THE IMPACT OF THE ECOLOGICAL CRISIS IN THE ARAL SEA REGION ON THE PROGRESSION OF CHRONIC KIDNEY DISEASE: A COMPREHENSIVE ANALYSIS OF TRADITIONAL AND NON-TRADITIONAL RISK FACTORS (6-MONTH OBSERVATIONAL STUDY)

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Abstract
In the context of the ecological crisis in the Aral Sea region (dust storms, water mineralization, and intense insolation), a study was conducted to investigate the risk factors for the development and progression of chronic kidney disease (CKD). At the first stage, 500 residents of the region (aged 25–65) underwent a screening questionnaire using a modified scoring system that included both traditional risk factors (arterial hypertension, diabetes mellitus, obesity, smoking) and region-specific "non-traditional" factors (proximity to the Aral Sea, drinking water source, level of insolation). In 115 patients with high or moderate risk (based on the questionnaire), CKD stages II–IV were verified, and a 6-month follow-up was initiated with monitoring of GFR and ultrasound. In parallel, data from 217 CKD patients from primary healthcare settings were analyzed. The results showed:
1. After 6 months, CKD progression was observed in 25% of monitored patients, with the most pronounced progression among those living less than 200 km from the Aral Sea, consuming well water, and working in open areas;

2. In primary care patients, modifiable risk factors predominated: hypertension (51.15%), type 2 diabetes (45.16%), obesity (47.0%), dyslipidemia (71.0%), high sympathetic nervous system activity (70.5%), and smoking (16.6%);

3. Common non-modifiable factors included blood group III/IV (61.8%), older age (49.31%), male sex (50.7%), and congenital anomalies (28.6%);

4. Dominant extra-renal manifestations were anemia (up to 80.98%), hypertension, weight loss, apathy, and dyslipidemia.

The developed questionnaire proved effective in early identification of CKD risk groups considering the regional environmental burden. The high proportion of modifiable risk factors (80%) highlights the preventive potential at the primary care level through management of hypertension, diabetes, obesity, and lifestyle modification. The implementation of the questionnaire in clinical practice in the Aral region is recommended for personalized prevention of CKD progression.

Keywords: Chronic Kidney Disease (CKD), Aral Sea region, CKD risk factors, traditional risk factors, non-traditional risk factors, modifiable risk factors, non-modifiable risk factors, questionnaire, screening, risk score assessment, environmental factors, dust storms, water mineralization, insolation, distance from the Aral Sea, CKD progression, CKD stages (II, IIIA, IIIB, IV), early diagnosis, primary healthcare, follow-up monitoring, CKD prevention, extra-renal manifestations, arterial hypertension, type 2 diabetes mellitus, obesity, dyslipidemia, blood group III and IV, econephropathy.

«ВЛИЯНИЕ ЭКОЛОГИЧЕСКОГО КРИЗИСА ПРИАРАЛЬЯ НА ПРОГРЕССИРОВАНИЕ ХРОНИЧЕСКОЙ БОЛЕЗНИ ПОЧЕК: КОМПЛЕКСНЫЙ АНАЛИЗ ТРАДИЦИОННЫХ И НЕТРАДИЦИОННЫХ ФАКТОРОВ РИСКА» (6 МЕСЯЧНОЕ НАБЛЮДЕНИЕ)

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Аннотация:

в условиях экологического кризиса Приаралья (пыльные бури, минерализация воды, интенсивная инсоляция) проведено исследование факторов риска развития и прогрессирования хронической болезни почек (ХБП). На первом этапе 500 жителей региона (25–65 лет) прошли скрининговое анкетирование по модифицированной балльной системе, включающей как традиционные факторы риска (артериальная гипертензия, сахарный диабет, ожирение, курение), так и специфические для Приаралья "нетрадиционные" (удаленность от Аральского моря, источник питьевой воды, уровень инсоляции). У 115 пациентов с высоким/умеренным риском (по анкете) верифицирована стадия ХБП (II–IV) и начато 6-месячное диспансерное наблюдение с контролем СКФ и УЗИ. Параллельно проанализированы данные 217 пациентов с ХБП на уровне первичного звена здравоохранения. Результаты показали:

1. Через 6 месяцев прогрессирование ХБП отмечено у 25% наблюдаемых, наиболее выраженное у проживающих <200 км от Арала, употребляющих колодезную воду и работающих на открытой местности;

2. У пациентов ПЗЗ преобладают модифицируемые факторы риска: АГ (51.15%), СД 2 типа (45.16%), ожирение (47.0%), дислипидемия (71.0%), высокая активность СНС (70.5%), курение (16.6%);

3. Частые немодифицируемые факторы: группа крови III/IV (61.8%), пожилой возраст (49.31%), мужской пол (50.7%), врожденные аномалии (28.6%);

4. Доминирующие экстраренальные проявления: анемия (до 80.98%), АГ, потеря веса, апатия, дислипидемия.

Разработанная анкета доказала эффективность для раннего выявления групп риска ХБП с учетом региональной экологической нагрузки. Высокая доля управляемых факторов риска (80%) подчеркивает потенциал профилактики на уровне ПЗЗ через контроль АГ, СД, ожирения и коррекцию образа жизни. Внедрение анкеты в практику врачей Приаралья рекомендовано для персонализированной профилактики прогрессирования ХБП.

Ключевые слова: Хроническая болезнь почек (ХБП), Приаралье, факторы риска ХБП, традиционные факторы риска, нетрадиционные факторы риска, модифицируемые факторы риска, немодифицируемые факторы риска, анкетирование, скрининг, балльная оценка риска, экологические факторы, пыльные бури, минерализация воды, инсоляция, удаленность от Аральского моря, прогрессирование ХБП, стадии ХБП (II, IIIA, IIIB, IV), ранняя диагностика, первичное звено здравоохранения, диспансерное наблюдение, профилактика ХБП, экстраренальные проявления, артериальная гипертензия, сахарный диабет 2 типа, ожирение, дислипидемия, группа крови III и IV, эконефропатия.

Relevance:

As is well known, climate change on our planet is becoming increasingly noticeable every year, and adverse environmental factors exert a significant negative impact on human health. The World Health Organization has reported that approximately 24% of all diseases and 23% of deaths worldwide are associated with harmful environmental influences, most of which are preventable. It has been proven that environmental conditions, including ecological factors, account for about 17–20% in the formation of human health, while lifestyle — closely linked to the natural and climatic characteristics of a specific region — contributes 48–53%. One of the most environmentally challenged areas in Central Asia is the Aral Sea region. This is due to the desiccation of the Aral Sea, which has resulted in a complex of issues affecting all aspects of human activity, including public health.

The main adverse environmental factors influencing the health status of the local population include a sharply continental arid climate, excessive solar radiation (insolation), strong winds with frequent dust storms, a shortage of drinking water and its high mineralization, large quantities of pesticides in the soil and groundwater, and the desertification of surrounding territories.

As a result of these environmental conditions, chronic diseases are more prevalent in the Aral Sea region, particularly those affecting organs and systems that serve as protective barriers at the interface between the external and internal environments. These include the respiratory, digestive, urinary, and immune

systems, which play a crucial role in maintaining and preserving the body's homeostasis.

In this context, researchers bear the responsibility of studying the consequences of climate change and developing systemic measures to mitigate the harmful effects of the environment, as well as to protect and promote public health. In recent decades, special attention in our country has been devoted to improving the ecological situation across the entire territory, particularly in the Aral Sea region. At the national level, a comprehensive strategy has been developed and implemented to transition to a "green" economy, aiming to mitigate the negative consequences of climate change by significantly reducing pollutant emissions from the energy, industrial, and construction sectors.

From this perspective, healthcare plays a critical role in addressing these challenges by investigating the "environment–human health" relationship. The goal is to establish and assess the significance of causal links between environmental factors and the frequency of occurrence and progression of internal organ diseases. The findings of such studies can enhance medical care in the Aral region by facilitating the early detection of diseases and the development of comprehensive treatment and prevention measures.

Scientific publications on medical issues related to internal organ diseases in the Aral Sea region have primarily focused on pulmonary and cardiovascular disorders. However, despite the relatively high prevalence of urological and nephrological diseases in this area, only a few publications addressing this topic exist, and most lack a deep and comprehensive approach. Studies conducted in the Aral region have revealed a high risk of nephropathies and urinary system anomalies in children living in areas contaminated with heavy metal salts. This has been confirmed by experimental research, leading to the term "econephropathy" to describe such environmentally induced kidney damage (V. V. Inogamova, Z. Sh. Giyasova, 2016). According to L.K. Ibraeva et al. (2017), the most common diseases of the urinary system in the region were urolithiasis and the closely related chronic pyelonephritis. The same authors reported that the incidence of urolithiasis in the region increased by 4.2 times over a ten-year period, largely due to the high mineral content and chemical contamination of tap water.

Given the above, the aim of this study was to identify, through questionnaire screening and a comprehensive assessment, both traditional and non-traditional risk factors for the development and progression of CKD in the Aral Sea region. This will allow the development of strategies to modify these risk factors and prevent CKD progression among the local population.

Materials and Methods
The study was conducted in two stages. At the initial stage, 500 individuals were randomly selected from primary healthcare settings. All participants were born and permanently resided in the Aral Sea region, aged between 25 and 65 years, with a mean age of 42 ± 3.4 years. They were given a questionnaire to identify those at risk for CKD development and progression. The questionnaire was based on a computer program for early diagnosis and prevention of CKD progression, developed by M.A. Sobirov and K.M. Daminova (Certificate DGU No. 12090 dated 12.08.2021). It included several sections: personal and anthropometric data, family and gynecological history, history of kidney diseases and urinary disorders, and traditional CKD risk factors, including comorbid and background conditions in accordance with current recommendations (A.M. Aringazina, O.Zh. Narmanova et al., 2021; V.V. Fomin, O.N. Kotenko, 2021).

Additionally, based on the goals of this study, a special section on "non-traditional" CKD risk factors was included in the questionnaire. The Aral Sea region has its own unique climatic features, with the most significant ones affecting kidney function being dust storms, poor drinking water quality, and intense solar radiation. These factors, along with the distance between a person's place of residence and the Aral Sea, were classified as "non-traditional" CKD risk factors, playing a particularly important role in the region.

For early detection and diagnosis at the primary healthcare level, as well as for slowing CKD progression, special attention must be paid to clinical symptoms and risk factors. Key risk factors that require focused attention include smoking, chronic infections, uncontrolled medication use, alcohol consumption, unfavorable environmental conditions, climate change, dietary habits, genetic predispositions, and more [7,4].

These risk factors for the development and progression of chronic kidney disease (CKD) can be divided into two main categories: **non-modifiable** and **potentially**

modifiable risk factors. The frequency of occurrence observed in our study is presented in the table below (Table 1).

Table 1. Risk Factors for the Development and Progression of Chronic Kidney Disease Observed During the Study

Non-modifiable, n=217	%	Modifiable, n=217	%
1. Old age	60(27,65%)	1. Type 2 diabetes	98(45,16%)
2. Male gender	110 (50,7 %)	2. Arterial hypertension	111(51,15%)
3. Female gender	107 (49,3 %)	3. Autoimmune diseases	7(3,2%)
4. Hereditary factors-family history of CKD	11(5,07%)	4. Systemic inflammatory diseases	8(3,7%)
5. Congenital malformations	62(28,6%)	5. Urinary tract infections and stones	25(11,5%)
6III and IV blood groups	134(61,8%)	6. Obstructed urine flow	27(12,4%)
		7. Drug toxicity	30(13,82%)
		8. High protein intake	41(18,89%)
		9. Dyslipoproteinemia	91(41,9%)
		9. Concomitant diseases (factors)	189(87,1%)
		10. Smoking	36(16,6%)
		11. Alcohol and drug abuse	73(33,6%)
		12. Obesity or metabolic syndrome	102(47%)
		13. Pregnancy	13(5,99%)
		14. Nutritional characteristics, diet	85(39,2%)
		15. Iatrogenic factors	10(4,6%)
		16. Increased activity of the SNS	153(70,5%)

Fig. 1 Frequency of occurrence of the main risk factors in observed patients with CKD at the level of primary care physicians, n=217

Chronic kidney disease is currently not only a medical problem but also a health problem in general all over the world. Unfortunately, it is beginning to reach epidemic proportions due to late diagnosis and rapid progression of terminal CKD. It has been established that risk groups for the development of acute kidney injury are distinguished based on the presence of risk factors. These include: initial decrease in SCF, old age, female gender, racial and ethnic characteristics, Negroid race, hereditary factor, acute and chronic diseases, diabetes, cancer, anemia, decreased circulating blood volume and etiologic factors of acute kidney injury (sepsis, burns, shock, severe trauma, critical conditions, major surgical and cardiac interventions, nephrotoxic drugs, radiocontrast agents, plant and animal poisons).

Table 2 Characteristics of CKD risk factors in observed patients with CKD at the level of primary care physicians, n=217

Types	Definition	Description of RF	% occurrence n=217
Factors that increase the body's susceptibility	Increased susceptibility of the renal parenchyma to injury	Older age	49.31
		Family history of CKD	5.07
		Low birth weight (low initial nephron count)	52.1
Initiation factors	Lead to damage to the renal parenchyma	Diabetes mellitus	45,2
		Arterial hypertension	51,15
		Autoimmune diseases	3,2
		Systemic infections	3,7
		Urinary tract infections	11,5
		Stone formation	9,7
		Drug toxicity	13,82
		Hereditary diseases	5,07
Progression factors	Contribute to further damage to the renal parenchyma and also accelerate the decline in renal function	Proteinuria	12,4
		Arterial hypertension	51,15
		High glycemia in type 2 diabetes	82,9
		Dyslipidemia	18,89
		Smoking	79,3

To assess the risk of developing CKD at the level of primary care physicians in the early stages of patients and predict further outcomes of chronic kidney disease, the study examined the main risk factors for the development and progression of kidney pathology in patients with CKD: age, arterial hypertension, obesity, anemia, etc. All risk factors were considered with and without complaints from patients. At the same time, the results of the study showed that among 217 patients at the level of primary care physicians, the average BMI was 29.5±5.92 kg/m2. Normal body weight was observed in 52 (24.0%) patients, overweight was observed in 72 (29.0%) patients, obesity was detected in -102 (47.0%)
Hypercholesterolemia was detected in -154 (71.0%) patients,
Arterial hypertension was detected in 111 (51.15%)
CVD in immediate relatives was detected in 149 (68.7%) patients, and

After analyzing complaints and risk factors, a high prevalence of extrarenal manifestations was noted, such as cardiovascular, gastrointestinal, manifestations from the central nervous system, musculoskeletal system and other general manifestations. (Table 4)

Table. 4. Prevalence of extrarenal manifestations of CKD in patients with a previously and newly diagnosed.

Extrarenal manifestations of CKD		Previously diagnosed CKD n=163(75.12%)	Newly diagnosed CKD n=54(24.88%)
Manifestations from the CCC	Arterial hypertension	77(47,24%)	34(62,96%)
	Heart palpitations and irregularities	15 (9,20%)	2(3,70%)
Manifestations from the central system	Headaches or dizziness	71(43,56%)	3(5,56%)
	Decreased clarity of thought	96(58,89%)	24(44.44%)
	Apathy	104(63,80%)	19(35,19%)
Gastroenterological manifestations	Weight loss	112(68,71%)	24(44.44%)
	Nausea	52(31,9%)	13(24,07%)
	Vomition	36(22,08%)	5(9,26%)
	Hyperlipidemia	125(76,68%)	29(53,7%)
	Overweight and obesity	90(55,21%)	12 (22,22%)
Musculoskeletal manifestations	Muscle pain	21(12,88%)	3(5,56%)
	Joint pain	18(11,04%)	4(7,41%)
Other manifestations	Stomatitis	18(11,04%)	3(5,56%)
	Lack of appetite, aversion to meat	112(68,71%)	24(44.44%)
	Anemia	132(80,98%)	25(46,30%)
	CKD in immediate relatives	11(6,75%)	7 (12,96%)

The most common extra-renal manifestations included arterial hypertension, palpitations and cardiac arrhythmias, headaches of varying intensity, dizziness, impaired mental clarity, and apathy (see Fig. 4.1.3). Among gastroenterological symptoms, prominent features were weight loss—both with and without loss of appetite—as well as the presence of patients with obesity. Other symptoms included nausea, vomiting, and lipid profile disturbances. It is also important to

note that patients frequently experienced muscle and joint pain, anemic syndrome, and other related manifestations.
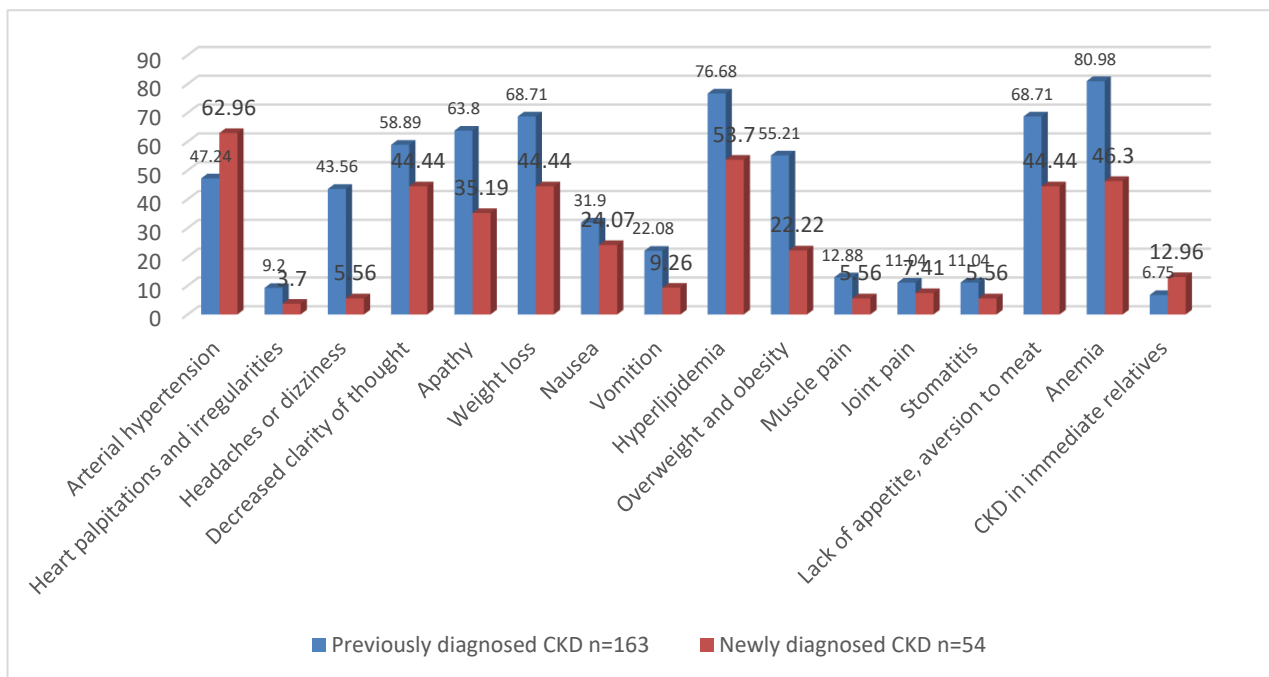

Fig. 1. Extrarenal manifestations in the group with newly diagnosed CKD and groups that were previously diagnosed (n=217)

In addition, the study results showed that the presence of certain modifiable (smoking 16.6%, increased sympathetic nervous system activity 70.5%, hypertension 51.15%, metabolic syndrome 47%, high protein intake 18.89%, urinary tract infections and stones 11.5%, diabetes mellitus 45.16%) and non-modifiable factors (blood group III and IV 61.8%, male gender 49.31%, old age 49.31%, congenital malformations and decreased renal nephrons 28.6%, hereditary factors (including family history of CKD) 5.07%) in patients indicates a high risk of CKD progression

Thus, the prevalence of extrarenal manifestations, as well as the high frequency of risk factors for the development of CKD at the level of primary health care physicians, 80% of whom modifiable, correlates with the severity of the disease.

Conclusion. Thus, a preliminary assessment of the dynamics of the course of CKD after 6 months in patients of the Aral region demonstrated disease progression in ¼ of patients who had a combination of known traditional and non-

traditional (proximity to the Aral Sea, quality of drinking water and the degree of intensity of ultraviolet radiation - insolation) risk factors. The use of a questionnaire modified by us with the inclusion of the above-mentioned risk factors for CKD, typical for residents of the Aral region, allows primary health care physicians in this region to use it in everyday clinical practice as a computer program for the early diagnosis of CKD with the development of an individual management scheme for each patient to reduce the rate of disease progression and improve the prognosis of the disease.

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