

Health Effects of Chernobyl and Fukushima: 30 and 5 years down the line



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РЕПОЗИТОРІЙ БГЛУ

GENERAL ABBREVIATIONS, UNIT ABBREVIATIONS, AND TERMINOLOGY

- AMS – Academy of Medical Sciences.
ACS DB DEMOSMONITOR - Automated control system of data bases of monitoring of medical and demographic consequences of Chernobyl catastrophe.
ARS - Acute Radiation Syndrome.
ATR - Attributive risk.
BSSR - Belorussian Soviet Socialistic Republic.
Bq (kBq) - Becquerel ($\text{Bq} \cdot 10^3$), radioactivity unit, in the SI system.
CER - Clinical and Epidemiological Register.
CFS - Chronic Fatigue Syndrome.
CLL - Chronic lymphoid leukaemia.
CI - Confidence Interval.
 $\text{Ci} \cdot \text{km}^{-2}$ - level of radioactive contamination of the territory, outdated non-system unit ($1 \text{ Ci} \cdot \text{km}^{-2} = 37 \text{ kBq} \cdot \text{m}^{-2}$)
CNS - Central Nervous System.
DCS - Diseases of the Circulatory System.
DS – Department of Statistics of Ukraine.
CMU - Cabinet of Ministers of Ukraine.
EAR - Excess Absolute Risk.
ERR - Excessive Relative Risk.
ED – Effective Dose.
FGI - French-German Initiative for Chernobyl.
Gy - Grey, absorbed dose unit, in the SI system.
GR - Growth Rate.
IAEA - International Atomic Energy Agency.
ICD - International Classification of Diseases.
IChP-1991 - International Chernobyl Project.
ICRP – International Commission on Radiological Protection.
IPHECA - International Program on Health Effects of the Chernobyl Accident.
IQ - Intelligence Quotient.
JSDF - Japan Self-Defense Force.
 $\text{kBq} \cdot \text{m}^{-2}$ - level of radioactive contamination of the territory, in the SI system.
ME - Ministry of Ukraine of Emergencies and Affairs of Population Protection from the Consequences of Chernobyl Catastrophe.
MH - Ministry for Health.
MIAU - Ministry of Internal Affairs of Ukraine.
NAMSU - National Academy of Medical Sciences of Ukraine.
NASU - National Academy of Sciences of Ukraine.
NCRPU - National Commission on Radiation Protection of Population of Ukraine.
NPP - Nuclear Power Plant.
NREER - National Radiation and Epidemiological Registry.
OR - Odds Ratio.
PTSD – Post-traumatic Stress Disorder.
RADRUE - Realistic Analytical Dose Reconstruction and Uncertainty Analysis.
RCR – Radioactively Contaminated Rayon.
RCT – Radioactively Contaminated Territories.
Rem - roentgen equivalent in man, the biological equivalent of Roentgen, outdated non-system unit for effective expose dose, $1 \text{ rem} = 0.01 \text{ Sv}$.

RF - Russian Federation.

RR - Relative Risk.

RSFSR – Russian Soviet Federation Socialistic Republic.

RSSU_97 - Radiation Safety Standard of Ukraine_97.

NRCRM - State Institution «National Research Centre for Radiation Medicine of NAMS of Ukraine».

SIR – Standardized Incidence Ratio.

SRU - The State register of Ukraine of the persons survived after the Chernobyl catastrophe», State Registry of Ukraine.

Sv (mSv) - Sievert (milliSievert) - effective dose unit, in the SI system.

TEPCO - Tokyo Electric Power Company.

UACOS – Ukrainian-American Chernobyl Ocular Study.

UNSCEAR – United Nations Scientific Committee on the Effects of Atomic Radiation.

USSR - The Union of Soviet Socialistic Republics.

UkrSSR - The Ukrainian Soviet Socialistic Republic.

WHO - World Health Organization.

Clean-up workers (liquidators, recovery operation workers, Chernobyl emergency workers) - citizens of the USSR including the UkrSSR who had participated in any activities connected with damage control and mitigation of the catastrophe and its consequences in the exclusion zone regardless of number of working days in 1986-1987, and at least 30 calendar days in 1988-1990. Citizens temporarily sent on mission to work in the exclusion zone, including servicemen, employees of state, public and other enterprise establishments and organizations irrespective from their departmental relation, and also those who worked at least 14 days in 1986 at functioning points of population sanitary treatment and decontamination of technical devices or at their building are also attributed to the clean up workers.

Radioactive contamination - presence of radioactive substances in or on a material or the human body or elsewhere being undesirable or potentially harmful. Units of measurements are: $\text{Bq}\cdot\text{l}^{-1}$, $\text{Bq}\cdot\text{kg}^{-1}$, $\text{Bq}\cdot\text{m}^{-2}$, $\text{Ci}\cdot\text{l}^{-1}$, $\text{Ci}\cdot\text{kg}^{-1}$, $\text{Ci}\cdot\text{km}^{-2}$.

Radiation effect - effects, for which a causative role of radiation exposure is proven; there are deterministic and stochastic effects.

Radioactively contaminated territories (RCT) – territories in Ukraine (Law of Ukraine, 1991a) with a stable contamination of environment by radioactive substances above a pre-accidental level, that with due regard for the natural-climatic and complex ecological characteristics of specific territories could result in irradiation of population to above 1.0 mSv (0.1 rem) per year, and which requires measures of radiation protection of population. Territories subjected to radioactively contamination, are divided in zones:

1) *exclusion zone* is a territory, which has been radioactively contaminated after the Chernobyl catastrophe, and from which the population has been evacuated in 1986.

2) *zone of obligatory (compulsory) resettlement* is a territory exposed to intensive long half-life radionuclide contamination with density of soil deposition at a threshold values of $15.0 \text{ Ci}\cdot\text{km}^{-2}$ ($555 \text{ kBq}\cdot\text{m}^{-2}$) and above for isotopes of caesium, or $3.0 \text{ Ci}\cdot\text{km}^{-2}$ ($111 \text{ kBq}\cdot\text{m}^{-2}$) and more for strontium, or $0.1 \text{ Ci}\cdot\text{km}^{-2}$ ($3.7 \text{ kBq}\cdot\text{m}^{-2}$) and over for plutonium. As a result the average by-settlement radiation dose of an equivalent human irradiation dose in a view of factors of radionuclides migration to the plants and other factors can exceed 5.0 mSv (0.5 rem) per one year is above the dose levels, been received in the pre-accident period;

3) *zone of guaranteed voluntary resettlement* is a territory with soil contamination density by isotopes of caesium from 5.0 up to $15.0 \text{ Ci}\cdot\text{km}^{-2}$ (185 up to $555 \text{ kBq}\cdot\text{m}^{-2}$), or strontium from 0.15 up to $3.0 \text{ Ci}\cdot\text{km}^{-2}$ (5.55 up to $111 \text{ kBq}\cdot\text{m}^{-2}$), or plutonium from 0,01 up to $0.1 \text{ Ci}\cdot\text{km}^{-2}$ (0.37 up to $3.7 \text{ kBq}\cdot\text{m}^{-2}$), where the average settlement of an equivalent human irradiation dose in a view of factors

of radionuclide migration to the plants and other factors can exceed 1.0 mSv (0.1 rem) per one year above the doses, been received in the pre-accident period;

4) *zone of strict radio-ecological control* is a territory with soil contamination density by isotopes of caesium from 1.0 up to 5.0 Ci·km⁻² (37 up to 187 kBq·m⁻²), or strontium from 0.02 up to 0.15 Ci·km⁻² (0.74 up to 1.85 kBq·m⁻²), or plutonium from 0.005 up to 0.01 Ci·km⁻² (0.185 up to 0.37 kBq·m⁻²) provided that the average settlement of an equivalent human irradiation dose in a view of factors of radionuclide migration to the plants and other factors exceeds 0.5 mSv (0.05 rem) per one year above the doses, been received in the pre-accident period.

Resettlement - because of possible exceeding of a life dose over 350 mSv in the inhabitants of the RCT the Government of the USSR in 1990 has accepted the decision to resettle from these districts in UkrSR, BSSR and RSFSR more than 200.000 people. About 50.000 persons had to be resettled to the clean districts in UkrSSR. The resettlement had to be carried out in 1991-1992. Further, in Ukraine the resettlement proceeded from zones of obligatory (compulsory) resettlement, guaranteed voluntary resettlement and strict radio-ecological control.

Chernobyl catastrophe survivors. The following population groups in Ukraine are recognised as the Chernobyl catastrophe survivors:

1) evacuees from the exclusion zone (including persons who at the moment of evacuation were at a fetal life period, later they have been born and become the adult persons nowadays) and person who had moved from zones of obligatory (compulsory) resettlement and guaranteed voluntarily resettlement;

2) individuals been permanently resident within the territories of obligatory (compulsory) and guaranteed voluntarily resettlement zones at the moment of the catastrophe, or having resided at least for two years on the territory of obligatory (compulsory) resettlement zone as of January 1, 1993, or at least for three years within the territories of guaranteed voluntarily resettlement zone, and individuals relocated or migrated themselves from those territories;

3) individuals been permanently resident or working in zones of obligatory (compulsory) and guaranteed voluntarily resettlement under condition that they have lived or worked there in the zone of obligatory (compulsory) resettlement for at least two years as of 1, January, 1993, and in the zone of guaranteed voluntarily resettlement – for at least three years;

4) individuals been permanently resident or working within territories of strict radio-ecological control zone under the condition that they have lived or worked there for at least four years as of January 1, 1993;

5) individuals having worked temporary since the moment of the catastrophe till July 1, 1986 for at least 14 calendar days or at least 3 months during 1986-1987 on the territory of obligatory (compulsory) resettlement zone under the condition that they were sent to that zone by an order of ministries, establishments, executive committees of oblast Councils of Peoples' Deputies;

6) children with thyroid irradiation doses exceeding the threshold levels established by the MH of Ukraine

Note

1. Units of measurement used in the report are those presented in submitted documents. Recalculation in the International system units is stated in brackets behind them.

2. Territory of Ukraine and of Belarus consists of several provinces (called "oblasts"), in turn each "oblast" consists of several districts (such district is called "rayon" or region).

3. The name for the city of Kiev in Ukrainian is "Kyiv", and for the city of Chernobyl is "Chornobyl". The spellings "Kiev" and "Chernobyl" are used in this report being known and recognised internationally.

5 HEALTH EFFECTS OF CHERNOBYL AND FUKUSHIMA: AN OVERVIEW

5.1 IAEA, WHO, and UNSCEAR reports: methodological issues

At the initiative of the IAEA an UN Chernobyl Forum was created in 2003. It was composed of experts from the IAEA, WHO, several departments of the United Nations, and representatives of the governments of Ukraine, Belarus and Russia. This organisation has the objective of arriving at a clear scientific consensus about the consequences of the Chernobyl NPP catastrophe. The results of the researches are published in reports of the UN Chernobyl Forum (Report, 2005; Health, 2005; Chernobyl's Legacy, 2006).

The positive fact is that the Chernobyl forum declared the Chernobyl NPP catastrophe as "the greatest nuclear disaster in human history". It summarized a large amount of research, which is most important for the human community in answering the question of possible radiation hazards to the health.

The provisions presented in Reports are the following:

(a) For the health of clean-up workers, evacuees, and people who lived in contaminated areas the irradiation is not dangerous, as at most 3,940 individuals could die from cancer due to radiation exposure;

(b) The radiation from the accident is not harmful to people because from many thousands of the thyroid cancer cases there are only 9 documented deaths from this disease in children and adults in the three affected countries at this time;

(c) The radiation from the accident is not harmful to humans because direct radiation-epidemiological studies have not found any association of the exposure with an increase of mortality in the total population, in particular of mortality from leukemia and solid cancers (except the thyroid cancer in children) or growth of the non-cancer diseases vs. the spontaneous level;

(d) The people who received an additional exposure doses of the low level die from the same causes as the people, who are not accident survivors. The actual number of deaths caused by the accident can never be exactly known.

(e) No convincing evidence was revealed of an increased incidence of leukemia among children or adults who reside in the exposed territories in Russia and Ukraine;

(f) The obtained doses were generally small and therefore not harmful to humans; there is no evidence of any radiation effects on Diseases of the Circulatory System and mortality from them;

(g) The carcinogenesis can occur at radiation of lower than those observed before, namely to about 250 mGy;

(h) Among the population that survived after the accident there is no evidence or any possible cases of the decreased male and female fertility as a direct result of radiation exposure. The radiation doses are also unlikely to affect the number of stillbirths, pregnancy outcomes, and complications of childbirth or children's health;

(i) The levels of fertility in contaminated areas can be lower through the fear to have children and high incidence of medical abortions. Because of low risk ratios no significant growth in hereditary effect caused by radiation is expected;

(k) The large number of thyroid cancer cases is the only confirmed result of the radiation impact;

(l) The affected countries unreasonably spent resources to protect the people from radiation.

The experts of the Chernobyl forum recognize only the presence of radiation induced effects, which are associated with acute exposure at the high doses (ARS, thyroid cancer, leukemia, solid cancers).

As for the DCS identified in the clean-up workers in Russia the experts make comments that these data should be interpreted cautiously in connection with possible influence of additional factors such as stress and unhealthy lifestyle.

The methodology of work of the experts was based on the analysis of peer-reviewed literature and some selected international journals. In this time the valuable results of scientific works of researchers from the different countries of the world were ignored.

Evaluation of the radiation effects and calculation of risk were conducted on the data from A-bombing of Hiroshima and Nagasaki. Such approach to calculation resulted in a reduced value of risk from the Chernobyl because there was quite another nature and level of exposure after the A-bombing.

The Chernobyl fallout and radiation doses not observed or registered in any countries except in Belarus, Ukraine and Russia have not been discussed in the reports.

The conclusions of the Chernobyl Forum were opposed by international organisations (Greenpeace, 2006) and scientists (Horishna, 2006; Burlakova, 2006; Yablokov *et al.*, 2009; Masurenko, V. 2010).

The data of this Report do not confirm the opinion of the experts of the Chernobyl Forum. The epidemiological studies in recent years and conclusions of scientists suggest that:

- 1) An increased incidence of thyroid cancer is registered not only among children and adolescents, but also in adults, namely in the clean-up workers and evacuees;
- 2) The increased risk of leukemia development in the clean-up workers is proven. The fact of a dose-dependent nature of chronic lymphocytic leukemia in the clean-up workers was proved for the first time in Ukraine;
- 3) There is an the increased risk of breast cancer in female clean-up workers;
- 4) There is an increased risk of malignant tumors in Ukrainian and Russian clean-up workers;
- 5) There is an increased risk of radiation cataracts.

Taking into account the long latency periods of the development of radiation-induced cancer of many organs and systems, it is necessary to continue the monitoring of this disease in a remote post-accident period.

Various non-cancer health effects in 10-27 years after the catastrophe that have been proven:

- Cardiovascular disease and mortality in the clean-up workers;
- Vascular eye disease in different groups of exposed persons;
- Cerebrovascular disease and cognitive dysfunction in the clean-up workers;
- Thyroid autoimmune diseases;
- Mental health disorders in children exposed *in utero*.

Data for the 30 years of observations show that the Chernobyl catastrophe and its consequences have caused harm to the survivors. These data give a reason to believe that estimates made by the IAEA and WHO on the 20th anniversary of the Chernobyl catastrophe were understated.

In contrast to Chernobyl, after the catastrophe at Fukushima on March 11, 2011 in Japan the existing rules of the alert of the national and international authorities and organizations about the catastrophe have been complied (Fukushima Daiichi NPP, 2011). The IAEA joined the cooperation to render help in the investigation of the causes and consequences of the catastrophe. Its report was presented to the Ministers on issues of nuclear safety on the meeting in Vienna on June 20-24, 2011

(Fukushima. Report of IAEA, 2011). Recognition of the fact that the Japanese government, developers and operators of the Fukushima Daiichi NPP have underestimated the danger of tsunamis was the main conclusion of the report. Some more reports followed. A report on the supposed consequences of the catastrophe at Fukushima NPP on the health of the Japanese was prepared in 2013 (Fukushima. Report of IAEA, 2013). In May 2015 the IAEA published a report on liquidation of the consequences of the catastrophe at Fukushima NPP. At the 59th General conference of IAEA in Vienna (September, 2015) a fundamental report was presented about the organisation of liquidation of consequences of the Fukushima catastrophe. The report included five technical tomes of applications (Fukushima. Report of IAEA, 2015).

Taking into account current information technology the experts and public have the unrestricted opportunities to receive information about the catastrophe at Fukushima and arrangements on liquidation of its consequences.

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