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*Original Article*

# Population-Based Screening during World Kidney Day in Kazakhstan: Prevalence and Risk Factors of Reduced Renal Function

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**Abstract:**

**Background:** Chronic kidney disease (CKD) is a major global health challenge, yet population-based data from Central Asia are scarce. We conducted a population-based screening study to assess kidney function distribution and associated risk factors in Astana, Kazakhstan.

**Methods:** In March 2024, 636 adults were screened through convenience sampling at four major institutions in Astana. After excluding incomplete data, 569 participants were analyzed. Demographic, lifestyle, and clinical information were collected, and serum creatinine was used to estimate glomerular filtration rate (eGFR). Reduced renal function was defined as eGFR <90 mL/min/1.73 m². Group comparisons and logistic regression analyses were performed to identify risk factors for reduced renal function.

**Results:** The median age of participants was 46 years (IQR 33–55), and 79.8% were women. Median eGFR was 92.8 (IQR 79.8–111.3) mL/min/1.73 m²; 54.1% had eGFR ≥90, 42.4% had eGFR 60–89, and 3.5% had eGFR 45–59. Reduced renal function was more common among older adults, females and those with hypertension and heart failure. In multivariable analysis, older age and female sex were independent predictors of reduced renal function. Awareness was low: only 15.0% of individuals with eGFR 45–59 reported having CKD.

**Conclusion:** This study provides the population-based evidence on kidney function in Astana, Kazakhstan. Reduced renal function was common, particularly among older adults. Findings highlight the importance of population-based screening and targeted prevention strategies to address kidney health in Kazakhstan.

**Keywords:** Chronic Kidney Disease; Screening; Awareness; Kazakhstan; Central Asia

## Introduction

Chronic kidney disease (CKD) is a major global health challenge, affecting over 10% of the worldwide population, with prevalence rising sharply over recent decades – an increase of approximately 92% between 1990 and 2021 (1-3). This progressive chronic condition substantially increases risks of cardiovascular events, premature mortality, and health system costs, particularly when patients present at advanced stages requiring renal replacement therapy (4,5).

Early detection of CKD is therefore essential. Timely intervention can slow disease progression, improve patient outcomes and reduce treatment costs (6). Yet, CKD is often asymptomatic in its early stages, leading to frequent underdiagnosis until significant kidney damage has occurred. Population-based screening using estimated glomerular filtration rate (eGFR) and albuminuria assessment has proven effective for identifying CKD early (7). However, screening strategies must be appropriately evaluated for cost-effectiveness, especially in resource-constrained settings where healthcare budgets are limited and competing priorities are high. Reliable prevalence data form a crucial component of this evaluation, as they provide the foundation for estimating disease burden, projecting healthcare needs, and assessing the potential value of implementing systematic screening programs (8).

Epidemiological studies have shown considerable variation in the prevalence of CKD across countries and regions, influenced by demographic, lifestyle, and healthcare factors (9). Central Asia is notably underrepresented in the current literature, with limited population-based data on kidney health. In Kazakhstan, an upper-middle income country located in Central Asia, only one nationally representative study has assessed CKD prevalence. It included 6,720 adults and reported that 25.2% had eGFR of 60–89 mL/min/1.73 m², indicating a large reservoir of early kidney impairment (10). While this study provides valuable insights, it represents the sole source of population-based prevalence data in the country. Some studies have attempted to estimate prevalence from national registry data; however, such estimates are likely to underestimate the true burden of CKD (11,12). Accordingly, further research is essential to generate more comprehensive and region-specific evidence on CKD burden in Kazakhstan and the wider Central Asian region, especially given the fact that the burden of CKD in Kazakhstan is expected to increase in the future (11), while national health system preparedness remains limited (13,14).

To address this evidence gap, this population-based screening study was conducted in Astana, Kazakhstan, as part of the World Kidney Day campaign. The primary objective of this study was to determine the prevalence of reduced renal function in a general adult population of Astana. Secondary objective was characterizing the sociodemographic and clinical risk factor profiles associated with reduced renal function. The findings are intended to inform healthcare policy development, guide resource allocation decisions, and contribute to the growing body of evidence supporting early detection and management of CKD in Central Asian populations.

## Methods

**Study Design:** This was a population-based, cross-sectional screening study conducted to assess kidney function distribution and the prevalence of reduced eGFR in Astana, Kazakhstan. The study design followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies (15).

**Participant Selection**: The study was conducted in Astana, the capital city of Kazakhstan on March 14, 2024. Participants were recruited through convenience sampling from four major institutions: National Research Center for Maternal and Child Health, Republican Diagnostic Center, National Scientific Cardiac Surgery Center, and Nazarbayev University Health Center. Participant recruitment involved approaching passersby at these four strategic locations. A total of 636 adults were successfully enrolled in the study. Adults aged 18 years and older, who were residents of Kazakhstan, able to provide informed consent and had willingness to participate were included. The criteria for exclusion were having an acute illness at the time of screening, pregnancy and inability provide informed consent.

**Data Collection & Variables**: The following data was collected from the participants:

*Sociodemographic Variables*: Age, sex, educational attainment, occupation, and residence (urban vs. rural).

*Lifestyle factors*: Smoking status (categorized as non-smoker, <1 pack/day, >1 pack/day) and alcohol consumption patterns (frequency).

*Medical history*: Participants were asked whether they believed they have CKD to assess their self-awareness of kidney health status. Additionally, history of comorbid conditions (history of hypertension, diabetes, cardiovascular disease, heart failure, and stroke) were assessed by self-report.

**Laboratory/Clinical Methods**: Blood pressure (measured using standardized protocols with participants in a seated position after at least 5 minutes of rest), height and weight were measured. Body mass index (BMI) was calculated by dividing weight in kg by height in m².

Serum creatinine and urinary microalbumin was measured using standardized laboratory methods. The normal albumin concentration is considered less than

20 mg/L and more than 200 mg/L is considered macroalbuminuria (16). The CKD-EPI equation (17) was used to calculate eGFR from serum creatinine. The CKD-EPI 2021 equation was used, which does not incorporate race as a factor.

Participants were classified into eGFR categories (≥90, 60–89, 45–59, 30–44, 15–29, <15 mL/min/1.73 m²) for descriptive stratification of kidney function. Because chronicity (≥3 months) and albuminuria quantified by albumin-to-creatinine ratio (ACR) were not available, these categories were used solely to describe cross-sectional kidney function and do not constitute CKD diagnoses or staging.

**Statistical Analysis**: Of the 636 adults initially screened, data were incomplete for 67 individuals. The pattern of missingness was assessed using Little's MCAR test. The missingness was consistent with being missing completely at random (MCAR) ($p = 0.419$). Therefore, a complete-case analysis was performed, and 569 participants were retained in the final dataset.

Descriptive statistics were computed for all variables. Normally distributed continuous variables were presented as mean ± standard deviation, while non-normally distributed variables were expressed as median with interquartile range (IQR). Categorical variables were reported as counts and percentages. Group comparisons were conducted using the chi-square test for categorical variables. For continuous variables, Student's t-test was applied when normality assumptions were met, and the Wilcoxon rank-sum test (Mann–Whitney U test) was used for non-normally distributed variables. For comparisons across more than two groups, one-way analysis of variance (ANOVA) or the Kruskal-Wallis test was applied as appropriate.

Categorization by eGFR was reported overall and by stage. For regression analysis, the outcome was defined as reduced renal function, coded as a binary variable using an eGFR threshold of <90 mL/min/1.73 m². Unadjusted and adjusted logistic regression models were used to examine associations between reduced renal function and potential risk factors. Results were presented as odds ratios (OR) with 95% confidence intervals (CI). A p-value <0.05 was considered statistically significant.

All analyses were performed in Stata (version 16.0; StataCorp, College Station, TX, USA). A p-value <0.05 was considered statistically significant.

**Ethical Considerations**: The study was conducted in accordance with the Declaration of Helsinki and local ethical guidelines. All process was performed after the approval of the Ethics Committee of CF "University Medical Center" in Astana, Kazakhstan (reference number 2024/02-38). Written informed consent was obtained from all participants before enrollment. Participants with abnormal findings were advised to seek appropriate medical follow-up.

## Results

**Participant characteristics:** The final analytic sample consisted of 569 participants, including 115 (20.2%) men and 454 (79.8%) women, with a median age of 46 years (IQR: 33–55). Women were significantly older than men (median age 47 vs. 40 years, $p < 0.001$). The majority of participants reported higher education (≥bachelor's degree: 45.0%) and urban residence (91.6%). More than half were employed in medicine or pharmaceuticals (55.4%). The prevalence of self-reported CKD was 13.0%, with no significant sex difference ($p = 0.767$). Hypertension and diabetes mellitus were reported by 24.3% and 8.1% of participants, respectively. Median systolic blood pressure was higher in men than women (120 vs. 110 mmHg, $p < 0.001$). Also, men had significantly higher eGFR values compared with women (109.1 vs. 89.8 mL/min/1.73 m², $p < 0.001$). Urinary microalbumin was measured in all participants, and concentrations were uniformly <0.3 mg/L, with a median of 0.07 mg/L (IQR:0.05-0.09) indicating absence of albuminuria in this cohort. Detailed characteristics of participants stratified by gender are provided in Table 1.

**Table 1.** Sociodemographic and Clinical Characteristics of Participants by Gender

| Characteristic | Total (n=569) | Men (n=115) | Women (n = 454) | p-value |
|---|---|---|---|---|
| **Age -** years, median (IQR) | 46 (33–55) | 40 (29-52) | 47 (35-56) | <0.001** |
| **Education** (bachelor's and higher), n (%) | 256 (45.0) | 66 (57.4) | 190 (41.9) | 0.003* |
| **Occupation,** n (%) | | | | <0.001** |
| Industrial production | 17 (3.0) | 13 (11.3) | 4 (0.9) | |

| | | | | |
|---|---|---|---|---|
| Trade/Sales | 16 (2.8) | 5 (4.4) | 11 (2.4) | |
| Science/Education | 31 (5.5) | 12 (10.4) | 19 (4.2) | |
| Civil service | 24 (4.2) | 5 (4.4) | 19 (4.2) | |
| Transport/Logistics | 8 (1.4) | 7 (6.1) | 1 (0.2) | |
| Medicine/Pharmaceuticals | 315 (55.4) | 31 (27.0) | 284 (62.6) | |
| Other | 102 (17.9) | 29 (25.2) | 73 (16.1) | |
| Unemployed | 56 (9.9) | 13 (11.3) | 43 (9.5) | |
| **Residence,** n (%) | | | | 0.388 |
| Urban | 521 (91.6) | 103 (89.6) | 418 (92.1) | |
| Rural | 48 (8.4) | 12 (10.4) | 36 (7.9) | |
| **Smoking,** n (%) | | | | <0.001** |
| No | 540 (94.9) | 90 (78.3) | 450 (99.1) | |
| Yes, < 1 pack/day | 24 (4.2) | 20 (17.4) | 4 (0.9) | |
| Yes, > 1 pack/day | 5 (0.9) | 5 (4.4) | 0 (0.0) | |
| **Alcohol,** n (%) | | | | <0.001** |
| Never | 408 (73.0) | 61 (54.5) | 347 (77.6) | |
| Every month | 37 (6.6) | 19 (17.0) | 18 (4.0) | |
| Every week | 5 (0.9) | 3 (2.7) | 2 (0.5) | |
| Every day | 1 (0.2) | 1 (0.9) | 0 (0.0) | |
| Other | 108 (19.3) | 28 (25.0) | 80 (17.9) | |
| **CKD –** yes, n (%) | 74 (13.0) | 14 (12.2) | 60 (13.2) | 0.767 |
| **"Have you ever been diagnosed with hypertension" –** yes, n (%) | 138 (24.3) | 24 (20.9) | 114 (25.1) | 0.343 |
| **"Have you ever been diagnosed with DM" –** yes, n (%) | 46 (8.1) | 8 (7.0) | 38 (8.4) | 0.619 |
| **"Have you ever been diagnosed with acute/chronic HF" -** yes, n (%) | 36 (6.3) | 9 (7.8) | 27 (6.0) | 0.460 |
| **Stroke -** yes, n (%) | 14 (2.5) | 3 (2.6) | 11 (2.4) | 0.909 |
| **SBP,** median (IQR) | 115 (105–125) | 120 (110-130) | 110 (100-120) | <0.001** |
| **BMI,** median (IQR) | 25.6 (22.6–29.4) | 26.3 (22.2–29.4) | 25.5 (22.7–29.4) | 0.901 |
| **eGFR,** median (IQR) | 92.8 (79.8–111.3) | 109.1 (86.5–122.7) | 89.8 (78.6-107.1) | <0.001** |
| **Microalbumin,** median (IQR) | 0.07 (0.05-0.09) | 0.07 (0.05-0.1) | 0.07 (0.05-0.09) | 0.610 |

*Note:* BMI, body mass index; CKD, chronic kidney disease; DM, diabetes mellitus, eGFR, estimated glomerular filtration rate; HF, heart failure; IQR, interquartile range; SBP, systolic blood pressure.

*p-value < 0.05

**p-value < 0.001

**Kidney Function Distribution:** The median eGFR in the cohort was 92.8 mL/min/1.73 m² (IQR: 79.8–111.3). Of the total, 308 participants (54.1%) had eGFR ≥90 mL/min/1.73 m², 241 (42.4%) had eGFR 60–89, and 20 (3.5%) had eGFR 45–59. No participants had eGFR <45. Participants with lower eGFR were significantly older (median age 64 years for eGFR 45–59 vs. 34 years for eGFR ≥90, $p < 0.001$). Lower eGFR was also associated with more frequent self-report of hypertension (70.0% in eGFR 45–59 vs. 14.3% in ≥90, $p < 0.001$) and heart failure (20.0% vs. 3.6%, $p = 0.002$). BMI and systolic blood pressure were progressively higher with declining eGFR ($p < 0.001$ for both). Among participants with preserved kidney function (eGFR ≥90), 11.7% reported knowing they had CKD. Awareness of CKD status was low across participants with reduced renal function - 14.5% and 15.0% in those with eGFR 60–89 and eGFR 45–59, respectively (Table 2).

**Table 2.** Participant Characteristics by eGFR Category.

| **Characteristic** | **eGFR category, ml/min/1.7 m²** | | | **p-value** |
|---|---|---|---|---|
| | **>90 (n=308)** | **60-90 (n=241)** | **45-60 (n=20)** | |
| **Age -** years, median (IQR) | 34 (28-42) | 55 (50-60) | 64 (58.5-71) | <0.001** |
| **Gender –** male, n (%) | 82 (26.6) | 30 (12.5) | 3 (15.0) | <0.001** |
| **Education –** bachelor's and higher, n (%) | 172 (55.8) | 81 (33.6) | 3 (15.0) | <0.001** |
| **Occupation –** medicine/pharmaceuticals, n (%) | 171 (55.6) | 133 (55.2) | 11 (55.0) | 0.996 |
| **Residence –** urban, n (%) | 20 (6.5) | 26 (10.8) | 2 (10.0) | 0.193 |
| **"Have you ever been diagnosed with CKD" –** yes, n (%) | 36 (11.7) | 35 (14.5) | 3 (15.0) | 0.597 |
| **"Have you ever been diagnosed with CKD" –** yes, n (%) (only among medicine/pharmaceuticals workers) | 13 (7.6) | 16 (12.0) | 1 (9.1) | 0.426 |
| **"Have you ever been diagnosed with hypertension" -** yes, n (%) | 44 (14.3) | 80 (33.2) | 14 (70.0) | <0.001** |
| **"Have you ever been diagnosed with DM" -** yes, n (%) | 19 (6.2) | 25 (10.4) | 2 (10.0) | 0.190 |
| **"Have you ever been diagnosed with acute/chronic HF" -** yes, n (%) | 11 (3.6) | 21 (8.71) | 4 (20.0) | 0.002* |
| **Stroke -** yes, n (%) | 4 (1.3) | 9 (3.73) | 1 (5.0) | 0.142 |
| **SBP,** median (IQR) | 111.4 (17.2) | 120.8 (18.0) | 130.5 (17.0) | <0.001** |
| **BMI,** median (IQR) | 24.5 (21.4-28.5) | 26.7 (24.1-30.3) | 29.1 (22.6-29.5) | <0.001** |
| **Microalbumin,** median (IQR) | 0.05 (0.04-0.07) | 0.09 (0.07-0.1) | 0.15 (0.11-0.2) | <0.001** |

*Note:* BMI, body mass index; CKD, chronic kidney disease; DM, diabetes mellitus, eGFR, estimated glomerular filtration rate; HF, heart failure; IQR, interquartile range; SBP, systolic blood pressure.

*p-value < 0.05

**p-value < 0.001

**Regression Analysis:** Figure 1 illustrates the linear relationship between age and eGFR stratified by sex. Both men and women demonstrated a progressive decline in eGFR with increasing age. Across the age spectrum, men consistently had higher predicted eGFR values compared with women, although the rate of decline was similar in both sexes.

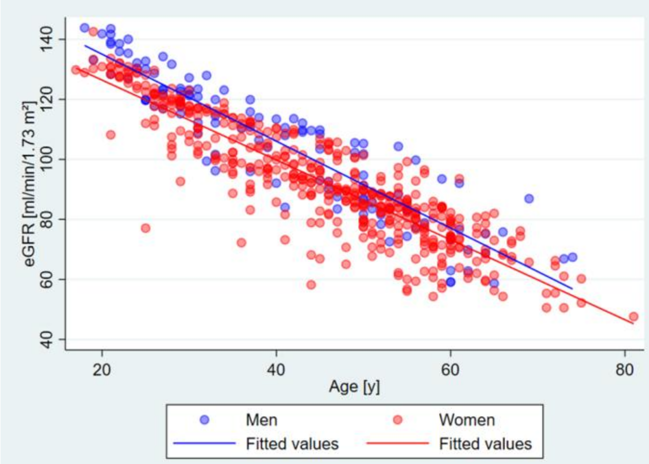


**Figure 1.** Linear regression of age and estimated glomerular filtration rate stratified by sex. Both men (blue line) and women (red line) showed a progressive decline in eGFR with advancing age, with men consistently having higher eGFR values.

In unadjusted logistic regression models, older age, female sex, higher BMI, higher blood pressure, lower education, and history of heart failure were significantly associated with higher odds of reduced kidney function. After adjustment, independent predictors of lower eGFR were older age (OR 1.34 (1.26 to 1.41), p < 0.001) and female sex (male vs. female OR 0.29 (0.12 to 0.71), p = 0.007). Notably, after adjustment, BMI exhibited an inverse association with reduced kidney function (OR 0.93 (0.87 to 0.99), p = 0.029). Education, systolic blood pressure, and history of heart failure were not significant in the multivariable model (Table 3).

**Table 3.** Logistic Regression Analysis of Factors Associated with Reduced Renal Function.

| Participant's characteristic | Unadjusted model OR (95% CI) | p-value | Adjusted model OR (95% CI) | p-value |
|---|---|---|---|---|
| Age | 1.31 (1.25 to 1.37) | <0.001** | 1.34 (1.26 to 1.41) | <0.001** |
| Gender - male | 0.39 (0.25 to 0.62) | <0.001** | 0.29 (0.12 to 0.71) | 0.007* |
| Education – bachelor's and higher | 0.38 (0.27 to 0.53) | <0.001** | 1.17 (0.60 to 2.27) | 0.645 |
| "Have you ever been diagnosed with acute/chronic HF" - yes | 2.86 (1.38 to 5.93) | 0.003* | 0.52 (0.14 to 1.83) | 0.306 |
| "Have you ever been diagnosed with acute/chronic CKD" – yes | 1.29 (0.79 to 2.10) | 0.311 | 0.54 (0.22 to 1.33) | 0.184 |
| SBP | 1.03 (1.02 to 1.04) | <0.001** | 1.01 (0.99 to 1.03) | 0.280 |
| BMI | 1.08 (1.04 to 1.12) | <0.001** | 0.93 (0.87 to 0.99) | 0.029* |

*Note:* BMI, body mass index; CI, confidence interval; HF, heart failure; SBP, systolic blood pressure.

*p-value < 0.05
**p-value < 0.001

## Discussion

This population-based screening study provides important insights into kidney function distribution and CKD awareness in Kazakhstan.

**Prevalence and Distribution of Reduced Renal Function:** The high prevalence of reduced renal function observed in our study is consistent with regional trends reported in Kazakhstan's national surveillance data. In our study, 45.9% of participants had eGFR below 90 mL/min/1.73 m², which is higher than the 25.2% reported by Nursultanova et al. (2023) (10). This large difference likely reflects an older and predominantly female sample and non-probability recruitment in healthcare facilities. The strong age-related decline in kidney function is observed in our cohort with participants having eGFR 45-59 mL/min/1.73 m² being significantly older (median 64 years) than those with preserved function (median 34 years). This age-stratified pattern is consistent with previous studies from Kazakhstan and globally, emphasizing the importance of age as a primary determinant of kidney function decline (10,18). The absence of stage 4–5 CKD (eGFR <30 mL/min/1.73 m²) in our screening cohort is consistent with global stage-specific prevalence (stage 4 ~0.4%, stage 5 ~0.1%) (9), making zero observed cases plausible given sampling variability and the cohort's relatively young median age (18).

Interestingly, no participants demonstrated microalbuminuria, as urinary albumin concentrations were uniformly <0.3 mg/L. However, interpretation is limited by the use of raw urinary microalbumin concentration rather than albumin-to-creatinine ratio, which is the recommended standard due to variability from urine dilution. Nonetheless, the absence of albuminuria supports our conclusion that reduced eGFR was the predominant renal abnormality observed in this sample.

**Risk Factor Profile and Associations*****:*** The independent association between older age and female sex with higher odds of reduced renal function in our multivariable analysis supports global patterns (19). The large between-sex difference in median eGFR (109.1 mL/min/1.73 m² in men vs. 89.8 mL/min/1.73 m² in women) may partly reflect men's younger age distribution and the sample's educational differences, both of which can influence creatinine-based eGFR through age- and muscle-mass–related effects and health behavior patterns (20,21).

Although higher BMI and systolic blood pressure showed association with higher odds of reduced renal function in unadjusted analyses, the blood pressure's association lost statistical significance after adjustment for age, sex, and comorbidities. Whereas, the reversal of BMI's association after adjustment should be interpreted as a modeling artifact driven by outcome dichotomization, nonlinearity around the eGFR threshold, and confounding/suppression by age and sex, rather than evidence that higher BMI is protective; the descriptive increase in BMI with declining eGFR supports this caution. Indeed, elevated adiposity and blood pressure remain recognized risk factors for CKD onset and progression, and their attenuation here likely reflects shared pathways and collinearity with other factors rather than absence of effect (19).

**CKD Awareness and Challenge of Limited Health Literacy:** One of the important findings of our study is the low CKD awareness among those who have it. Only 15.0% of those with CKD Stage 3 (eGFR 45-59 mL/min/1.73 m²) were aware of their condition. However, this estimate may still be overestimated because 11.7% of participants with normal kidney function (eGFR ≥90 mL/min/1.73 m²) reported having CKD, indicating substantial bias in self-reported diagnoses and suggesting true awareness among those with reduced renal function is even lower. The disconnect between objective kidney function and subjective CKD awareness in our study reflects broader challenges in health communication and medical literacy. In primary care clinics of Almaty, another large city in Kazakhstan, 45.5% of adults had limited health literacy, indicating substantial difficulty accessing, understanding, appraising, and applying health information in routine care contexts (22). This magnitude of limited literacy can plausibly lead to confusion between CKD and other kidney/urinary conditions, inflating self-reported CKD among people with normal eGFR and masking true awareness among those with reduced function. Regional evidence supports low CKD awareness: a 10-country survey across former Soviet states (n=2,715) documented limited public knowledge of kidney functions and CKD recognition (23). Within the subgroup employed in medicine/pharmaceuticals, awareness among those with Stage 3 CKD was only 9.1%, even lower than in the overall sample, which likely reflects more accurate understanding of what constitutes CKD rather than truly lower awareness; this pattern reinforces that misclassification inflates self-reported CKD in the general cohort.

**Strengths and Limitations:** This study has several strengths. First, it provides region-specific evidence on kidney function in Astana, addressing a major data gap for Central Asia and complementing limited national estimates from Kazakhstan. Second, concurrent collection of sociodemographic and clinical information enabled us to clarify potential confounding and shared pathways. Third, parallel reporting of self-reported CKD versus objectively measured eGFR reveals substantial misperception, quantifying information bias relevant to screening and education strategies.

Several limitations must be acknowledged in interpreting our findings. Our convenience sampling approach and recruitment from major healthcare institutions may have introduced selection bias, potentially overrepresenting health-conscious individuals or those with worse health. The lack of albuminuria assessment and the cross-sectional nature of our study mean we cannot definitively diagnose CKD according to standard criteria requiring persistence of abnormalities for at least three months. The reliance on self-reported comorbidities and CKD awareness introduces potential information bias, as demonstrated by our awareness findings. However, this limitation itself provides valuable insights into the challenges of using self-reported health data in research and clinical practice in this population. Additionally, albuminuria assessment was limited to spot urinary albumin concentration without a creatinine correction or 24 hours urine collection, which may underestimate the prevalence of early kidney damage.

## Conclusion

This study provides valuable insights into kidney function distribution and CKD awareness in Kazakhstan, contributing to the limited epidemiological data from Central Asia. While our findings show kidney function patterns consistent with regional trends, they reveal concerning gaps in CKD awareness that may compromise early detection and management efforts. Our findings emphasize the critical importance of improving health literacy, enhancing clinical communication, and developing targeted education programs to address the growing burden of CKD in Kazakhstan and the broader Central Asian region. Understanding and addressing these awareness biases will be essential for implementing effective CKD prevention and management strategies in resource-constrained healthcare settings.

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**Ethics approval:** The study was conducted in accordance with the Declaration of Helsinki and local ethical guidelines. All process was performed after the approval of the Ethics Committee of CF "University Medical Center" in Astana, Kazakhstan (reference number 2024/02-38). Written informed consent was obtained from all participants before enrollment. Participants with abnormal findings were advised to seek appropriate medical follow-up.

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