cheung, Michel Jadoul, and Wolfgang C Winkelmayer. 2020. "Nomenclature for Kidney Function and Disease: Executive Summary and Glossary from a Kidney Disease: Improving Global Outcomes Consensus Conference*." Nephrology Dialysis Transplantation 35 (7): 1077–84. https://doi.org/10.1093/ndt/gfaa153
19. Levey, Andrew S., Kai-Uwe Eckardt, Nijsje M. Dorman, Stacy L. Christiansen, Ewout J. Hoorn, Julie R. Ingelfinger, Lesley A. Inker, et al. 2020. "Nomenclature for Kidney Function and Disease: Report of a Kidney Disease: Improving Global Outcomes (KDIGO) Consensus Conference." Kidney International 97 (6): 1117–29. https://doi.org/10.1016/j.kint.2020.02.010
20. Lewis, Sharon L, Linda Bucher, Margaret M Heitkemper, Mariann M Harding, Jeffrey Kwong, and Dottie Roberts. 2016. Medical-Surgical Nursing: Assessment and Management of Clinical Problems, Single Volume. Mosby. p. 1025.
21. Li, Deming, Jiuhong Xu, Fang Liu, Xinjing Wang, Huanhuan Yang, and Xinli Li. 2019. "Alcohol Drinking and the Risk of Chronic Kidney Damage: A Meta-Analysis of 15 Prospective Cohort Studies." Alcoholism: Clinical and Experimental Research 43 (7): 1360–72. https://doi.org/10.1111/acer.14112.
22. Liao, Min-Tser, Chih-Chien Sung, Kuo-Chin Hung, Chia-Chao Wu, Lan Lo, and Kuo-Cheng Lu. 2012. "Insulin Resistance in Patients with Chronic Kidney Disease." Journal of Biomedicine and Biotechnology 2012: 1–12. https://doi.org/10.1155/2012/691369
23. Malekmakan, Leila, Taraneh Tadayon, Jamshid Roozbeh, and Mehrab Sayadi. 2018. "End-Stage Renal Disease in the Middle East: A Systematic Review and Meta-Analysis." Iranian Journal of Kidney Diseases 12 (4): 195–203. https://pubmed.ncbi.nlm.nih.gov/30087213/
24. Mayo Clinic. 2023. "Diabetes - Diagnosis and Treatment." Mayoclinic.org. Mayo Clinic. September 15, 2023. https://www.mayoclinic.org/diseases-

conditions/diabetes/diagnosis-treatment/drc-20371451

25. Moradinazar, Mehdi, Maryam Babakhani, Reza Rostami, Mohammad Shakiba, Atefeh Moradi, and Ebrahim Shakiba. 2022. “Epidemiological Status of Type 2 Diabetes Mellitus in the Middle East and North Africa, 1990-2019.” Eastern Mediterranean Health Journal 28 (7): 478–88. https://doi.org/10.26719/emhj.22.050
26. Murray, Christopher J L, Ryan M Barber, Kyle J Foreman, Ayse Abbasoglu Ozgoren, Foad Abd-Allah, Semaw F Abera, Victor Aboyans, et al. 2015. “Global, Regional, and National Disability-Adjusted Life Years (DALYs) for 306 Diseases and Injuries and Healthy Life Expectancy (HALE) for 188 Countries, 1990–2013: Quantifying the Epidemiological Transition.” The Lancet 386 (10009): 2145–91. https://doi.org/10.1016/s0140-6736(15)61340-x
27. National Institute of Diabetes and Digestive and Kidney Diseases. 2018. “Your Kidneys & How They Work.” National Institute of Diabetes and Digestive and Kidney Diseases. June 2018. https://www.niddk.nih.gov/health-information/kidney-disease/kidneys-how-they-work
28. Saeed Al-Ghamdi, Ali Abu-Alfa, Turki Alotaibi, Ali AlSaaidi, Abdulkareem AlSuwaida, Mustafa Arici, Tevfik Ecder, et al. 2023. “Chronic Kidney Disease Management in the Middle East and Africa: Concerns, Challenges, and Novel Approaches” Volume 16 (April): 103–12. https://doi.org/10.2147/ijnrd.s363133
29. “Syria Obesity - Adult Prevalence Rate - Demographics.” 2016. Indexmundi.com. 2016. https://www.indexmundi.com/syria/obesity_adult_prevalence_rate.html
30. “Syria’s Water Crisis: Assessing the Intersection of Climate Change and Geopolitical Interests.” n.d. Fanack Water 2025. https://water.fanack.com/publications/syrias-water-crisis-assessing-the-intersection-of-climate-change-and-geopolitical-interests/
31. Terashita, Maho, Kohei Kinoshita, Ryousuke Satou, Akemi Katsurada, Gweneth Eliza Lavalla, Akihiro Maenaka, Yuji Hidaka et al. "Renin-Angiotensin-Aldosterone System (RAAS) in Pig-to-Baboon Kidney Xenotransplantation—Relevance to Clinical Pig Kidney Xenotransplantation." Xenotransplantation 33, no. 2 (2026): e70129.
32. Wang, Angela Yee-Moon, and Csaba P Kovesdy. 2021. “Nutrition and Obesity Impacts on Kidney Health.” Contributions to Nephrology 199: 24–42. https://doi.org/10.1159/000517669
33. Zheng, Yan, Sylvia H. Ley, and Frank B. Hu. 2018. “Global Aetiology and Epidemiology of Type 2 Diabetes Mellitus and Its Complications.” Nature Reviews Endocrinology 14 (2): 88–98. https://doi.org/10.1038/nrendo.2017.151