

1986-2016: CHERNOBYL at 30

An update

On 26 April 1986, an explosion and fires at the Chernobyl nuclear plant in Ukraine caused the largest uncontrolled radioactive release in the history of the civil nuclear industry. Large quantities of radioactive iodine and cesium were released into the air due to the explosion and fire at the accident site. Most of this radioactive material was deposited near the installation, but a substantial amount of these radionuclides was carried by wind currents over Belarus, the Russian Federation and Ukraine and, to some extent, over parts of Europe.

In 2006, WHO published a report “Health Effects of the Chernobyl Accident and Special Health Care Programmes”¹ summarizing 20 years of research on the health consequences of the Chernobyl accident.

1. Updated assessments of health effects of the Chernobyl accident since 2006

In 2011, the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) published a report “Health effects due to radiation from the Chernobyl accident”. The findings were based on more than two decades of experimental and analytical studies of the radiation consequences of the Chernobyl accident on the health of the exposed populations. The report is the most comprehensive evaluation to date of human exposure levels and health effects from the Chernobyl accident².

- **Thyroid cancer**

For the last three decades, attention has focused on investigating the association between exposure to radionuclides released in the Chernobyl accident and late effects, in particular thyroid cancer. Doses to the thyroid received in the first few months after the accident were particularly high in those children and adolescents living in the most affected regions, who drank milk contaminated with radioactive iodine. This subpopulation has since been followed-up through national Chernobyl registries for increased risk of thyroid cancer³.

The 2006 WHO report anticipated that thyroid cancer incidence due to the Chernobyl accident would continue to increase over time. According to national studies in the three affected countries, more than 11,000 thyroid cancer cases had been diagnosed in this group by 2016. It is most likely that a fraction of these thyroid cancers is attributable to radioiodine intake in 1986, although long-term increases are difficult to quantify, for the study population is aging and their spontaneous thyroid cancer risk is also increasing.

- **Other cancers**

Previously reported increase in the incidence of solid cancers and leukaemia due to radiation from the Chernobyl accident in the exposed populations continues to be investigated. In particular, a Chernobyl cohort of 530,000

¹ Report of the UN Chernobyl Forum Expert Group “Health”, WHO, Geneva, 2006 — is available at:

http://whqlibdoc.who.int/publications/2006/9241594179_eng.pdf

² UNSCEAR Chernobyl report (2011). URL: <http://www.unis.unvienna.org/unis/en/pressrels/2011/unisinf398.html>

³ Bogdanova T. et al. Histopathological features of papillary thyroid carcinomas detected during four screening examinations of a Ukrainian-American cohort. Br J Cancer. 2015 Dec 1; 113(11):1556-64. URL: <http://www.ncbi.nlm.nih.gov/pubmed/26625214>

registered recovery and clean-up operation workers, who received doses ranging from 20 to 500 millisievert (mSv) in 1986-1990, is being closely followed up for potential risk of cancer and other diseases⁴. Three WHO Collaborating Centers in the Russian Federation and Ukraine are leading long-term follow-up programmes on Chernobyl-affected populations in cooperation with WHO.

There is emerging evidence from other studies (workers in the nuclear industry and medically exposed populations) that low dose protracted exposures to ionizing radiation increase the relative risk of cancer. Such risk increase can only be validated through large, well-designed epidemiological studies of populations with well-characterized exposures from the Chernobyl accident. It should be noted that a general increase in cancer incidence has been reported in recent decades worldwide, which must be also taken into account when interpreting the results of the Chernobyl studies.

- **Non-cancer diseases**

Since the publication of the WHO 2006 report, new evidence has emerged on radiation induced cataracts in clean-up workers who were externally exposed to radiation in the course of their work in Chernobyl. Until recently, it was considered that the risk of cataract increases at doses above 150 mSv, based on earlier data derived from other studies on non-Chernobyl populations, e.g. radiation technologists and astronauts. Recent international reports show that doses of radiation as low as 20 mSv may cause an increased risk of developing a radiation-induced cataract of the eye lens^{5,6,7}. The data obtained in the Ukrainian-American Chernobyl Ocular Study resulted in a revision down to 20 mSv of ICRP recommendations for occupational dose limit for the lens of the eye⁸.

In the WHO report on Chernobyl (2006), experts noted an indication of potentially increased risk of cardiovascular diseases (CVDs) among clean-up workers and suggested further studies on this effect. Recently, the risk of CVDs due to ionizing radiation exposure at low doses was reported in a meta-analysis study that demonstrated increased cardiovascular mortality in cohorts of persons exposed to ionizing radiation, including Ukrainian clean-up workers⁹. One should however keep in mind that many other factors contribute to the increased risk of CVDs, such as smoking, diet, physical activity, stress, general health, age and genetics.

- **Psycho-social impact and mental health**

The psycho-social impact of disasters and emergencies has been well documented. It has been reported to be the Chernobyl accident's main public health impact that affected the largest number of people. A similar effect is now reported in the aftermath of the Fukushima disaster, that caused evacuation and relocation of large group of people, who lost their homes, jobs, were placed in temporary housing in shelters and did not have an adequate access to health care.

Several international studies reported that Chernobyl-affected populations had anxiety levels that were twice as high than non-exposed population, and were more likely to report multiple unexplained physical symptoms and subjective poor health. To some extent, these symptoms were driven by the belief that their health was adversely affected by the disaster and the fact that they were diagnosed by a physician with a "Chernobyl-related health

⁴ Kashcheev V. et al. Incidence and mortality of solid cancer among emergency workers of the Chernobyl accident: assessment of radiation risks for the follow-up period of 1992–2009. *Radiation and Environmental Biophysics*. March 2015, Volume 54, Issue 1, pp 13-23. URL: <http://link.springer.com/article/10.1007%2Fs00411-014-0572-3>

⁵ V. V. Chumak, et al., Dosimetry for a study of low-dose radiation cataracts among Chernobyl clean-up workers. *Radiat. Res.* 167, 606–614 (2007). URL: http://www.bioone.org/doi/10.1667/RR0302.1?url_ver=Z39.88-2003

⁶ R., Shore et al. Epidemiological studies of cataract risk at low to moderate radiation doses: (not) seeing is believing. *Radiat Res.* 2010 Dec;174(6):889-94. 1. *Epub* 2010 Aug 30. URL: <http://www.bioone.org/doi/pdf/10.1667/RR1884.1>

⁷ Hammer G. et al. Occupational exposure to low doses of ionizing radiation and cataract development: a systematic literature review and perspectives on future studies. *Radiat Environ Biophys.* 2013 Aug;52(3):303-19. URL: <http://www.ncbi.nlm.nih.gov/pubmed/23807741>

⁸ ICRP statement on Tissue Reactions: <http://www.icrp.org/docs/2011%20Seoul.pdf>

⁹ Little M. et al. Systematic Review and Meta-analysis of Circulatory Disease from Exposure to Low-Level Ionizing Radiation and Estimates of Potential Population Mortality Risks. *Environ Health Perspect.* 2012 Nov; 120(11): 1503–1511.. URL: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3556625/>

problem". Given that rates of mental health problems increase after a disaster and may manifest years after the event, it is important to provide access to mental health services in disaster-affected areas on a long-term basis.

It is also extremely important to provide adequate information to the affected populations and to provide them with psychological support through special programmes. Several international projects aimed at developing such infrastructure, providing training materials and facilitating training programs for the various target groups in the affected regions of Belarus, Ukraine and Russia: primary health care workers, teachers, media workers, and local decision makers.

In addition, the implementation of long-term health surveillance programmes, which continue for 30 years, may also leave a certain psychological impact. The cost-efficiency of such programmes, their ethical implications and clinical justification should be evaluated. Chernobyl's wealth of experience provides a unique opportunity to study the efficacy of such programmes.

2. UN Action Plan for the Third Decade of Chernobyl and ICRIN project

In 2007, the UN General Assembly adopted a Resolution on Chernobyl and announced the launch of the UN Action Plan for the Third Decade of Chernobyl with the key priorities set on sustainable development of Chernobyl-affected areas and return to normality.

Between 2009 and 2013, as part of the UN Action Plan implementation, WHO contributed to the inter-agency International Chernobyl Research and Information Network (ICRIN) project¹⁰. The joint UNDP, IAEA, WHO and UNICEF project aimed to alleviate the stigma of psychological impact in society, encourage self-reliance, and empower local communities to take control over their own lives. One of the ways to achieve these goals is to promote healthy life styles, including physical activity and healthy diet, and to put the radiation risk in the context of environmental, behavioural, and other risk factors for various non-communicable diseases, including cancer. It was necessary to dispel the Chernobyl myths and make it clear that for most Chernobyl-affected people, Chernobyl radiation is not the driving factor in the broad spectrum of health and socio-economic problems of the affected territories.

3. Food safety in the Chernobyl affected areas

The safety of locally produced food in the areas affected by the accident is often a subject of public and media inquiries. It should be noted that monitoring of radioactivity in food and drinking water, as well as setting up and implementing national norms, standards, and safety limits for various exposures (occupational, medical, etc.), falls under the responsibility of the national competent authorities.

- **International safety standards**

The international radiation basic safety standards (BSS) published in 2014¹¹, cosponsored by eight international organizations including WHO, contain general safety requirements for the control of exposure of the public from food and drinking water. There are other international standards relating to radioactivity in food and drinking water that also provide guidance in terms of individual radiation dose and/or radioactivity concentrations of specific radionuclides. One of such documents, published by the Joint WHO/FAO Codex Alimentarius

¹⁰ ICRIN project, April 2009:

http://www.who.int/mediacentre/news/releases/2009/chernobyl_anniversary_20090424/en/index.html

¹¹ *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards IAEA Safety Standards Series No. GSR Part 3, Vienna (2014) cosponsored by EC, FAO, ILO, IAEA, NEA, PAHO, UNEP, and WHO.*

Commission: “Codex General Standard for Contaminants and Toxins in Food and Feed”¹², provides guideline levels for radioactivity in food destined for human consumption and traded internationally following a nuclear or radiological emergency. Another publication jointly prepared by several international organizations, provides criteria for radionuclide activity concentration in food and drinking water (2016)¹³

- **National norms and regulations**

Each country decides whether, how and to what extent to implement the international standards. WHO provides technical support to Member States but it is not involved in the development and implementation of national norms and regulations, which is the responsibility of national governments. Indeed, one of WHO’s core functions is setting norms and standards and promoting and monitoring their implementation.

- **WHO-FAO INFOSAN network – a tool for monitoring food safety**

The International Food Safety Authorities Network (INFOSAN¹⁴) is a global network of national food safety authorities, jointly managed by FAO and WHO. It promotes the rapid exchange of information on food safety in the respective countries, including on issues related to radioactivity in food. INFOSAN enables sharing information on important food safety related issues of global interest, promoting partnerships and collaboration between countries, and helping countries strengthen their capacity to manage food safety emergencies. Countries report to INFOSAN on a voluntary basis. If requested by the country, WHO in cooperation with FAO will conduct a health risk assessment as was done after Fukushima nuclear accident¹⁵.

4. Thirty years of mitigation of health consequences of the Chernobyl accident: the role of the WHO

1986-1990: The early response of WHO to the Chernobyl accident is described in http://www.who.int/ionizing_radiation/chernobyl/Overview_WHO_past_involvement.pdf

1991: Soon after the break-up of the Soviet Union, the governments of Belarus, Ukraine and the Russian Federation requested WHO to examine the health effects of the Chernobyl accident.

1991-98: WHO developed and implemented the International Program on the Health Effects of the Chernobyl Accident (IPHECA), a 20 million US dollar project –.

1994: WHO’s Regional Office in Europe initiated an international project on thyroid pathologies, which ran until September 2000. The project helped Belarus, the Russian Federation, and Ukraine enhance diagnosis techniques, treatment and monitoring of thyroid pathologies, and improve methods of identification of causes, nature, and estimated scope of the outbreak of radiation-induced thyroid cancer. Special priority was accorded to thyroid screening, establishment of registry, laboratory tests for iodine deficiency level, support for laboratory capacity development for thyroid hormones assessment, and training.

1995: A WHO conference in Geneva brought together a broad variety of scientists from all over the world. The conference secretariat selected a set of key papers for publication in a special 1996 issue of the *WHO Bulletin* (a copy of the journal is available upon request).

¹² JOINT FAO/WHO FOOD STANDARDS PROGRAMME, CODEX ALIMENTARIUS COMMISSION, *Codex General Standard for Contaminants and Toxins in Food and Feed, Schedule 1 — Radionuclides, CODEX STAN 193-1995, CAC, Rome (2006).*

¹³ IAEA TECDOC 1788 Criteria for radionuclide activity concentration in food and drinking water , IAEA 2016 URL: at http://www-pub.iaea.org/MTCD/Publications/PDF/TE-1788_web.pdf

¹⁴ INFOSAN website: http://www.who.int/foodsafety/areas_work/infosan/en/

¹⁵ WHO report on Health risk assessment from the nuclear accident after the 2011 Great East Japan earthquake and tsunami, based on a preliminary dose estimation (2013). URL: http://www.who.int/ionizing_radiation/pub_meet/fukushima_risk_assessment_2013/en/

1996: WHO contributed to the international conference for the 10th anniversary of Chernobyl, held in Vienna, Austria.

1997-2002: WHO's International Agency for Research on Cancer (IARC) carried out a benchmark study on thyroid cancer risk in young people of Belarus, Ukraine, and Russia that by improved the understanding of the link between thyroid cancer and radiation risk.

1998-2002: WHO's Chernobyl Tissue Bank project was implemented to develop a unique database of Chernobyl thyroid cancer tissue samples, which are used for research on molecular mechanisms of radiation induced cancer world-wide until these days.

1999-2004: The WHO Chernobyl Telemedicine Project was implemented in Belarus by the WHO Collaborating Centre (Nagasaki University, Japan) to provide remotely a high-quality technical support to Belarusian physicians by means of video-conferencing.

2002: The UN Strategy for Recovery gave all UN agencies and the international community a framework for rebuilding the most-affected areas of Belarus, the Russian Federation, and Ukraine.

2003 Within the UN Strategy for Recovery, representatives from the International Atomic Energy Agency (IAEA), the UN Food and Agriculture Organization (FAO), the UN Office for the Coordination of Humanitarian Affairs (OCHA), the UN Development Programme (UNDP), the UN Environment Programme (UNEP), UNSCEAR, WHO and the World Bank and Belarus, the Russian Federation, and Ukraine, established and launched the Chernobyl Forum.

2006: The Chernobyl Forum released the most authoritative scientific findings of that time on the accident's consequences for health and the environment. The health impact assessment of the accident was conducted by the WHO expert panel. The WHO report "Health Effects of the Chernobyl Accident and Special Health Care Programmes" is available for free download in English and Russian.¹⁶

2006: IARC published estimates of excess cancers to occur across Europe (Cardis et al. 2006)¹⁷. IARC's estimates took into account a European population of 570 million and arrived at a figure of 25,000 excess diagnosed cancer cases (other than thyroid cancer) and 15,700 thyroid cancers attributable to radiation from Chernobyl were estimated to occur in Europe by 2065. However, these estimates were subject to substantial uncertainty due to the various limitations of the study.

2007: Following the UN inter-agency Chernobyl Forum in 2006, the UN launched its Action Plan for the third decade of Chernobyl until 2016. As part of the UN family, WHO has a mandate to implement this Action Plan according to UN General Assembly resolutions.

2009-2013: The International Chernobyl Research and Information Network (ICRIN) was launched by four United Nations agencies, as a part of the UN Action Plan implementation programme. It was a \$2.5 million project designed to meet the priority information needs of affected communities in Belarus, the Russian Federation, and Ukraine. This was part of a larger effort to help local communities "return to normal" in the course of the decade that ends in 2016. Funded by the UN Trust Fund for Human Security, this initiative aimed to translate the latest scientific information on the consequences of the accident into sound practical advice for residents of the affected territories. ICRIN project activities included the dissemination of information, through

¹⁶ Report of the UN Chernobyl Forum Expert Group "Health", WHO, Geneva, 2006, URL: :

http://whqlibdoc.who.int/publications/2006/9241594179_eng.pdf

¹⁷ Cardis E. et al. Estimates of the cancer burden in Europe from radioactive fallout from the Chernobyl accident *Int. J. Cancer*: 119, 1224-1235 (2006) URL: <http://onlinelibrary.wiley.com/doi/10.1002/ijc.22037/epdf>

education and training for teachers, medical professionals, community leaders, and the media; providing local residents with practical advice on health risks and healthy lifestyles; the creation of internet-equipped information centers in rural areas; and small-scale community infrastructure projects aimed at improving living conditions and promoting self-reliance.

2010: IARC completed an EC-funded project Agenda on Research on Chernobyl Health effects (ARCH) on the development of a strategic research agenda (SRA) for Chernobyl studies.¹⁸ A key to the success of the implementation of the SRA recommendations is the creation, maintenance and follow-up of life-span cohorts. These include already existing cohorts of liquidators from the Baltic countries, Belarus, Russian Federation and Ukraine, as well as the cohorts exposed to fallout as children in Belarus and Ukraine with detailed thyroid activity measurements, currently supported by the US National Cancer institute and hosting countries. The ARCH group of experts and advisors recommended setting up a mechanism to coordinate and fund studies that will enable assessment of the overall long-term health effects of this disaster.

2015-2016: An international group of experts and advisors under the leadership of IARC is carrying out the European Union funded project “Cooperation on Chernobyl Health Research” (CO-CHER)¹⁹. The CO-CHER project partners are principally institutions that are extensively involved in research on Chernobyl health effects. The group performed an assessment of the existing research infrastructures and identified a number of research priorities to form a basis for sustainable future research on Chernobyl. The established international network of institutions and individual experts in epidemiology, clinical medicine, mental health, dosimetry, molecular biology, pathology and risk communication met in subgroups to discuss and agree upon the priorities in their field to develop a Research Programme. The project brought together key scientists, stakeholders and potential funding partners to agree on the coordinating mechanism, to decide on the research priorities and to seek sustainable funding for those priority areas.

5. Commemoration of the 30 years of the Chernobyl with participation of WHO:

- 18-19 April, Kiev/Ukraine: Int. Conference on Health Consequences of the Chernobyl accident, hosted by the WHO Collaborating Center (CC) – National Research Center for Radiation Medicine (with participation of WHO and IARC)

URL: http://nrCRM.gov.ua/en/news-2016_01/

- 17-19 May, Obninsk/Russia: International Conference "Health Effects of Chernobyl: Prediction and Actual Data 30 years after the Accident" – Obninsk, Russia, hosted by WHO CC – Medical-Radiological Research Center

URL: <http://mrrc-obninsk.ru/en/science/health-effects-chernobyl>

- 11 June: WHO/IARC International Scientific Symposium Chernobyl: 30 years after – in the frame of the International Conference for the 50th anniversary of IARC – Lyon, France,

URL: <http://www.iarc-conference2016.com/index.php?langue=en&onglet=26>

- 16-17 June: 4th International Seminar Radiation Medicine in Research and Practice: Health effects 30 years after Chernobyl, 5 years after Fukushima – Wuerzburg, Germany, hosted by the WHO Collaborating Center University of Wuerzburg.

URL: <http://www.reman.ukw.de/aktuelles/aktuelle-interne-veranstaltungen.html>

¹⁸ Additional information can be found at: http://arch.iarc.fr/documents/ARCH_SRA.pdf.

¹⁹ Co-CHER website: <http://co-cher.iarc.fr/>

Key Chernobyl documents

- UN Action Plan for the Third Decade of Chernobyl URL:
http://chernobyl.undp.org/russian/docs/UNActionPlan_revised.pdf
- WHO report on Health Effects of the Chernobyl Accident and Special Health Care Programmes (2006),
URL: http://apps.who.int/iris/bitstream/10665/43447/1/9241594179_eng.pdf
- IAEA report on Environmental Impact of the Chernobyl accident (2006).
http://www-pub.iaea.org/MTCD/publications/PDF/Pub1239_web.pdf
- UNSCEAR Chernobyl report (2011): <http://www.unscear.org/unscear/en/chernobyl.html>
- FAQs developed for the 20th anniversary of Chernobyl in April 2011:
http://www.who.int/ionizing_radiation/chernobyl/20110423_FAQs_Chernobyl.pdf