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RADIATION POLLUTION OF THE ENVIRONMENT AS A RESULT OF THE CHORNOBYL DISASTER AND ITS IMPACT ON HUMAN HEALTH

The Chernobyl nuclear power plant accident in April 1986 significantly impacted the lives of hundreds of thousands of people. The initial fatalities among rescue workers were followed by numerous cases of thyroid cancer, particularly among children, and various other malignancies linked to the nuclear leak. Extensive areas of farmland, forests, rivers, and urban regions were contaminated with radioactive fallout. Consequently, hundreds of thousands of individuals were evacuated from these affected zones, forced to leave behind their homes, possessions, and livelihoods, leading to enduring psychological and social trauma¹.

¹ Shevchenko O. M. Sotsialno-psykholohichni aspekty naslidkiv chornobylskoi katastrofy. Aktualni problemy, napriamky ta shliakhy yikh vyryshennia. Chornobylska katastrofa. Aktualni problemy, napriamky ta shliakhy yikh vyryshennia [Socio-psychological aspects of the consequences of the Chernobyl disaster. Current problems, directions and ways to solve them. Chernobyl disaster. Current problems, directions and ways to solve them]. Zhytomyr. ZhNAEU, 2018. S. 87–91.

People's reactions to the Chernobyl disaster, as one would expect, varied not only in terms of their level of knowledge about what had happened. The behavior and decision-making of each individual person were influenced by their unique characteristics. It is difficult, of course, to imagine anyone, except for people with inadequate reactions, the sick, etc., who did not react to such a terrible event. The features of these reactions are of considerable practical interest, in particular, for studying and predicting behavior in emergency situations, in a state of panic, etc.; especially since we have quite a lot of such studies².

Human life is situated within the environment, and health is influenced by both heredity and natural factors. The internal environment of an individual, which maintains bodily homeostasis, is closely interconnected with environmental influences. This interaction operates at the level of human adaptation mechanisms. Consequently, environmental issues are becoming increasingly significant in the modern world. Ecology addresses the crucial matter of adaptation to various environmental conditions³.

As a result of the Chernobyl disaster, the environment is contaminated with radionuclides: strontium-90, iodine-129, radium-226, cesium-137, plutonium-239. In such a situation, a significant number of the Ukrainian population is forced to consume food products with a certain content of radioactive substances, which leads to the accumulation of radionuclides and causes chronic internal irradiation of the body⁴. Radioactive fallout pollutes air, soil, vegetation, water, and agricultural products. Soil and water pollution happens when radioactive substances enter these environments, partially dissolving and settling at the bottom. This affects lakes, ponds, slow-flowing rivers, rain, and meltwater the most.

Radionuclides are absorbed by plant-based food materials via their root systems and leaves. Consequently, these radionuclides can enter the bodies of humans, animals, and birds through air, water, and the consumption of fruits,

2 Moliako V. O. *Psikhologichni naslidky chornobylskoi katastrofy* (ros.). Zb. nauk. prats inst.-tu psikhologii im. H.S. Kostiuka APN Ukrainy. «Aktualni problemy psikhologii» u 12 tomakh. T. 12. Vyp. 12. [Psychological consequences of the Chernobyl disaster. Collection of scientific works of the G.S. Kostyuk Institute of Psychology of the Academy of Sciences of Ukraine. "Current problems of psychology" in 12 volumes. Vol. 12. Issue 12.] Zhytomyr: Vyd-vo ZhDU im. I. Franka – Zhytomyr Ivan Franko State University Publishing House, 2010. S. 8–21.

3 Hryban H. P., Skoryi O. S., Pantus O. O. *Problemy ekolohii navkolyshnoho seredovyscha v olimpiiskomu i profesiinomu sporti. Chornobylska katastrofa. Aktualni problemy, napriamky ta shliakhy yikh vyrishennia* [Environmental ecology problems in Olympic and professional sports. Chernobyl disaster. Current problems, directions and ways to solve them.]. Zhytomyr. ZhNAEU, 2018. S. 99–103.

4 Hryban H. P. *Problemy ekolohii u fizychnomu vykhovanni: monohrafiia* [Problems of ecology in physical education: monograph]. Zhytomyr: Vyd-vo «Ruta» – Zhytomyr: Ruta publishing house. 2008. 182 s.

vegetables, and cereals that have been cultivated on contaminated lands. Thus, becoming part of the cycle of substances, radionuclides enter the human body with food, water, and air, moving through the food chains (Fig. 1).

The first chain: air – human being.

The second chain: soil – plant food – human being.

The third chain: soil – vegetation – cows, goats – milk – human being.

The fourth chain: soil – vegetation – herbivorous domestic and wild animals, domestic and wild birds – human being.

The fifth chain: 1) water – human being; 2) sea and river water – phytoplankton – fish – human being; 3) sea and river water – zooplankton – crayfish, crabs, mollusks, algae (seaweed) – human being; 4) sea and river water – waterfowl domestic and wild birds – human being.

The primary pathways for radionuclides to enter the human body are through the consumption of contaminated drinking water and inhalation of atmospheric air containing radioactive dust. Among all radioactive substances introduced into the human body from external sources, over 90 % are ingested via food products, 5-9 % through drinking water, and less than 1 % through air. The gastrointestinal tract is the main pathway for radionuclide entry into the human body. Once absorbed, radioactive substances are distributed throughout the body via the bloodstream and lymphatic system. The majority of soluble radionuclide compounds are absorbed in the small intestine, with a lesser amount absorbed in the stomach, and a minor portion in the large intestine.

Radioactive elements behave as their corresponding stable counterparts: the principle of selective absorption is based on the fact that when the body is provided with the necessary substances, the probability of absorption of radioactive substances by cells decreases. Depending on this, the following isotopes are distinguished:

- accumulate in the bones: strontium, barium, radium, calcium;
- concentrate in the liver and skeleton: lanthanum, cerium, promethium;
- are evenly distributed: tritium, carbon, iron, polonium;
- accumulate in the muscles: potassium, cesium, rubidium;
- concentrate in the spleen and lymph nodes: ruthenium, niobium;
- accumulate in the thyroid gland: iodine⁵.

5 Peresichnyi M.I., Kravchenko M.F., Hryhorenko O.M. Tekhnolohiia vyrobnytstva produktii hromadskoho kharchuvannia radiozakhysnoi dii – teoriia ta praktyka [Technology of production of radioprotective catering products – theory and practice]. K.: «Medekol» – Medecol; MNITs BluEKOS. 1999. 231 s.

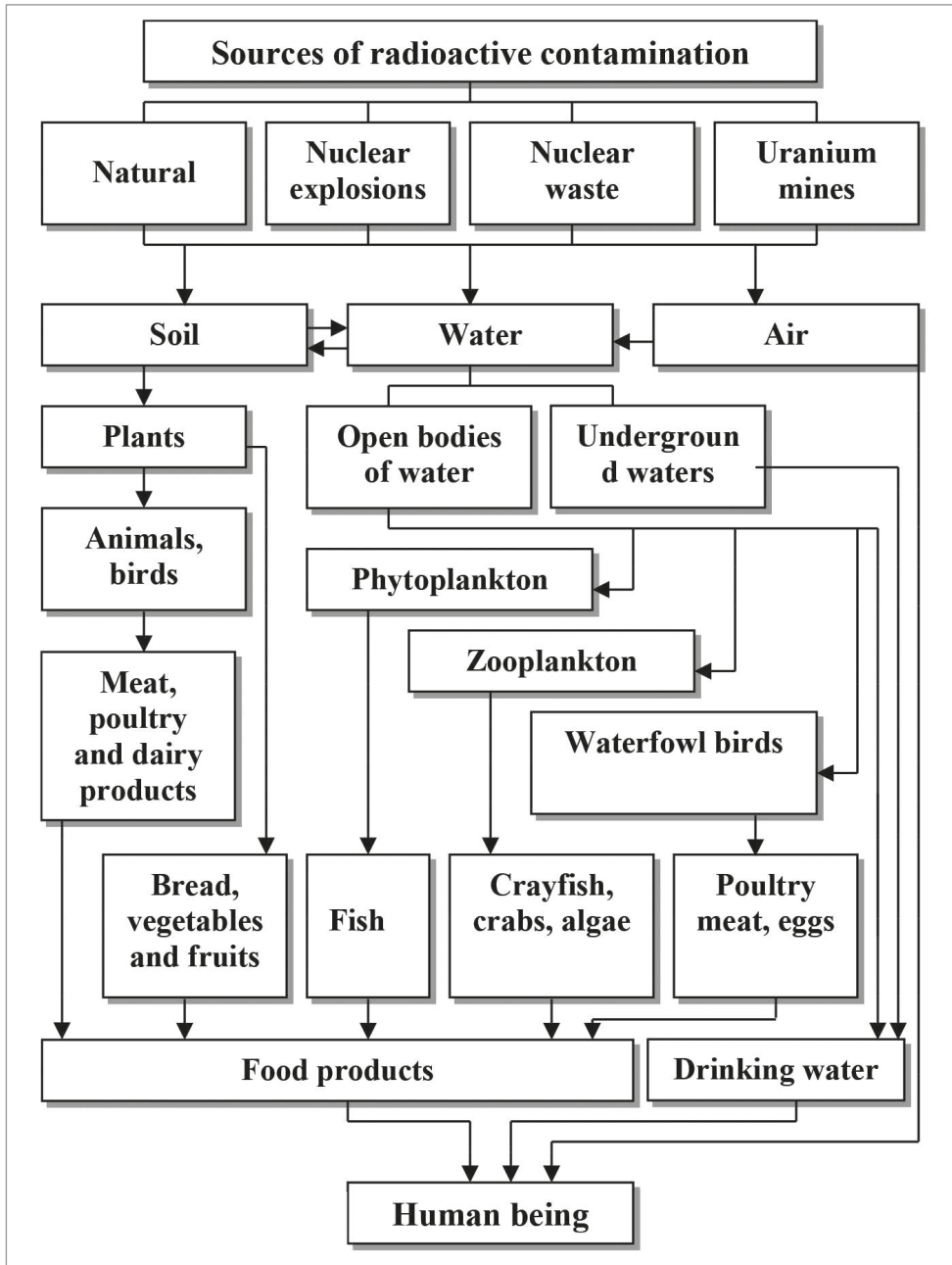


Fig. 1. Migration of radionuclides from the environment into the human body

The degree of danger of contamination with radionuclides depends on the frequency of consumption of products contaminated with radioactive substances, as well as on the speed of their elimination from the body. If the

radionuclides that have entered the body are of the same type as the elements that a person consumes with food (sodium, potassium, chlorine, calcium, iron, manganese, iodine, and others), then they are quickly excreted from the body together with them. Radioactive isotopes accumulate in the tissues of various organs, becoming a source of long-term radioactive emission. The concentration of radionuclides in a particular organ can many times exceed that in the human body as a whole. Therefore, absorbed doses accumulated in one of the organs can cause negative consequences, although the total content of the isotope in the body remains small. Regardless of the narrow professional specialization, it is necessary to consider the degree of influence of environmental factors on the human body, especially the consequences of technogenic impact. Thus, to avoid pathologies of a genetic nature, it is necessary to identify areas of increased risk, assess the level of mutagenic background and mutational variability, and identify sources of mutagens entering the environment⁶.

Particular attention should be paid to the fact that cesium-137 activity in local food products in Ukraine increased significantly after the Chernobyl accident. Milk, meat, mushrooms, and fish were contaminated the most. Radionuclide accumulation in fish varies based on the reservoir's distance from Chernobyl and the fish type. Predatory fish have higher radionuclides than benthic feeders, with plankton feeders having the most. Radionuclides are primarily found in the gills, scales, internal organs, and less in the muscles⁷.

When studying the effects of radiation on the human body, the following specific features were identified:

- even a small amount of radiation that is absorbed causes profound biological changes in the body;
- the presence of a latent (incubation) period of ionizing radiation;

6 Hryban H. P., Krasnov V.P., Prysiashniuk S.I. Zmitsnennia zdorovia i fizychnoi pidhotovlenosti studentiv v umovakh malykh doz radiatsiinoho zabrudnennia: navch. posib [Improving the health and physical fitness of students in conditions of low doses of radiation pollution: teaching manual]. K.: Aharna osvita – Agrarian Education, 2005. 113 s.; Hryban H.P. Polipshennia stanu zdorovia studentskoi molodi v umovakh radionuklidnoho zabrudnennia shliakhom spetsialnoho kharchuvannia. Problemy fizychnoho vykhovannia studentiv: Mater. Vseukr. nauk.-metod. konf., shcho prysviachena 85-richchiu Dnipropetrovskoho nats. u-tu. Dnipropetrovsk: DNU [Improving the health of student youth in conditions of radionuclide contamination by means of special nutrition. Problems of physical education of students: collection of materials of All-Ukrainian scientific-methodical conference dedicated to the 85th anniversary of the Dnipropetrovsk National University. Dnipropetrovsk: DNU], 2003. S. 72–73; Romanenko O. V., Kostylov O. V., Reshetniak T. A. Nastupnist ekolohichnoi osvity yak element formuvannia svitohliadu. Ekolohiia ta noosferolohiia [The continuity of environmental education as an element of worldview formation. Ecology and noosphereology]. 1996. № 3–4. T. 2. S. 187–188.

7 Lohvynenko L.V., Burlaka V.A., Kryhfalumii Kh.I., Khomiak I.V. Suchasna kontseptsiiia radiozakhysnoho kharchuvannia. Ekolohiia: vcheni u vyryshenni problem nauky, osvity i praktyky: Zb. mizhnar. nauk.-prakt. konf. Zhytomyr [Modern concept of radioprotective nutrition. Ecology: scientists in solving problems of science, education and practice: Proceedings of the International Scientific and Practical Conference, Zhytomyr]: Vyd-vo «Derzhavnyi ahroekol. u-t» – Publishing house "State Agro-Ecological University". 2007. S. 222–230.

- radiation has a genetic effect;
- organs of a living organism have different sensitivity to radiation;
- individual organisms react differently to radiation;
- radiation depends on the frequency. A single exposure to a large dose causes more profound changes.

In sports activities, the impact of negative environmental factors on the human body causes even greater harm, as this is associated with greater consumption of polluted air, food, water and the intensity of work of all functional systems and the body as a whole. Therefore, the construction of sports facilities, the choice of a place for educational and training classes, leisure and recreation in nature, swimming in open water bodies should consider environmental factors and their impact on the health of young people⁸.

Among the main areas of research into the effects of radioactive radiation on the human body are medical, radiological and biological. The main attention is paid to the study of the medical aspects of the consequences of the Chernobyl disaster. Despite the wide range of research areas of this problem, the state of the environment is not improving, the population continues to be exposed to radiation and worsening of health. It has been experimentally proven that there is no safe dose of radiation. A wide range of minimum doses of radiation by incorporated radionuclides, when various pathological disorders occur in the human body (general weakness of the body, drowsiness, apathy, etc.), confirms the unequal sensitivity of organs and tissues to ionizing radiation⁹. It is also recognized that the relationship between low doses of radiation and disease in the population is linear, as this most fully corresponds to existing experimental data and clinical observations¹⁰.

8 Hryban H. P. Problemy ekolohii u fizychnomu vykhovanni: monohrafiia [Problems of ecology in physical education: monograph]. Zhytomyr: Vyd-vo «Ruta» – Zhytomyr: Ruta publishing house. 2008. 182 s.; Hryban H. P., Opanasiuk F. H. Vplyv navkolyshnoho seredovysshcha na metody i zasoby fizychnoho vykhovannia uchnivskoi ta studentskoi molodi. Nauk.-teoret. zb. Visnyk Derzhavnoi ahroekolohichnoi akademii Ukrainy. № 2 [The influence of the environment on the methods and means of physical education of schoolchildren and students. Scientific-theoretical collection. Bulletin of the State Agroecological Academy of Ukraine. No. 2]. 1998. S. 14–17.

9 Hryban H.P. Polipshennia stanu zdorovia studentskoi molodi v umovakh radionuklidnoho zabrudnennia shliakhom spetsialnoho kharchuvannia. Problemy fizychnoho vykhovannia studentiv: Mater. Vseukr. nauk.-metod. konf., shcho prysviachena 85-richchiu Dnipropetrovskoho nats. u-tu. Dnipropetrovsk: DNU [Improving the health of student youth in conditions of radionuclide contamination by means of special nutrition. Problems of physical education of students: collection of materials of All-Ukrainian scientific-methodical conference dedicated to the 85th anniversary of the Dnipropetrovsk National University. Dnipropetrovsk: DNU], 2003. S. 72–73.

10 Lohvynenko L.V., Burlaka V.A., Kryhfalumii Kh.I., Khomiak I.V. Suchasna kontseptsiiia radiozakhysnoho kharchuvannia. Ekolohiia: vcheni u vyryshenni problem nauky, osvity i praktyky: Zb. mizhnar. nauk.-prakt. konf. Zhytomyr [Modern concept of radioprotective nutrition. Ecology: scientists in solving problems of science, education and practice: Proceedings of the International Scientific and Practical Conference, Zhytomyr]: Vyd-vo «Derzhavnyi ahroekol. u-t» – Publishing house "State Agro-Ecological University". 2007. S. 222–230.

The health of a population is a key indicator of the "man – environment" system's effectiveness, primarily influenced by pollution levels. Thus, socio-ecological monitoring must include health assessments. In Ukraine, the medical and demographic situation is worsening, with declining birth rates, deteriorating health, and natural population decline. Zhytomyr Regional Department of Statistics reports reduced natural population growth in recent years¹¹.

The dominant place in the system of diseases and mortality of the population of Ukraine is occupied by chronic diseases of the respiratory system, circulatory system, malignant neoplasms, diseases of the nervous system and sensory organs, allergic, genetic and other diseases of complex etiology, which reflects the influence of the entire variety of living conditions¹². The main causes of mortality in the Zhytomyr region are diseases of the circulatory system, respiratory organs, neoplasms, poisoning, injuries and accidents.

According to modern concepts, health is a natural state of the organism, which is in complete equilibrium with the biosphere and is characterized by the absence of any pathological changes. The state of health reflects the dynamic equilibrium between the natural environment and the organism. The state of health is characterized by two factors: the integration of functions, which is provided by the correlations carried out by the nervous and endocrine systems, and the energy, which is provided by the energy of food and the free energy of the environment. Interacting with each other, the integration and energy components of health form a state of negentropy – the ability of the organism to be a holistic system and to resist disturbances¹³. The proper health of young people depends on the social, economic and spiritual development of society, the state of the environment, waste disposal, the availability of a sufficient amount of wholesome and safe food, clean water, fresh air and certain scientific and educational knowledge about behavior in the environment and the use of its natural resources. Morbidity reflects the degree of human adaptation to environmental conditions, and the structure of

11 Hryban H. P. Problemy ekolohii u fizychnomu vykhovanni: monohrafiia [Problems of ecology in physical education: monograph]. Zhytomyr: Vyd-vo «Ruta» – Zhytomyr: Ruta publishing house. 2008. 182 s.

12 Nahorniuk O.M., Tarasiuk S.I. Zdorovia liudyny yak intehralnyi pokaznyk sotsialno-ekolohichnoho monitorynhu ahrosfery. Reformuvannia systemy ahrarynoi vyshchoi osvity v Ukraini: dosvid i perspektyvy. Mater. Vseukr. nauk.-prakt. Konf [Human health as an integral indicator of socio-ecological monitoring of the agricultural sphere. Reforming the system of agricultural higher education in Ukraine: experience and prospects. Materials of the All-Ukrainian Scientific-Practical Conference.]. – K.: NAU – NAU, 2005. S. 154–157.

13 Chaplyhin V. Vplyv faktoriv zovnishnoho seredovyscha na formuvannia zdorovia liudyny. Fizychna kultura, sport ta zdorovia natsii. Zb. nauk. prats. Vyp. 5 [The influence of environmental factors on the formation of human health. Physical culture, sports and health of the nation. Collection of scientific works. Issue 5]. DOV «Vinnytsia» – Vinnytsia PH. 2004. S. 509–513.

morbidity – the specific weight of each disease in their total number. About 50 % of morbidity is due to the lifestyle of each individual person. Bad habits, improper nutrition, insufficient physical activity, loneliness, stress, violations of work and rest regimes contribute to the development of the disease. Morbidity depends on heredity and environmental conditions – climate, state of the geosphere, level of environmental pollution and is determined by approximately 10 % by the modern level of medical care. Analysis of the causes of morbidity and the environmental conditions in which people live provides grounds for protecting each individual from the influence of negative environmental factors¹⁴.

Humanity must make significant changes in consciousness and behavior, and accept restrictions dictated by natural laws. Educational systems also need fundamental changes to address today's ecological, economic, political, social, and spiritual needs. The main causes of modern youth diseases and functional disorders include:

- environmental pollution with radioactive substances, pesticides, nitrates, heavy metals, and a number of other harmful substances;
- ignorance and illiteracy, as well as the lack of elementary skills and habits of behavior in a polluted environment;
- violation of the diet and nutrition regimen;
- low level of material security and harmful household habits;
- violation of the norms of a healthy lifestyle, the appearance of hypodynamia in a significant part of youth;
- neuro-emotional stress and social unrest in society;
- reduction of propaganda activities in the press and on television regarding the involvement of young people in active physical exercises and sports and determining their importance for human life;
- the appearance in society of a significant number of entertainment activities that distract young people from a healthy lifestyle (computerization, slot machines, telephones, etc.).

14 Hryban H. P., Krasnov V.P., Prysiazhniuk S.I. Zmitsnennia zdorovia i fizychnoi pidhotovenosti studentiv v umovakh malykh doz radiatsiinoho zabrudnennia: navch. Posib [Improving the health and physical fitness of students in conditions of low doses of radiation pollution: teaching manual]. K.: Ahrarna osvita – Agrarian Education, 2005. 113 s.; Hryban H. P. Naukovi zasady ekolohichnoi osvity zdobuvachiv u fizychnomu vykhovanni. Fizyчне vykhovannia, sport ta zdorovia liudyny: dosvid, problemy, perspektyvy: materialy Kh Vseukr. nauk.-praktychnoi onlain-konferentsii [Scientific foundations of environmental education of students in physical education. Physical education, sports and human health: experience, problems, prospects: materials of the 10th All-Ukrainian scientific and practical online conference]. 15 hrudnia, 2023 r. Kyiv. Un-t imeni Borysa Hrinchenka – Borys Hrynchenko University PH. 2023. S. 57–61.