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RISK MANAGEMENT AND PREVALENCE OF ARTERIAL HYPERTENSION IN A COHORT OF PEOPLE LIVING IN THE AFFECTED AREA OF RADIOACTIVE WASTE STORAGE

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Summary

Relevance: The Republic of Kazakhstan occupies a leading place in the world in terms of uranium ore reserves, where about 25% of the world's proven uranium reserves are concentrated. Currently, more than 200 million tons of radioactive waste has accumulated on the territory of the Republic in the form of tailings from concentration plants, heap leaching piles, tailing dumps of hydrometallurgical plants, dumps of poor and unprocessed marketable ore, which are very dangerous as a source of radioactive and chemical pollution of the environment. Currently, there are several radioactive waste tailings in use in the republic. The largest of them is the tailing dump of radioactive waste of the Hydrometallurgical Plant of the Stepnogorsk Mining and Chemical Combine which has been operating since 1956. The plant is one of the largest complexes for the production of uranium oxide and other rare metals. The main types of industrial waste are the tailings of uranium ore processing, which, in terms of the content of radionuclides, are classified as hazard class I. Its mining undoubtedly causes an increase in uranium production and an increase in the complex of technogenic radiation and toxic effects. At the same time, an urgent issue is the assessment of the impact of low doses of ionizing radiation on the population living in the zone of impact of technogenic factors of the radioactive wastestorage of uranium processing enterprises, and the study of the risk of somatic morbidity.

Aim: to assess the possible impact of technogenic factors of the storage of radioactive waste of a uranium processing enterprise on the risk and prevalence of arterial hypertension in the population.

Materials and methods: The results of a cohort retrospective study over three years among persons exposed to long-term exposure to negative technogenic factors on the frequency and risk of developing somatic diseases in the main group - the population living near the storage of radioactive waste of uranium production, as well as the control group – the population of the city of Akkol located more than 100 km from the city of Stepnogorsk constituting the control group. The study covers 399 people, including 255 people in the main group and 174 people in the control group. The results of the study were processed using the IBM SPSS Statistics 20 software product and the Microsoft Excel program. Statistical calculations were carried out using the sanitary statistics method.

Results: Studies have shown that long-term exposure to low doses can lead to an increase in somatic morbidity. The most characteristic for people living near radioactive waste storage facilities is the pathology of the cardiovascular system, in the structure of which the first rank is occupied by arterial hypertension – 83%, which indicates the possible influence of small doses of ionizing radiation on the risk and prevalence of arterial hypertension in the population.

Conclusions: The data obtained show that long-term residence of the population in this territory has a significant impact on the prevalence of arterial hypertension.

Key words: *arterial hypertension, radioactive waste, population.*

Резюме

МОНИТОРИНГ РИСКА И РАСПРОСТРАНЕННОСТЬ АРТЕРИАЛЬНОЙ ГИПЕРТЕНЗИИ В КОГОРТЕ ЛЮДЕЙ, ПРОЖИВАЮЩИХ В ЗОНЕ ВЛИЯНИЯ ХРАНИЛИЩ РАДИОАКТИВНЫХ ОТХОДОВ

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Актуальность: Республика Казахстан занимает ведущее место в мире по запасам урановых руд, где сосредоточено около 25% разведанных мировых запасов урана**.** В настоящее время на территории Республики накопилось более 200 млн. тонн радиоактивных отходов в виде хвостов обогатительных фабрик, штабелей кучного выщелачивания, хвостохранилищ гидрометаллургических заводов, отвалов беднотоварной и непереработанной товарной руды, представляющих большую опасность, как источник радиоактивного и химического загрязнения окружающей среды. В настоящее время в республике используется несколько хвостохранилищ радиоактивных отходов. Крупнейшим из них является хвостохранилище радиоактивных отходов Гидрометаллургического завода Степногорского горно-химического комбината, действующего с 1956 года, завод, в свою очередь, является одним из крупнейших комплексов производства окиси урана и других редких металлов. Основными видами производственных отходов являются хвосты переработки урановых руд, которые по содержанию в них радионуклидов относятся к I классу опасности. Его добыча, несомненно, вызывает увеличение производства урана и повышение комплекса техногенных радиационных и токсичных воздействий. При этом актуальным вопросом является оценка влияния низких доз ионизирующих излучений на население, проживающее в зоне воздействия техногенных факторов хранилища радиоактивных отходов ураноперерабатывающих предприятий, и исследование риска соматической заболеваемости.

Цель исследования: оценить возможное влияния техногенных факторов хранилища радиоактивных отходов ураноперерабатывающего предприятия на риск и распространенность артериальной гипертензии у населения.

Материал и методы: Представлены результаты когортного ретроспективного исследования с 2018 года по 2020 год среди лиц, подвергавшихся долговременному воздействию негативных техногенных факторов на частоту и риск развития соматических заболеваний у основной группы - населения, проживающих вблизи хранилищ радиоактивных отходов уранового производства, а также сравнительной группы – населения города Акколь находящегося более чем в 100 км от г. Степногорск. Исследование охватывает 399 человек, из них 255 человек основной группы и 174 человек контрольной группы. Результаты исследования обрабатывались с использованием программного продукта IBM SPSS Statistics 20 и программы Microsoft Excel. Статистические расчеты проводились методом санитарной статистики.

Результаты: Исследованиями установлено, что длительное облучение в малых дозах может привести к росту соматической заболеваемости. Наиболее характерной для лиц, проживающих вблизи хранилищ радиоактивных отходов является патология сердечно-сосудистой системы, в структуре которой первое ранговое место занимает артериальная гипертензия – 83%, что свидетельствует о возможном влиянии малых доз ионизирующего излучения на риск и распространенность артериальной гипертензии у населения.

Выводы: Полученные данные свидетельствуют о том, что длительное проживание населения в данной территории оказывает значительное влияние на распространенность заболеваний артериальной гипертензии.

Ключевые слова: артериальная гипертензия, радиоактивные отходы, население.

Түйіндеме

РАДИОАКТИВТІ ҚАЛДЫҚТАРДЫ САҚТАУ АЙМАҒЫНДА ТҰРАТЫН АДАМДАРДЫҢ ТОПТАРЫНДАҒЫ АРТЕРИЯЛЫҚ ГИПЕРТЕНЗИЯНЫҢ ҚАУПІ МЕН ТАРАЛУЫН БАҚЫЛАУ

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Зерттеудің өзектілігі: Қазақстан Республикасы әлемдегі уран қорының шамамен 25% ие және уран кені бойынша әлемде жетекші орын алады.Қазіргі уақытта, Қазақстан Республикасы аумағында байыту қондырғыларының қалдықтары, үймелік сілтісіздендіру қатарлары, гидрометаллургиялық зауыттардың қалдыққоймасы, өңделмеген шикізат кенінің үйінділері ретінде 200 млн тоннадан астам уран кенінің қалдықтары жинақтаған. Олар радиоактивті және химиялық ластану көзі ретінде қоршаған ортаға үлкен қауіп болып табылады.

Қазіргі уақытта республикада радиоактивті қалдықтардың бірнеше қалдық қоймалары пайдаланылады. Олардың ішіндегі ең ірісі 1956 жылдан бері жұмыс істеп келе жатқан Степногорск тау-кен химиялық комбинатының гидрометаллургиялық зауытының радиоактивтік қалдықтарының қалдыққоймасы пайдаланылуда, зауыт өз кезегінде уран тотығы мен басқа да сирек металдар өндірісінің ірі кешендерінің бірі болып табылады. Өнеркәсіптік қалдықтардың негізгі түрлері - уран кенін өңдеудегі қалдықтар құрамындағы радионуклидтер қауіптің бірінші класына жатады. Оның өндірілуі республика уранның өндірісінің ұлғаюы мен техногенді радиациялық және токсиндік әсерлер кешенінің жоғарлауына әкеледі. Бұл ретте уран өңдеу кәсіпорындарының радиоактивті қалдықтар қоймасының техногенді факторлары оның әсер ету аймағында тұратын халыққа иондаушы сәулелердің төмен дозаларының әсерін бағалау және сомотикалық аурушаңдық қаупін зерттеу өзекті мәселе болып табылады.

Зерттеу мақсаты: уран өңдеу кәсіпорнының радиоактивті қалдықтарын сақтау қоймасының техногендік факторларының осы аймақта тұратын адамдардың топтарындағы артериялық гипертензияның қаупі мен таралуына ықтимал әсерін бағалау.

Зерттеу материалдары мен әдістері: Негізгі топ - уран өндірісінің радиоактивті қалдықтарының қоймаларына жақын тұратын халық, сондай – ақ бақылау тобы-Степногорск қаласынан 100 км-ден астам жерде орналасқан Аққөл қаласы тұрғындарының соматикалық аурулардың жиілігіне және даму тәуекеліне теріс техногендік факторлардың ұзақ мерзімді әсеріне ұшыраған адамдар арасында когортты ретроспективті зерттеу нәтижелері ұсынылды. Зерттеу 399 адамды қамтиды, оның ішінде 255 адам негізгі топ және 174 адам бақылау тобы. Зерттеу нәтижелері IBM SPSS Statistics 20 бағдарламалық өнімін және Microsoft Excel бағдарламасын пайдалану арқылы өңделді.

Зерттеу нәтижелері: Зерттеулер көрсеткендей, аз мөлшерде ұзақ сәулелендіру соматикалық аурушаңдықтың өсуіне әкелуі мүмкін. Радиоактивті қалдықтарды сақтау қоймаларына жақын тұратын адамдарға жүрек-қан тамырлары жүйесінің патологиясы тән болып табылады, оның құрылымында бірінші дәрежелі орынды артериялық гипертензия – 83% алады, бұл иондаушы сәуле шығарудың кіші дозаларының халық арасында артериялық гипертензияның қаупі мен таралуына ықтимал әсерін көрсетеді.

Қорытынды: Алынған деректер халықтың осы аумақта ұзақ өмір сүруі артериялық гипертензия ауруларының таралуына айтарлықтай әсер ететінін көрсетеді.

Негізгі сөздер: *артериялық гипертензия, радиоактивті қалдықтар, халық.*

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Introduction

Modern living conditions Kazakhstan population are characterized by a high level of technical and social adverse effects on the state of the human body. The main and determining factor of technogenic impact on human health is currently the radiation component. According to the sources of the World Nuclear Association, a fifth of the world's uranium reserves are concentrated in Kazakhstan, the total resources of which are about 1.5 million tons. Over the past 50 years, 20 uranium deposits have been developed in Kazakhstan. Currently, more than 200 million tons of radioactive waste has accumulated on the territory of the Republic in the form of tailings from concentration plants, heap leaching piles, tailing dumps of hydrometallurgical plants, dumps of poor and unprocessed marketable ore, which are very dangerous as a source of radioactive and chemical pollution of the environment. As you know, the radiation situation in Kazakhstan is the most difficult. This is due, firstly, to the contamination of zones with artificial radionuclides caused by nuclear weapons tests at the Semipalatinsk test field and explosions created for “peaceful” purposes at other test sites, as well as the environmental impact of radioactive waste arising from uranium mining. Uranium mining and uranium processing enterprises are located throughout the country. Its extraction, undoubtedly, causes serious problems in the field of ecology, health care and education on the territory of the republic, the accumulation of large-scale open radioactive waste. The total volume of accumulated radioactive waste from uranium mining enterprises in our country is 61 million tons with a total activity of 168.4 thousand curies [2]. From the point of view of the presence in the Central Asian region of a large amount of radioactive waste from the uranium mining and processing industries their negative impact on the environment is manifested in two main forms:

- the systematic and long-term pollution of various components of the environment, and especially the

hydrographic network of transboundary rivers of the region with radionuclides and other toxic materials;

- an increased threat of the occurrence of hazardous natural processes and phenomena (earthquakes, landslides and landslides, mudflows and floods) in the areas of storage of radioactive waste that cause a high risk of destruction of storage facilities with catastrophic environmental consequences of a regional scale and transboundary nature [4].

Currently, the study of the effects of small doses of ionizing radiation on biological objects continues to be a complex problem in the field of radiation biology. The relevance of this problem is due to the increase in the number of people exposed to technogenic radiation in small doses, this category of population includes people living near the storage facilities for radioactive waste of uranium production. At the same time, as a result of previous clinical and epidemiological studies, it was found that prolonged exposure in small doses can lead to an increase in somatic morbidity [1]. The most common and significant disease of the cardiovascular system is arterial hypertension. The term "arterial hypertension" means a syndrome of increased systolic blood pressure (SBP) 140 mm RT. Art. and / or diastolic blood pressure (DBP) 90 mm RT. Art., which occurs as a result of irreversible changes in arterioles, either for an unknown reason (essential), or as a secondary condition, the functions of both the muscle and endothelial layer of the vessel membrane [8].

According to the research of the Institute of Radiobiology and Radiation Protection (hereinafter referred to as the Institute), Astana Medical University, the most characteristic of people living near the radioactive waste storage facilities was the pathology of the cardiovascular system, which is represented by essential arterial hypertension (hereinafter referred to as hypertension) [5].

However, the available literature data on the pathology of the cardiovascular system after prolonged exposure of the population is contradictory.

The aim of the study is to assess the possible impact of technogenic factors of the storage facility for the radioactive waste of a uranium processing enterprise on the risk and prevalence of arterial hypertension in the population.

Materials and methods

The article presents the results of a cohort retrospective study of the impact of technogenic factors of storage of radioactive waste from a uranium processing enterprise on the risk and prevalence of arterial hypertension in the population.

In order to copy the data of outpatient cards into the Medical Data Card developed by the Institute for each examined and subsequent entry of these data into the Industry radiation and epidemiological register, the medical group made business trips to Stepnogorsk and Akkol in the Akmola region.

In order to study the prevalence of arterial hypertension in the population and taking into account the data on the radiation situation in residential and administrative premises of the Aksu, Kvartsitka and Zavodskoy settlements, the Institute of Radiobiology and Radiation Protection of the NJSC "Astana Medical University" staffs generated data on the health of the population with possible risks of pathology from previously copied medical data. And also, this issue was discussed in the local bioethical committee on September 7, 2017 and it was decided to approve and recommend for implementation the measures for the implementation of the study "Research and development of methods to reduce the population radiation risk living in the zone of impact of radioactive waste storage facilities" with subsequent monitoring of implementation taking into account ethical standards when testing research objects. The data collection period was from 2018 to 2019. Since 2020, an in-depth study of 2,070 outpatient records of the population living near radioactive waste storage facilities has been conducted. An in-depth study of 2070 outpatient cards of the population living near radioactive waste storage facilities was carried out. 478 (23%) of these people were accounted for circulatory diseases in the structure of morbidity. The greatest contribution to the prevalence of diseases of the circulatory system was made by arterial hypertension (n = 399, 83%). Depending on the place of residence, the surveyed were divided into 2 groups: main and control (comparative).

The main group (n = 225) included people living in the settlements of Zavodskoy and Aksu, which are located in the adjacent territory to the storage of radioactive waste of the uranium processing enterprise of the Hydrometallurgical plant in Stepnogorsk.

The selection of the population in the study group was based on intermediate results of sanitary and radiometric studies of the tailings area where the received radiation data exceeds the background values.

The control group consisted of people (n = 174) who lived for a long time in the Akkol settlement, located more than 100 km from Stepnogorsk. Natural-climatic, social and other conditions among the population of the main and control groups were approximately the same due to living in the Akmola region. The main criterion for selection to the study groups was the period of residence in this territory for more than 5 years. The exclusion criterion was professional contact with sources of ionizing radiation - the fact of working at the hydrometallurgical plant (HMP) of the Stepnogorsk mining and chemical combine (SMCC).

Risk assessment and prevalence of arterial hypertension of the population living in the influence zone of radioactive waste storage was carried out based on the materials of outpatient treatment (outpatient cards (form-025-u)).

Statistical processing of the research results was carried out using the statistical package of the SPSS program (Statistical Package for the Social Sciences, license of nCJSC "AMU" Nur - Sultan). Fractions, average, and standard error (SE) were used to describe quantitative data. The level of statistical significance of the tests used was defined as 5% ($p \leq 0.05$).

Given the lack of contact with the surveyed population and the use of outpatient records to obtain data, there was no need to obtain informed consent. The management of the Stepnogorsk city's policlinic was informed about the work have been carrying out and gave the official letter agreement. Statistical analysis of the research results was carried out using the IBM SPSS Statistics 20 software product and the Microsoft Excel program.

Results

According to the calculation, in the structure of the prevalence of arterial hypertension in the population of the main group, AH degree I was diagnosed in 32 (14.2%) people, AH II - 153 people (68%), AH III - 40 people (17.7%) and AH IV - in 6 people (2.6%). In the control group, AH I - in 28 people (16%), AH II - 101 people (58%) and AH III - 45 people (25.8%), AH degree IV was not detected (Figure 1).

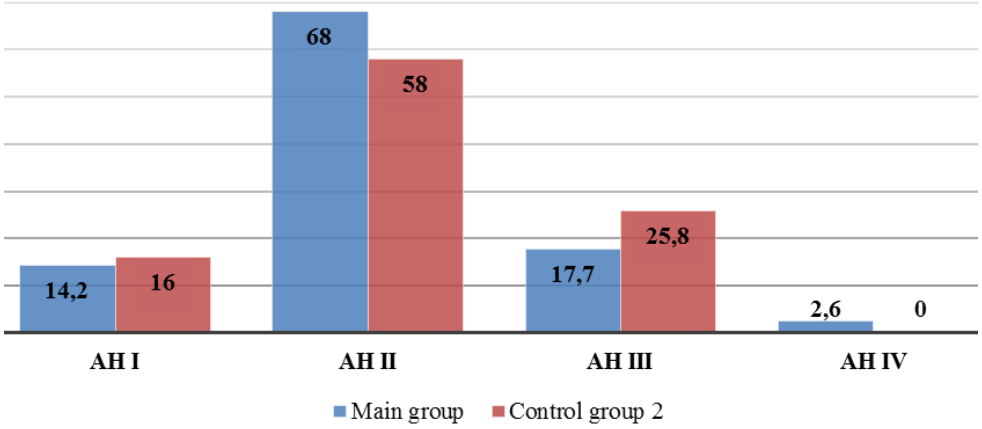

Figure 1. Prevalence of arterial hypertension in the main and control groups of the population, depending on the degree (in % of the total)

In addition to determining the degree of arterial hypertension, an intensive indicator was calculated that demonstrates the frequency of the phenomenon in the environment. The total prevalence of the disease in the population was calculated per 100 people. An assessment of the frequency of the disease in the population living near the storage of radioactive waste of uranium production showed that the level of their prevalence did not significantly differ from the indicators in the control group: 20.4 versus 17.9 per 100 people.

We also investigated risk factors. Adverse factors include the following controlled (overweight, alcohol consumption, smoking, low physical activity, increased salt intake with food, high cholesterol, stress) and unmanageable (age over 55, burdened heredity).

The population of both sexes aged from 20 to 70 years represented the main population of the surveyed. In many epidemiological studies, the dependence of arterial hypertension on age and duration of residence is clearly observed. Our research also confirms that the frequency of hypertension depends on age in all the study groups. However, indicators prevail in the main group in people aged 50 to 60 years (31,1 %) (Table 1).

Table 1.

Comparative characteristics of the prevalence of disease in the population studied by age groups (per 100 people).

№	Age group (years)	Prevalence of diseases per 100 people	
		Main group (n=225)	Control group (n=174)
1	20-29	0,4	0,5
2	30-39	1,7	4,0
3	40-49	6,6	6,8
4	50-59	**31,1**	**20,1**
5	60-69	31,5	39,6
6	older than 70	28,4	28,7

The studied population was divided into subgroups depending on the duration of residence on the territory adjacent to the storage of radioactive waste. People with a length of residence from 5 to 10 years in the main group made up 11,1 %, from 10,1 to 20 years - 40 %, from 20,1 to 30 years - 13,3 %, more than 30 years - 35,5 %. In the comparative group from 5 to 10 years were 1,1%, from 10,1 to 20 years - 5,7 %, from 20,1 to 30 years - 22,4 %, more than 30 years - 70,6 % (Figure 2).

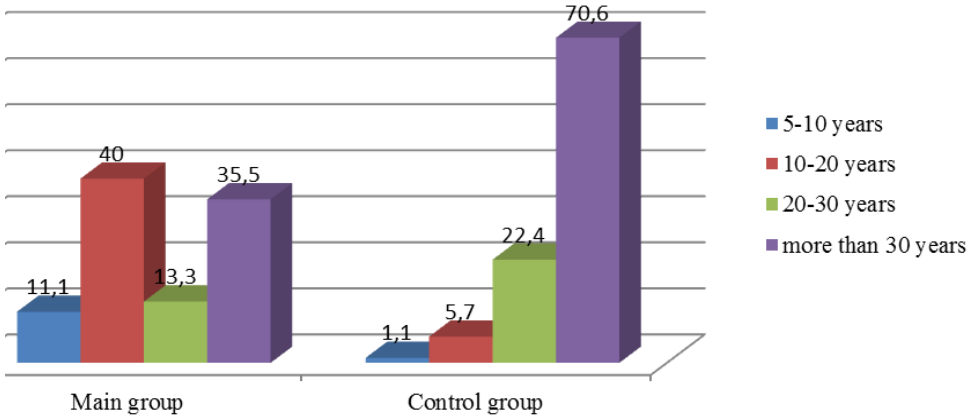

Figure 2. The prevalence of arterial hypertension in the main and control groups of the population, depending on the duration of residence in the zone of influence of radioactive waste storage (in % of the total).

Discussions

Arterial hypertension (AH) is a common disease. In the system of diseases of the circulatory system, as well as in preventive medical examinations, one of the leading places is occupied by arterial hypertension – 83%. The wide prevalence of arterial hypertension is consistent with the literature data, since in recent decades diseases of the circulatory system occupy a leading position in the structure of primary morbidity, mortality and disability [3,6].

A number of authors also noted the possible direct and indirect effects of radiation on the cardiovascular system, however studies have not made it possible yet to clearly establish the dose limits of radiation exposure to the development of pathological processes or diseases of the circulatory system [7].

In the population of the control group, the prevalence of hypertension, depending on the period of residence in Akkol, Akmola region, tended to increase, but did not change significantly. This may indicate that the influence of technogenic factors of radiation nature on the overall morbidity of the population living for a long time near the tailings dam is not excluded.

This data analysis demonstrates the ability to analyze of other diseases cases of the cardiovascular system. This cohort has great potential for research on the risk of cancer incidence of the population living for a long time near the tailing dump.

Conclusions

1. The study of morbidity according to outpatient treatment showed that in the structure of diseases of the circulatory system, the first rank among the population of the main group is occupied by arterial hypertension - 83%.

2. Length of living near radioactive waste storage affect the formation and character of General somatic morbidity: an increase in life expectancy in the areas adjacent to the tailings, leading to increased incidence of chronic diseases.

3. There are known circumstances that make it difficult to deal with adverse risk factors. These factors include: overweight, alcohol consumption, Smoking, low physical activity, increased salt intake in the diet, high cholesterol, stress that prevents people from monitoring their health; negative emotions: depression and anxiety have a negative value. All residents with high blood pressure and any risk of cardiovascular complications, regardless of whether or not medication is used to correct blood pressure, are recommended to take measures to change their lifestyle and improve their quality of life.

Contribution of authors:

Ilbekova K.B. - chief author, processing and analysis of the material; scientific management;

Djanabaev D.D. - chief author, set of material;

Kazymbet P.K. - material processing;

Aumalikova M.N. – scientific support, material processing;

Bakhtin M.M. - set of material;

Ibrayeva D.S. - English translation, material processing, stylistic correction.

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