

Addressing underdiagnosis of chronic kidney disease in Kazakhstan: a public health perspective

Alimzhan Muxunov¹, Zhannat Kuanshaliyeva¹

¹Clinical Academic Department of Internal Medicine, CF "University Medical Center", Astana, Kazakhstan

Received: 2026-03-10.

Accepted: 2026-05-31.



This work is licensed under a Creative Commons Attribution 4.0 International License

J Clin Med Kaz 2026; 23(3): 85-91

Corresponding author:

Alimzhan Muxunov.

E-mail: alimzhan.muxunov@nu.edu.kz.

ORCID: 0009-0001-8860-0363.

ABSTRACT

Chronic kidney disease represents a growing public health challenge in Kazakhstan, yet a substantial proportion of cases remain undiagnosed. National registry data suggest lower recorded prevalence compared with global estimates, while local epidemiological studies indicate that many individuals live with impaired kidney function without awareness of their condition. Late diagnosis limits opportunities for early intervention, contributes to adverse clinical outcomes, and increases long-term healthcare costs, particularly when patients progress to end-stage kidney disease. Although Kazakhstan has strengthened prevention and early detection of several non-communicable diseases through primary healthcare services, chronic kidney disease is not currently included as a dedicated condition within national screening programs and is largely detected through opportunistic testing. This perspective examines key barriers to systematic chronic kidney disease detection, including laboratory requirements, geographic dispersion, rural - urban disparities, workforce constraints, and low public awareness. Drawing on international evidence, the paper discusses potential approaches to improve early detection that are compatible with national health system capacity. A phased, risk-stratified strategy integrated into existing primary care and chronic disease management pathways may offer a feasible starting point. Complementary delivery models, including point-of-care diagnostics and community-based outreach services, could further expand access in underserved regions. Context-specific economic and implementation research is needed to guide sustainable policy decisions and optimize screening strategies.

Keywords: Chronic Kidney Disease; Health Policy; Mass Screening; Public Health; Primary Health Care; Central Asia

Introduction

Chronic kidney disease (CKD) is a major global health issue affecting approximately 13% of the world population [1]. In recent decades, both the incidence and mortality associated with CKD have increased significantly, reflecting population aging, increasing prevalence of diabetes and hypertension, and improved survival from other chronic conditions [2]. Kazakhstan mirrors these global trends, with registry-based analyses of national healthcare data demonstrating an increasing burden of CKD in recent years [3].

Despite this upward trend, the overall number of officially registered cases remains relatively low compared with global estimates. Analysis of nationwide healthcare data indicates that the prevalence of officially registered CKD cases in Kazakhstan was only 38,287 per million population (3.8%) in 2020 [3]. Findings from local epidemiological studies further suggest that the actual prevalence of CKD may be considerably higher. Population-based screening initiatives and community studies have reported that up to 20-30% of individuals in the general population live with reduced kidney function [4,5].

However, these figures should also be interpreted with caution. In addition to being conducted in specific populations that may not be nationally representative, those studies rely on single measurements of kidney function and do not include albuminuria assessment, which may lead to misclassification and potential overestimation of CKD prevalence. Despite uncertainty regarding the exact magnitude, the available evidence consistently indicates that a considerable proportion of CKD cases remain undetected in Kazakhstan.

The underdiagnosis of CKD has important health implications. Most undiagnosed individuals with CKD are in the early stages of disease, which are typically asymptomatic. Diagnosis often occurs only when kidney impairment becomes clinically apparent or when complications arise. By that time, substantial decline in kidney function may already have occurred, which limits opportunities for interventions that could slow disease progression, such as blood pressure control, glycaemic management, and treatment with renoprotective medications [6]. Also, the risk of serious complications at later stages is significantly higher as demonstrated by numerous studies. Mortality risk rises progressively with declining kidney function, reaching approximately three to four times higher levels in patients with advanced CKD compared with those in earlier stages. Similarly, the risk of cardiovascular events increases substantially, with individuals in advanced stages experiencing up to two to four times higher cardiovascular risk [7–9]. In addition to these clinical outcomes, CKD is also associated with a significant decline in quality of life, especially at later stages of disease [10]. As kidney function deteriorates, patients frequently experience fatigue, physical limitations, psychological distress, and reduced social participation. Among individuals requiring dialysis, treatment burden, dietary restrictions, and frequent medical visits substantially affect daily functioning and overall well-being [11].

Beyond its clinical consequences, delayed detection also has significant economic implications. The costs of CKD management increase substantially with disease progression, particularly when patients reach end-stage kidney disease (ESKD) and require kidney replacement therapy such as dialysis or transplantation. An international analysis across 31 countries reported that mean annual direct costs increase from approximately \$3,060 per patient in CKD stage G3a to \$8,736 in stage G5, while the initiation of kidney replacement therapy increases costs dramatically, reaching \$57,334 annually for hemodialysis and \$75,326 during the first year following kidney transplantation [12]. Data from high-income countries show that a relatively small proportion of CKD patients who progress to ESKD, account for a large share of total CKD-related healthcare spending. For instance, in the United States, treatment of patients with ESKD represented nearly one-third of all CKD-related expenditures among Medicare beneficiaries in 2019, despite the comparatively small number of individuals requiring dialysis or transplantation [13].

Given the growing burden of CKD and the substantial clinical and economic consequences associated with late diagnosis, improving early detection of the disease represents an important public health priority. In Kazakhstan, strengthening strategies for timely identification of kidney disease may play a key role in improving patient outcomes and reducing long-term healthcare costs. This perspective paper examines the challenges associated with CKD detection in Kazakhstan and discusses potential opportunities for improving early diagnosis and disease management within the national healthcare system.

Current landscape of CD detection in Kazakhstan

In this paper, different approaches to CKD detection are distinguished as follows:

1. population-wide screening refers to systematic testing of all individuals within a defined population group, typically based on age criteria;
2. risk-based screening refers to systematic identification and testing of individuals with established risk factors, such as diabetes or hypertension;
3. opportunistic testing refers to unsystematic testing conducted during healthcare encounters, without a structured, programmatic approach; and
4. routine monitoring refers to regular, guideline-recommended assessment of kidney function in patients with known risk conditions as part of ongoing clinical management.

In Kazakhstan, prevention and early detection of non-communicable diseases (NCDs) are recognized as important priorities within the national healthcare system [14,15]. Over the past decade, the country has implemented several public health initiatives aimed at improving early diagnosis and management of chronic conditions through primary healthcare services [14]. These initiatives are largely integrated within the national population-wide screening programs, which are primarily delivered through primary healthcare facilities, which serve as the main entry point for preventive services and routine health monitoring [16]. Within this framework, screening activities are conducted for conditions including arterial hypertension, coronary artery disease, diabetes mellitus, cervical cancer, breast cancer, and colorectal cancer [16–19].

Despite the strong emphasis on prevention of chronic diseases, CKD has not yet been included as a separate condition within the national screening programs [16]. According to clinical guidelines, CKD detection in Kazakhstan is intended to occur through routine monitoring of high-risk patients, particularly those with diabetes and hypertension; however, in the absence of an organized screening framework, implementation is inconsistent, and testing often occurs in an opportunistic rather than systematic manner [3,20]. In contrast, several countries have developed more structured and systematic approaches to CKD detection, supported by standardized testing protocols, consistent identification of target populations and defined follow-up pathways. Examples include population-based screening initiatives in Japan [21], as well as risk-based screening programs in countries such as Taiwan [22], the United States, the United Kingdom, and Canada [23]. Integrating similar approaches within Kazakhstan's existing NCD prevention framework could potentially enhance identification of individuals with undiagnosed kidney disease and facilitate earlier management.

Barriers to early detection of CKD

Although early detection of CKD is essential, several barriers limit its effective implementation in many healthcare systems, including Kazakhstan. These barriers arise from diagnostic requirements, health system organization, access inequalities, and gaps in awareness and care pathways.

A key barrier to implementing systematic CKD screening in Kazakhstan relates to the operational and organizational requirements of laboratory-based detection at a population level. Unlike screening programs that rely on single procedures or point-of-care tests, CKD detection requires series of biochemical testing, including serum creatinine measurement

to estimate glomerular filtration rate (eGFR) and assessment of urinary albumin-to-creatinine ratio (uACR) [24]. Scaling these tests within a nationwide screening program would require sufficient laboratory capacity, reliable sample collection and transportation systems. Although Kazakhstan has an established primary healthcare network and ongoing efforts to expand access to diagnostic services, rural-urban disparities in the availability and quality of medical services suggest that consistent access to diagnostic testing may be uneven across Kazakhstan [25,26]. Review of rural healthcare infrastructure highlight underdevelopment of service facilities and limited availability of medical resources [27]. Also, the geographical context is important. Kazakhstan is the world's ninth-largest country by land area and has one of the lowest population densities globally, with fewer than 8 people per km² despite a total population of over 20 million [28,29]. In 2024, roughly 37.3% of the population lived in rural areas, indicating a large rural catchment that may face greater distances to health facilities and diagnostic services [30]. Geographic dispersion of the population, long travel distances in rural areas, and variability in local diagnostic capacity may complicate the organization of large-scale laboratory screening.

Workforce capacity may further constrain implementation. Primary healthcare providers serve as the main entry point for preventive services and already manage a substantial burden of NCDs. Systematic CKD screening would increase demands related to laboratory testing, interpretation of results, patient counseling, repeat assessments, and referral coordination. Without appropriate workforce planning and capacity strengthening, additional screening responsibilities may strain service delivery. Studies of Kazakhstan's health system identify ongoing public health implementation challenges and coordination constraints that relate to workforce capacity and readiness for expanded preventive services [31]. Reviews of rural healthcare in Kazakhstan also highlight that workforce distribution in Kazakhstan remains uneven, with staffing in rural areas continuing to present challenges and 82.8% of physicians concentrated in urban settings [27,32].

Another important barrier relates to limited public awareness of CKD. As described previously, CKD often progresses without noticeable symptoms in its early stages, reducing perceived need for preventive testing and limiting participation in screening programs. International and local evidence shows that awareness of CKD remains low, even among affected individuals, which contributes to delayed care-seeking and missed opportunities for early diagnosis [33–36]. Low awareness may also reduce screening uptake and adherence to follow-up after abnormal results, weakening the effectiveness of early detection initiatives [37].

Taken together, these challenges highlight key implementation constraints that may limit the feasibility and effectiveness of systematic CKD screening in Kazakhstan. Future screening strategies should be developed with explicit consideration of these contextual barriers.

International evidence on CKD screening and potential strategies for Kazakhstan

Although implementation of CKD screening presents practical challenges, international research provides important evidence on how screening strategies can be designed to maximize feasibility and effectiveness. A substantial body of evidence supports risk-based screening among individuals at increased risk of CKD. Studies conducted in the United

States and Europe have demonstrated that screening programs focused on high-risk groups - such as individuals with diabetes, hypertension, cardiovascular disease, and older age - can facilitate earlier diagnosis and improve disease management [23,38,39]. Clinical guidelines developed by Kidney Disease: Improving Global Outcomes (KDIGO) initiative recommend routine assessment of kidney function in these high-risk populations [40]. Economic evaluations also support the risk-stratified approach. Cost-effectiveness analyses conducted in multiple high-income settings indicate that screening high-risk groups is generally cost-effective [41–44].

In contrast to risk-based approaches, broader population-wide screening remains controversial, largely due to concerns about cost-effectiveness of such approach. Earlier cost-effectiveness review generally concluded that population-wide CKD screening was not economically attractive compared with risk-based strategies, primarily due to higher program costs and less favorable incremental cost-effectiveness ratios [45]. However, a more recent systematic review presents a more nuanced perspective, suggesting that population-based screening may become economically reasonable under certain conditions, such as higher disease prevalence, improved testing efficiency, or integrated implementation within existing health systems [46].

For Kazakhstan, given the implementation barriers previously described, immediate population-based screening may be challenging to implement efficiently. A risk-based strategy focusing on individuals at elevated risk may therefore represent a more feasible and resource-efficient option. Integrating CKD detection into existing primary healthcare services and NCD management pathways could improve case detection while minimizing additional operational burden [47]. However, the transferability of evidence from high-income settings to Kazakhstan should be considered carefully. Differences in health system organization, laboratory infrastructure, workforce capacity, geographic accessibility, and referral pathways may influence both the feasibility and effectiveness of screening interventions. Therefore, local implementation and economic evaluation studies are essential to assess the real-world applicability of these strategies.

Beyond decisions about whom to screen, the mode of screening delivery is also critical for effective implementation. As mentioned earlier, screening for CKD typically relies on two key clinical indicators: eGFR, which reflects kidney filtration function, and uACR, which indicates the presence of kidney damage. Traditionally, these parameters have been measured using laboratory-based testing, requiring blood and urine samples analyzed in clinical laboratories. Recent technological advances have expanded the possibilities for CKD screening through the use of point-of-care (POC) diagnostic tools [48]. Portable POC devices can provide rapid eGFR and uACR measurements during the same clinical encounter, reducing dependence on centralized laboratory services and shortening diagnostic delays [49–51]. This approach may be particularly relevant for rural and remote areas where access to laboratory infrastructure is limited.

Community-based screening has been used in various settings to reach populations with limited access to facility-based services, particularly in rural or geographically dispersed regions. Such approaches may help identify individuals who do not routinely engage with primary healthcare, thereby improving population coverage and reducing access-related disparities [52,53]. Given Kazakhstan's large territorial area,

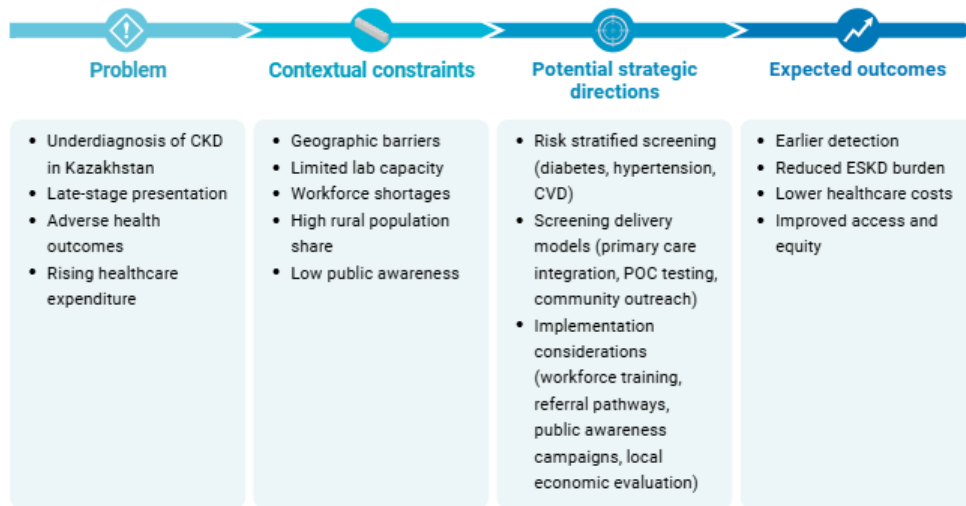


Figure 1 – Conceptual overview of potential approaches to improve early detection of chronic kidney disease in Kazakhstan

The figure summarizes key problem drivers, contextual constraints, potential strategic directions, and expected system-level outcomes. Note: CKD, chronic kidney disease; CVD, cardiovascular disease; POC, point-of-care; ESKD, end-stage kidney disease.

low population density, and substantial rural population, community-based initiatives could potentially improve outreach to underserved groups. Community-based delivery models are feasible in Kazakhstan, as demonstrated by the long-standing use of government-supported mobile medical complexes that bring preventive and diagnostic services directly to residents of remote and rural settlements. Mobile medical complexes are legally defined as healthcare facilities equipped to expand service provision in rural areas, and have been deployed across over 1,100 remote settlements, improving the range and quality of care available to underserved populations [54,55].

Together, these approaches could support more flexible and accessible screening models in Kazakhstan, particularly when aligned with risk-based targeting and integrated within primary healthcare services. Their potential contribution lies in improving geographic reach and operational feasibility while maintaining linkage to formal diagnostic and management pathways. A conceptual overview of these key considerations and potential approaches is presented in Figure 1.

Future directions and policy recommendations

Addressing the underdiagnosis of CKD in Kazakhstan requires practical policy measures that take into account both the scale of the problem and the realities of the national health system. Drawing on the evidence presented and the structure of healthcare delivery in the country, several priority actions could strengthen early detection and management of kidney disease.

First, although CKD testing is recommended within routine follow-up of patients with diabetes, hypertension, and cardiovascular disease, its implementation could be strengthened and standardized across primary healthcare settings. Implementation should be supported by monitoring indicators such as screening coverage among high-risk groups, proportion of positive tests receiving confirmatory assessment, time to diagnosis, and linkage to care. Besides screening protocols, clear follow-up pathways should be defined to ensure that individuals with abnormal screening results are appropriately managed.

This includes confirmatory testing protocols, referral criteria to nephrology services, and integration with existing primary care management systems.

Second, pilot implementation projects should be launched in selected regions to evaluate the feasibility of combining laboratory testing, POC diagnostics, and mobile outreach models. These pilots could inform scalable implementation strategies adapted to geographic and resource constraints. POC diagnostics and community-based outreach models should be considered as complementary delivery mechanisms integrated within primary healthcare services, rather than standalone approaches, to ensure continuity of care and appropriate follow-up.

Third, workforce preparation should focus on practical competencies, including CKD risk identification, test interpretation, referral coordination, and patient counseling, supported by simplified clinical pathways. Fourth, public communication strategies should emphasize the silent nature of early CKD and promote participation in preventive testing among high-risk groups. Finally, local economic and implementation research should guide national decision-making, ensuring that screening strategies reflect Kazakhstan's epidemiology, cost structures, and health system capacity.

In summary, improving early detection of CKD in Kazakhstan will likely require a phased, integrated approach that combines risk-stratified screening, expanded diagnostic access, community outreach, workforce strengthening, and locally informed policy planning. Aligning screening strategies with existing health system structures and contextual realities will be essential to achieving sustainable clinical and economic benefits.

Conclusion

CKD represents a growing public health challenge in Kazakhstan, with a substantial gap between estimated and officially registered cases. Although CKD detection is intended to occur through routine monitoring of high-risk patients, implementation remains inconsistent, and testing often occurs in an opportunistic rather than systematic manner. As a result, many individuals are diagnosed at advanced stages, when

opportunities for effective intervention are limited. International experience suggests that earlier detection can be achieved through more structured and systematically implemented approaches, including both population-based and risk-based strategies. In Kazakhstan, strengthening and standardizing routine monitoring of high-risk groups, supported by clear follow-up pathways and monitoring indicators, may represent a feasible starting point. Complementary use of point-of-care diagnostics and community-based outreach could further improve access, particularly in underserved areas. Generating local evidence will be essential to guide effective and sustainable policy decisions.

Author Contributions: Conceptualization, A. M.; methodology - not applicable; validation - not applicable; formal analysis - not applicable; investigation, A.M.; resources - not applicable; data curation - not applicable; writing - original draft preparation, A.M.; writing - review and editing, A. M. and Z. K.;

visualization, A. M.; supervision, Z. K.; project administration - not applicable; funding acquisition, A.M. and Z. K. All authors have read and agreed to the published version of the manuscript.

Disclosures: The authors have no conflicts of interest.

Acknowledgments: None.

Funding: This research was funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP26197503).

Data availability statement: The corresponding author can provide the data supporting the study's conclusions upon request.

Artificial Intelligence (AI) Disclosure Statement: The authors declare no AI Tools used for preparation of this work.

References

1. Hill NR, Fatoba ST, Oke JL, Hirst JA, O'Callaghan CA, Lasserson DS, Hobbs FDR. Global Prevalence of Chronic Kidney Disease – A Systematic Review and Meta-Analysis. Remuzzi G, editor. PLOS ONE. 2016 Jul 6;11(7):e0158765. <https://doi.org/10.1371/journal.pone.0158765>
2. Bikbov B, Purcell CA, Levey AS, Smith M, Abdoli A, Abebe M, Adebayo OM, Afarideh M, Agarwal SK, Agudelo-Botero M, Ahmadian E, Al-Aly Z, Alipour V et al. Global, regional, and national burden of chronic kidney disease, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*. 2020 Feb;395(10225):709–33. [https://doi.org/10.1016/S0140-6736\(20\)30045-3](https://doi.org/10.1016/S0140-6736(20)30045-3)
3. Zhakhina G, Mussina K, Yerdessov S, Gusmanov A, Sakko Y, Kim V, Syssoyev D, Madikenova M, Assan A, Kuanshaliyeva Z, Turebekov D, Yergaliyev K, Bekishev B, Gaipov A. Analysis of chronic kidney disease epidemiology in Kazakhstan using nationwide data for 2014–2020 and forecasting future trends of prevalence and mortality for 2030. *Ren Fail*. 2024 Dec 31;46(1):2326312. <https://doi.org/10.1080/0886022X.2024.2326312>
4. Muxunov A, Kuanshaliyeva Z, Sarria-Santamera A, Altynova V, Kozybayeva Z, Madikenova M, Kozhakhmet D, Suleimenov S, Bayakhmetova S, Gaipov A. Population-Based Screening during World Kidney Day in Kazakhstan: Prevalence and Risk Factors of Reduced Renal Function. *Cent Asian J Nephrol*. 2025 Sep 17;1(2):cajn007. <https://doi.org/10.63946/cajn/17084>
5. Nursultanova L, Kabulbayev K, Ospanova D, Tazhiyeva A, Datkhayev U, Saliev T, Tanabayeva S, Fakhradiyev I. Prevalence of chronic kidney disease in Kazakhstan: evidence from a national cross-sectional study. *Sci Rep*. 2023 Sep 7;13(1):14710. <https://doi.org/10.1038/s41598-023-42031-2>
6. Levey AS, Coresh J. Chronic kidney disease. *The Lancet*. 2012 Jan;379(9811):165–80. [https://doi.org/10.1016/S0140-6736\(11\)60178-5](https://doi.org/10.1016/S0140-6736(11)60178-5)
7. Chronic Kidney Disease Prognosis Consortium, Matsushita K, van der Velde M, Astor BC, Woodward M, Levey AS, de Jong P, Coresh J, Gansevoort RT. Association of estimated glomerular filtration rate and albuminuria with all-cause and cardiovascular mortality in general population cohorts: a collaborative meta-analysis. *The Lancet*. 2010 Jun;375(9731):2073–81. [https://doi.org/10.1016/S0140-6736\(10\)60674-5](https://doi.org/10.1016/S0140-6736(10)60674-5)
8. Go AS, Chertow GM, Fan D, McCulloch CE, Hsu C yuan. Chronic Kidney Disease and the Risks of Death, Cardiovascular Events, and Hospitalization. *N Engl J Med*. 2004 Sep 23;351(13):1296–305. <https://doi.org/10.1056/NEJMoa041031>
9. Sharapov O, Daminov B. Cardiovascular Diseases in Dialysis Patients at Different Levels of Healthcare of the Republic of Uzbekistan. *Cent Asian J Nephrol*. 2025 Jul 21;1(1):cajn001. <https://doi.org/10.63946/cajn/16627>
10. Muxunov A, Almazan J, Kalinina D, Kuanshaliyeva Z, Gaipov A, Makhadiyeva D, Kabibulatova A, Madikenova M, Nabiyeu A, Sarria-Santamera A. Health-related quality of life in chronic kidney disease patients in low- and lower-middle income countries: a systematic review and meta-analysis. *Qual Life Res*. 2026 Feb;35(2):28. <https://doi.org/10.1007/s11136-025-04154-z>
11. Asanova A, Bolatov A, Suleimenova D, Khazhgaliyeva Y, Shaisultanova S, Altynova S, Pya Y. Assessing Quality of Life in Hemodialysis Patients in Kazakhstan: A Cross-Sectional Study. *J Clin Med*. 2025 Jul 16;14(14). <https://doi.org/10.3390/jcm14145021>
12. Jha V, Al-Ghamdi SMG, Li G, Wu MS, Stafylas P, Retat L, Card-Gowers J, Barone S, Cabrera C, Garcia Sanchez JJ. Global Economic Burden Associated with Chronic Kidney Disease: A Pragmatic Review of Medical Costs for the Inside CKD Research Programme. *Adv Ther*. 2023 Oct;40(10):4405–20. <https://doi.org/10.1007/s12325-023-02608-9>
13. Johansen KL, Chertow GM, Foley RN, Gilbertson DT, Herzog CA, Ishani A, Israni AK, Ku E, Kurella Tamura M, Li S, Li S, Liu J, Obrador GT, O'Hare AM, Peng Y, Powe NR, Roetker NS, St. Peter WL, Abbott KC, Chan KE, Schulman IH, Snyder J, Solid C, Weinhandl ED, Winkelmayer WC, Wetmore JB. US Renal Data System 2020 Annual Data Report: Epidemiology of Kidney Disease in the United States. *Am J Kidney Dis*. 2021 Apr;77(4):A7–8. <https://doi.org/10.1053/j.ajkd.2021.01.002>
14. WHO Regional Office for Europe. WHO Country Office in Kazakhstan: annual activity report 2024. Copenhagen; 2025.
15. Government of the Republic of Kazakhstan. On the approval of the National Development Plan of the Republic of Kazakhstan until 2029 and the invalidation of certain decrees of the President of the Republic of Kazakhstan [Decree of the President of the Republic of Kazakhstan] [Internet]. 2024. Available from: <https://adilet.zan.kz/rus/docs/U2400000611#z13>

16. Ministry of Health of the Republic of Kazakhstan. On approval of the rules for screening examinations of the target population of the Republic of Kazakhstan. [Order of the Minister of Health of the Republic of Kazakhstan No. КР ДСМ-131/2020] [Internet]. 2020. Available from: <https://adilet.zan.kz/rus/docs/V2000021572>
17. Orazumbekova B, Issanov A, Atageldiyeva K, Berkinbayev S, Junusbekova G, Danyarova L, Shyman Z, Tashmanova A, Sarria-Santamera A. Prevalence of Impaired Fasting Glucose and Type 2 Diabetes in Kazakhstan: Findings From Large Study. *Front Public Health*. 2022 Feb 24;10:810153. <https://doi.org/10.3389/fpubh.2022.810153>
18. Bekbergenova Z, Derbissalina G, Umbetzhanova A, Koikov V, Bedelbayeva G. Evaluating the effectiveness of a screening program for cardiovascular diseases in Kazakhstan. *Eur J Public Health*. 2019 Nov 1;29(Supplement_4):ckz186.229. <https://doi.org/10.1093/eurpub/ckz186.229>
19. Shamsutdinova A, Kulkayeva G, Karashutova Z, Tanabayev B, Tanabayeva S, Ibrayeva A, Fakhradiyev I. Analysis of the Effectiveness and Coverage of Breast, Cervical, and Colorectal Cancer Screening Programs in Kazakhstan for the Period 2021–2023: Regional Disparities and Coverage Dynamics. *Asian Pac J Cancer Prev*. 2024 Dec 1;25(12):4371–80. <https://doi.org/10.31557/APJCP.2024.25.12.4371>
20. Ministry of Health of the Republic of Kazakhstan. Chronic kidney disease in adults: Clinical protocol. Astana: Ministry of Health of the Republic of Kazakhstan [Internet]. Available from: <https://diseases.medelement.com/disease/хроническая-болезнь-почек-у-взрослых-кп-рк-2023/17777>
21. Imai E, Yamagata K, Iseki K, Iso H, Horio M, Mkinno H, Hishida A, Matsuo S. Kidney Disease Screening Program in Japan: History, Outcome, and Perspectives. *Clin J Am Soc Nephrol*. 2007 Nov;2(6):1360–6. <https://doi.org/10.2215/CJN.00980207>
22. Hwang S, Tsai J, Chen H. Epidemiology, impact and preventive care of chronic kidney disease in Taiwan. *Nephrology*. 2010 Jun;15(s2):3–9. <https://doi.org/10.1111/j.1440-1797.2010.01304.x>
23. Kushner P, Mende C. Screening programmes for early detection of chronic kidney disease in the USA and other English-speaking countries (Canada, Australia and UK): a systematic literature review. *BMJ Open*. 2025 Nov;15(11):e099966. <https://doi.org/10.1136/bmjopen-2025-099966>
24. Stevens PE, Ahmed SB, Carrero JJ, Foster B, Francis A, Hall RK, Herrington WG, Hill G, Inker LA, Kazancıoğlu R, Lamb E, Lin P, Madero M, McIntyre N, Morrow K, Roberts G, Sabanayagam D, Schaeffner E, Shlipak M, Shroff R, Tangri N, Thanachayanont T, Ulas I, Wong G, Yang CW, Zhang L, Levin A. KDIGO 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease. *Kidney Int*. 2024 Apr;105(4):S117–314. <https://doi.org/10.1016/j.kint.2023.10.018>
25. Spankulova L, Chulanova Z, Konyrbay A. Evaluating Healthcare Accessibility in Kazakhstan: Urban and Rural Perspectives. *Eurasian J Econ Bus Stud*. 2024 Jun 30;68(2):5–19. <https://doi.org/10.47703/ejeb.v68i2.376>
26. Rechel B, Sydykova A, Moldoisava S, Sodiqova D, Spatayev Y, Ahmedov M, Robinson S, Sagan A. Primary care reforms in Central Asia – On the path to universal health coverage? *Health Policy OPEN*. 2023 Dec;5:100110. <https://doi.org/10.1016/j.hopen.2023.100110>
27. Turgambayeva A, Imanova Z, Tulegenova A. Rural Healthcare in Kazakhstan: Problems and Trends(Literature Review). *J Health Dev*. 2021;43(3):13–8. <https://doi.org/10.32921/2225-9929-2021-3-43-13-18>
28. World Bank Group. World Bank Open Data [Internet]. [cited 2026 Mar 6]. Population density (people per sq. km of land area) - Kazakhstan. Available from: <https://data.worldbank.org/indicator/EN.POP.DNST?locations=KZ>
29. World Bank Group. World Bank Open Data [Internet]. [cited 2026 Mar 6]. Land area (sq. km) - Kazakhstan. Available from: <https://data.worldbank.org/indicator/AG.LND.TOTL.K2?locations=KZ>
30. Mirasbek B. Population of the Republic of Kazakhstan as of July 1, 2024 [Internet]. Department of Population Statistics; 2024. Available from: [https://stat.gov.kz/upload/iblock/978/4a34ya7f2gnk770d4c9wgh294fu7s8ro/%D0%91-18-06-%D0%9A%20\(1%202024\)%20%D0%B0%D0%BD%D0%B3.pdf](https://stat.gov.kz/upload/iblock/978/4a34ya7f2gnk770d4c9wgh294fu7s8ro/%D0%91-18-06-%D0%9A%20(1%202024)%20%D0%B0%D0%BD%D0%B3.pdf)
31. Aringazina A, Gulis G, Allegrante JP. Public Health Challenges and Priorities for Kazakhstan. *Cent Asian J Glob Health*. 2012 Nov 5;1(1). <https://doi.org/10.5195/cajgh.2012.30>
32. European Observatory on Health Systems and Policies, WHO Europe. OBS [Internet]. 2024 [cited 2026 Mar 6]. Health systems in action: Kazakhstan. Available from: <https://eurohealthobservatory.who.int/publications/i/health-systems-in-action-kazakhstan-2024>
33. Plantinga L, Tuot DS, Powe NR. Awareness of Chronic Kidney Disease Among Patients and Providers. *Adv Chronic Kidney Dis*. 2010;17(3):225–36. Located at: Scopus. <https://doi.org/10.1053/j.ackd.2010.03.002>
34. Muxunov A, Bulanov N, Makhmetov S, Sharapov O, Abdullaev S, Loboda O, Aiyopova D, Haziyeu E, Rashidov I, Tchokhanelidze I, Okpechi IG, Gaipov A. Awareness of chronic kidney disease and its risk factors in the former Soviet Union countries. *Electron J Gen Med*. 2023 Nov 1;20(6):em528. <https://doi.org/10.29333/ejgm/13517>
35. Bello AK, Okpechi IG, Levin A, Ye F, Saad S, Zaidi D, Houston G, Damster S, Arruebo S, Abu-Alfa AK, Ashuntantang G, Caskey FJ, Cho Y, Coppo R, Davids MR, Davison S, Gaipov A, Htay H, Jindal K, Lalji R, Madero M, Osman MA, Parekh RS, See E, Shah DS, Sozio SM, Suzuki Y, Tesar V, Tonelli M, Wainstein M, Wong M, Yeung E, Johnson D. ISN–Global Kidney Health Atlas: A report by the International Society of Nephrology: An Assessment of Global Kidney Health Care Status focussing on Capacity, Availability, Accessibility, Affordability and Outcomes of Kidney Disease. Brussels, Belgium: International Society of Nephrology; 2023.
36. Asanbek Kyzy A, Omorova A, Sakibaeva A, Zhumaeva K, Kudaiberdieva E, Rysbekova G, Nawa N, Ismanov K, Kalmatov R. Diabetic Kidney Disease Prevention in Type 2 Diabetes: Knowledge, Attitudes and Practices Study from Kyrgyzstan. *Cent Asian J Nephrol*. 2026 Apr 2;2(1):cajn012. <https://doi.org/10.63946/cajn/18298>
37. Tuot DS, Wong KK, Velásquez A, Crews D, Zonderman AB, Evans MK, Powe NR. CKD Awareness in the General Population: Performance of CKD-Specific Questions. *Kidney Med*. 2019;1(2):43–50. Located at: Scopus. <https://doi.org/10.1016/j.xkme.2019.01.005>
38. Farrell DR, Vassalotti JA. Screening, identifying, and treating chronic kidney disease: why, who, when, how, and what? *BMC Nephrol*. 2024 Jan 25;25(1). <https://doi.org/10.1186/s12882-024-03466-5>
39. Early chronic kidney disease intervention could save four European health systems up to €15.8 billion over 10 years [Internet]. 2024 [cited 2026 Mar 10]. Available from: <https://www.astrazeneca.com/content/astraz/media-centre/press-releases/2024/early-chronic-kidney-disease-intervention-could-save-four-european-health-systems-up-to-15-billion-euro-over-10-years.html>
40. Iatridi F, Carrero JJ, Cornec-Le Gall E, Kanbay M, Luyckx V, Shroff R, Ferro CJ. KDIGO 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease in Children and Adults: a commentary from the European Renal Best Practice

- (ERBP). *Nephrol Dial Transplant Off Publ Eur Dial Transpl Assoc - Eur Ren Assoc*. 2025 Feb 4;40(2):273–82. <https://doi.org/10.1093/ndt/gfae209>
41. Palmer AJ, Valentine WJ, Chen R, Mehin N, Gabriel S, Bregman B, Rodby RA. A health economic analysis of screening and optimal treatment of nephropathy in patients with type 2 diabetes and hypertension in the USA. *Nephrol Dial Transplant*. 2008;23(4):1216–23. <https://doi.org/10.1093/ndt/gfn082>
 42. Howard K, White S, Salkeld G, McDonald S, Craig JC, Chadban S, Cass A. Cost-effectiveness of screening and optimal management for diabetes, hypertension, and chronic kidney disease: a modeled analysis. *Value Health J Int Soc Pharmacoeconomics Outcomes Res*. 2010;13(2):196–208. Located at: Ovid MEDLINE(R) <2010 to 2011>. <https://doi.org/10.1111/j.1524-4733.2009.00668.x>
 43. Siegel KR, Ali MK, Zhou X, Ng BP, Jawanda S, Proia K, Zhang X, Gregg EW, Albright AL, Zhang P. Cost-effectiveness of Interventions to Manage Diabetes: Has the Evidence Changed Since 2008? *Diabetes Care*. 2020 Jul;43(7):1557–92. <https://doi.org/10.2337/dci20-0017>
 44. Thornton Snider J, Sullivan J, Van Eijndhoven E, Hansen MK, Bellosillo N, Neslusan C, O'Brien E, Riley R, Seabury S, Kasiske BL. Lifetime benefits of early detection and treatment of diabetic kidney disease. Mischak H, editor. *PLOS ONE*. 2019 May 31;14(5):e0217487. <https://doi.org/10.1371/journal.pone.0217487>
 45. Komenda P, Ferguson TW, Macdonald K, Rigatto C, Koolage C, Sood MM, Tangri N. Cost-effectiveness of Primary Screening for CKD: A Systematic Review. *Am J Kidney Dis*. 2014 May;63(5):789–97. <https://doi.org/10.1053/j.ajkd.2013.12.012>
 46. Li J, Zhao M, He Q. Screening for chronic kidney disease: a systematic review of emerging evidence and perspectives. *Ren Fail*. 2025 Dec 31;47(1):2572353. <https://doi.org/10.1080/0886022X.2025.2572353>
 47. Vassalotti JA, Boucree SC. Integrating CKD Into US Primary Care: Bridging the Knowledge and Implementation Gaps. *Kidney Int Rep*. 2022 Mar;7(3):389–96. <https://doi.org/10.1016/j.ekir.2022.01.1066>
 48. Gama RM, Nebres D, Bramham K. Community Point of Care Testing in Diagnosing and Managing Chronic Kidney Disease. *Diagnostics*. 2024 Jul 17;14(14):1542. <https://doi.org/10.3390/diagnostics14141542>
 49. Gbinigie O, Thompson M, Price CP, Heneghan C, Plüddemann A. Point-of-Care creatinine testing for the detection and monitoring of chronic kidney disease [Internet]. Primary Care Diagnostic Horizon Scanning Centre Oxford; [cited 2026 Mar 10]. Available from: <https://www.community.healthcare.mic.nihr.ac.uk/reports-and-resources/horizon-scanning-reports/point-of-care-creatinine-testing-for-the-detection-and-monitoring-of-chronic-kidney-disease>
 50. Thiengsusuk A, Youngvises N, Pochairach R, Taha RO, Sirisabhabhorn K, Muhamad N, Meesiri W, Chaijaroenkul W, Na-Bangchang K. Urinary Albumin-to-Creatinine Ratio (uACR) Point-of-Care (POC) Device with Seamless Data Transmission for Monitoring the Progression of Chronic Kidney Disease. *Biosensors*. 2025 Feb 24;15(3):145. <https://doi.org/10.3390/bios15030145>
 51. Dally M, Amador JJ, Butler-Dawson J, Lopez-Pilarte D, Gero A, Krisher L, Cruz A, Pilloni D, Kupferman J, Friedman DJ, Griffin BR, Newman LS, Brooks DR. Point-of-Care Testing in Chronic Kidney Disease of Non-Traditional Origin: Considerations for Clinical, Epidemiological, and Health Surveillance Research and Practice. *Ann Glob Health*. 2023 Feb 1;89(1):7. <https://doi.org/10.5334/aogh.3884>
 52. Zhang L, Zuo L, Xu G, Wang F, Wang M, Wang S, Lv J, Liu L, Wang H. Community-based screening for chronic kidney disease among populations older than 40 years in Beijing. *Nephrol Dial Transplant Off Publ Eur Dial Transpl Assoc - Eur Ren Assoc*. 2007 Apr;22(4):1093–9. Located at: Ovid MEDLINE(R) <2005 to 2007>. <https://doi.org/10.1093/ndt/gff763>
 53. McCullough PA, Brown WW, Gannon MR, Vassalotti JA, Collins AJ, Chen SC, Bakris GL, Whaley-Connell AT. Sustainable Community-Based CKD Screening Methods Employed by the National Kidney Foundation's Kidney Early Evaluation Program (KEEP). *Am J Kidney Dis*. 2011 Mar;57(3):S4–8. <https://doi.org/10.1053/j.ajkd.2010.11.010>
 54. Review of Kazakhstan's healthcare system: Results of 2020 and plans for 2021 - Official Information Source of the Prime minister of the Republic of Kazakhstan [Internet]. [cited 2026 Mar 10]. Available from: <https://primeminister.kz/en/news/reviews/review-of-kazakhstans-healthcare-system-Results-of-2020-and-plans-for-20215968>
 55. Code of the Republic of Kazakhstan [Internet]. [cited 2026 Mar 10]. ON PUBLIC HEALTH AND HEALTHCARE SYSTEM - 'Adilet' LIS. Available from: https://adilet.zan.kz/eng/docs/K2000000360?utm_source=chatgpt.com