

Compendium of WHO and other UN guidance on health and environment



Chapter 6. Radiation



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6.1 UV radiation – natural and artificial





















Overview












Human exposure to solar UV radiation may result in acute and chronic health effects of the skin (such as skin cancers) the eye (such as cataracts) and the immune system. All skin types can be affected (1, 2). Natural UV radiation levels depend on sun elevation, latitude and altitude, cloud cover and ground reflection. More than 60 000 skin melanoma-related deaths were estimated to be caused by solar UV radiation in the year 2000 (3).

Exposures can occur through UV radiation from the sun, but also from sunbeds and other artificial tanning devices. While all populations are potentially at risk, specific subpopulations such as children, outdoor workers and fair skinned people are at particular risk of skin cancer.

What exposure levels to UV radiation do we want to achieve?

Only small amounts of UV radiation are beneficial for people and essential in the production of vitamin D. The UV index can assist to make healthy choices about the level of sun protection needed (4).

 Guidance	 Sector principally involved in planning/implementation	 Level of implementation	 Instruments
Solar UV radiation exposure from the sun: policies and actions			
1. Develop or update national sun protection policies and action plans to help prevent skin cancer and eye disease from solar radiation exposure.	 Health	National	Regulation
2. Support the production, labelling and distribution of affordable UV protection products that use national or international protection labels/standards such as sunscreens (sun protection factor), clothing (UV protection factor), and sunglasses to ensure clear and safe guidelines for manufacturers and consumers (1).	 Health	National	Regulation
3. Establish and enforce exposure limits and protective measures for outdoor workers, such as education programmes, tailored working hours, PPE, health surveillance (5).	 Health  Industry  Agriculture  Construction	National; workplace	Regulation
4. Establish national registries/statistics on UV radiation-induced skin and eye diseases (1).	 Health	National	Assessment and surveillance
5. Support the provision of shaded areas in schools and in public places such as playgrounds, parks and swimming pools (1).	 Health	National; community; schools/child-care settings; Universal health coverage	Infrastructure, technology and built environment
Artificial UV radiation: policies and actions			
6. Establish and enforce exposure limits and protective measures for indoor workers (e.g. welders) such as engineering controls and administrative controls, such as training, access limitation, hazard warning and signs and PPE (5).	 Health  Industry	National; workplace	Regulation;
7. Ban the use, marketing and promotion of artificial tanning services (sunbeds for cosmetic purposes) (6).	 Health	National	Regulation
8. Ban the hire and sale of sunbeds and other artificial tanning devices for domestic use (6).	 Health	National	Regulation
Note: in case no bans (actions 7 and 8) are being implemented, a combination of the following (actions 9 to 10) can be opted for.			
9. Restrict the use of sunbeds and other artificial tanning devices (6): <ul style="list-style-type: none"> prohibit unsupervised access; set an age limit on the use of sunbeds and other artificial tanning devices. 	 Health	National	Regulation
10. Manage the use of sunbeds and other artificial tanning devices (6): <ul style="list-style-type: none"> require surveillance and licensing of artificial tanning services; set tanning lamp limits and exposure times; require eye protection; train operators. 	 Health	National	Regulation

 Guidance	 Sector principally involved in planning/implementation	 Level of implementation	 Instruments
11. Impose taxes on sunbed sessions (6).	 Health  Finance	National	Regulation; taxes and subsidies
12. Require informing users of sunbeds and other artificial tanning devices about health risks and display of warning signs (6).	 Health	National	Regulation
Awareness raising and capacity building			
13. Develop a risk communication strategy to sustainably raise awareness and educate the public about the health risks of skin cancer and eye diseases from UV radiation exposure.	 Health	National; community Universal health coverage	Information, education and communication
14. Use the UV Index through the media as part of public awareness programmes (1).	 Health	National; community Universal health coverage	Information, education and communication
15. Implement repeated education programmes to raise awareness about the health risks from prolonged UV exposure and protection measures to take, including (1) the following. <ul style="list-style-type: none"> • Supply health care professionals, teachers and caregivers of children with educational material for distribution to the public. • Organize workshops for medical doctors and other health professionals. • Establish education programmes for teachers. • Establish education programmes for outdoor workers. 	 Health	National; community; health care; schools/child-care settings; workplace Universal health coverage	Information, education and communication
16. Inform the public about the risks of sunbeds and other artificial tanning devices (6).	 Health	National; community Universal health coverage	Information, education and communication

Selected tools

WHO 2021: *The Global Health Observatory data repository – legislation of artificial tanning sunbeds* (7)
 WHO 2017: *Artificial tanning devices: public health interventions to manage sunbeds* (6)
 WHO 2020: *Ultraviolet (UV) radiation* (8)

6.2 Electromagnetic fields









Overview

EMF covered in this section include those generated by consumer products (electric appliances, mobile phones), fixed installations (power lines, base stations, TV antennas, medical devices (e.g. those using magnetic resonance imaging) and other technologies which can be found in the environment, at the workplace and in health care facilities.

What EMF exposure levels do we want to achieve?

Exposure standards for EMF generally refer to maximum levels of exposure to the body. Such standards have been developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP)¹, and the Institute of Electrical and Electronics Engineers (IEEE/ICES),² as well as many national authorities. WHO provides a framework which can be used to develop national standards (9).

 Guidance	 Sector principally involved in planning/implementation	 Level of implementation	 Instruments
Policies and actions			
1. Establish exposure standards that limit EMF exposures to the public and workers as part of national legislation (9).	 Health	National	Regulation
Awareness raising and capacity building			
2. Inform the public about potential health risks from EMF (mobile phones, antennas and emerging technologies). Updates should be made as evidence from ongoing studies becomes available (10). Engage in dialogue and consider the issues, perceptions and concerns of all interested parties, while relying on the available evidence.	 Health	National; community Universal health coverage	Information, education and communication

Selected tools

WHO Global Health Observatory – Database of national regulations for electromagnetic fields (11)

¹ <http://www.icnirp.org>

² <https://www.ices-emfsafety.org/>

6.3 Radiation exposures in health care



Overview

Every year, millions of patients globally benefit from medical uses of radiation. Because of the risks associated with radiation exposure, enhancing access to radiation technologies should be linked to building capacity to their safe and appropriate utilization. A balanced approach is required to maximize the benefits while minimizing risks for patients, health care workers and members of the public.

Policies and interventions are needed to ensure that radiation safety standards (12) are applied and that guidance and tools are available for health facilities utilizing radiation for diagnostic and/or therapeutic purposes (13, 14). Radiation protection should be integrated into policies and actions to improve quality of care, thus providing a framework for intersectoral cooperation involving all relevant stakeholders.

What radiation exposure levels do we want to achieve in medical settings?

Justification and optimization are the two fundamental principles of radiation protection in medicine. Medical exposures must result in a sufficient benefit to the patient, based on a benefit–risk analysis that provides the basis for the justification of radiological medical procedures. To ensure optimization of protection and safety, the design and construction of equipment and installations as well as the protocols and working procedures applied should result in the minimum patient dose required to achieve the clinical purpose and the probability of errors/incidents should be minimized. While dose limits are not applied to medical exposures, annual radiation dose limits are applied to health workers and members of the public. Further information on radiation safety in health care settings can be found on the WHO web site: <https://www.who.int/activities/enhancing-radiation-safety-in-health-care>. Description of guidance, examples of policies and practices, as well as of awareness raising and capacity building interventions are provided in section [11.4 Health care facilities](#) under “Radiation”.

6.4 Radon



Overview

Radon is a radioactive gas that emanates from uranium in rocks and soils and tends to concentrate in enclosed spaces such as buildings and underground mines. It can also be present in water and in some building materials. Radon causes increased risk of lung cancer. A combination of smoking and indoor radon gas further increases the cancer risk. Exposure to radon causes 84 000 deaths per year (2019 data) (15).

How polluted are indoor environments with radon?

The air concentration of radon can be informed through the following.













- In-situ measurements: devices for measuring radon levels in homes are available and measurements should comply with prevailing (national) protocols (16).
- Radon maps: several countries/regions have created radon maps and databases (16).























What are the indoor radon levels we want to achieve?

To limit the risk to individuals, a national reference level of 100 Bq/m³ is recommended. Wherever this is not possible, the chosen level should not exceed 300 Bq/m³ (16, 17).

Additional information is available.

- *WHO handbook on indoor radon: a public health perspective* (16).
- *WHO guidelines for indoor air quality: selected pollutants* (18).

 Guidance	 Sector principally involved in planning/implementation	 Level of implementation	 Instruments
Policies and actions			
1. Develop or update a national radon action plan covering both radon prevention (new buildings) and mitigation (existing buildings) to control public and occupational radon exposure in order to achieve an overall risk reduction (16).	 Housing  Construction  Health  Workplace	National	Regulation
2. Establish national reference levels for air concentration in homes/buildings with high public occupancy, and workplaces (16, 17).	 Housing  Construction  Workplace  Health	National	Regulation

 Guidance	 Sector principally involved in planning/implementation	 Level of implementation	 Instruments
3. Establish national regulations, building codes and/or guidelines for radon prevention and mitigation (16).	 Housing  Construction  Workplace  Health	National	Regulation
4. Test radon levels and monitor to determine the effectiveness of any radon prevention or mitigation effort, especially in the context of energy efficiency programmes (16, 19, 20).	 Housing  Construction	National; community	Assessment and surveillance
5. Incorporate radon as a risk factor in national cancer control, tobacco control, energy conservation and indoor air quality strategies and health promotion programmes (16).	 Housing  Health	Community; national Universal health coverage	Governance
6. Subsidize or provide tax incentives to householders carrying out radon mitigation renovations (16).	 Finance  Housing	National, community	Taxes and subsidies
7. Impose radon measurements and remediation as part of property transactions, where relevant (16).	 Finance  Housing	National, community	Regulation
Awareness raising and capacity building			
8. Educate radon professionals, who are key for controlling radon exposure. Radon control choices depend on concentration, sources and levels of transport of radon through housing materials. Examples of control options include active and passive ventilation and soil depressurization (16).	 Housing  Construction	National; community	Information, education and communication
9. Develop a risk communication strategy to raise awareness and educate the public about the health risks of lung cancer from radon exposure (16, 17).	 Health  Housing  Construction	Community; national Universal health coverage	Information, education and communication
10. Raise awareness among policy-makers and health practitioners that radon is an important public health issue that requires action (16).	 Health	National; community Universal health coverage	Information, education and communication

Selected tools

WHO 2020: Global Health Observatory – database of national regulations on radon exposure (21)

WHO 2018: *Management of radioactivity in drinking-water* (22)

WHO 2009: *Handbook on indoor radon: a public health perspective* (16)

6.5 Radioactivity in food and drinking-water










Overview

Food and drinking-water can contain radioactive substances (radionuclides) that could present a risk to human health. The radiation exposure resulting from ingestion of radionuclides makes a contribution to the overall population radiation dose from the many different natural and human-made radiation sources of radiation found in our everyday lives. Foods and drinking-water can have a considerable range in variation of radionuclide concentrations, reflecting the radionuclide content of water, rocks, soil and fertilizers from where they originated and the prevalent circumstances (e.g. normal situations vs radiation emergencies).

What are the radiation exposure levels we want to achieve in food and drinking-water?

In normal circumstances, natural radionuclides are the major source of exposure through ingestion, and the radiation risks are usually small compared with the risks from microorganisms and chemicals that may be present in food and drinking-water. Following radiation emergencies, human-made radionuclides released into the environment may be transferred to food and water and represent a significant source of exposure. These factors should be considered for establishing criteria for food and water safety regulation, management and surveillance. In normal situations, the International Basic Safety Standards require that the national relevant regulatory authorities establish specific reference levels for radiation exposure due to radionuclides in food and drinking-water, each of which shall typically be expressed as, or based on, an annual effective dose to the representative person generally that does not exceed a value of about 1 mSv (12). Specific standards for response to nuclear and radiological emergencies include criteria for management of radioactivity in food and drinking-water (23). Further guidance on radioactivity in food and drinking-water has been developed by WHO and other international organizations (22, 24-26); for further information specifically related to drinking-water, see section [3.2.1 Drinking-water](#).

 Guidance	 Sector principally involved in planning/implementation	 Level of implementation	 Instruments
Policies and actions			
<p>1. Manage radioactivity in food and drinking-water (3.2.1 Drinking-water) (26).</p> <p>Radioactivity in food</p> <p>Ensure consistency with international radiation safety standards for the provision of food in the market, which includes the following.</p> <ul style="list-style-type: none"> Consider the international standards developed by the FAO/WHO Codex Alimentarius Commission when adopting criteria in terms of levels of individual radiation dose, levels of activity concentration of specific radionuclides or both. Seek to improve radiation safety in food trade and consumption engaging relevant stakeholders including regulators, suppliers and consumers. Foster cooperation between relevant authorities in the field of public health, food and agriculture, radiation protection and trade to ensure consistency in policies, and regulations about radioactivity in food. 	 Water/sanitation  Agro-food  Health	National	Regulation, other action

6.6 Radiological emergencies



IHR (2005) have established provisions and requirements for countries to be prepared for radiological and nuclear emergencies, and be able to detect, assess and respond to a crisis (27). WHO, in turn, should provide technical assistance on request to Member States for assessment and management of risks, as well as for a long-term recovery process.




















For radioactivity in drinking-water, please refer to section [6.5 Radioactivity in food and drinking-water](#) and section [3.2.1 Drinking-water](#).













Overview

Radiation emergencies (including radiological and nuclear emergencies) may result from technological incidents, natural disasters, transport accidents, acts of terrorism, polluted environments, and may involve over-exposure from external sources or internally from contaminated air, drinking-water, foods and products. Large-scale nuclear accidents such as those that occurred in Chernobyl or Fukushima are rare but may affect millions and have global consequences.

<p>Detection, monitoring, and assessing risk of radiation emergencies</p>	<p>In most countries, the responsibility for monitoring radioactivity and detecting radiation emergencies rests with specialized competent authorities (e.g. radiation protection or nuclear safety agencies) and environmental protection agencies. In case of an industrial accident, the operator of the facility will notify the competent authorities, which in turn will notify the International Atomic Energy Agency (IAEA) under the international convention for early notification in case of a nuclear accident or radiological emergency (28). For other accidents not involving licensed activities – such as human over-exposure from a lost radioactive source or due to a malevolent act – health specialists may be the first to identify a cluster of radiation injuries. In this case, the notification channel will involve the national IHR focal point and WHO, which will promptly inform the IAEA, according to Article 6 of the IHR (2005) (27).</p> <p>The timely identification of the cause of clusters or suspected outbreaks associated with exposure to radiation may require a detailed investigation involving clinical, epidemiological, environmental and laboratory analytical approaches from multiple sectors/agencies.</p> <p>Risk assessment in case of radiological and nuclear emergencies also involves a multidisciplinary approach. Identification and assessment of exposure and determining the radiation dose for affected individuals/populations will be crucial for risk assessment.</p>
<p>What do we want to achieve?</p>	<p>Comprehensive management of radiation emergencies requires prevention and preparedness, early detection and effective response and recovery (23).</p> <p>Prevention focuses on general measures that can be taken to diminish the likelihood of a radiation emergency and to limit its severity.</p> <p>Emergency planning and preparedness involve putting in place relevant legislation, financing for a whole system of emergency preparedness and response based on the protection strategy, putting in place operating procedures and well-coordinated emergency response plans. In addition, adequate public health preparedness involves designated health facilities to be equipped and well-resourced and emergency response staff to be trained regularly.</p> <p>Response deals with the various aspects of radiation emergencies (25), including public health aspects of emergency sheltering and evacuation, distribution of potassium iodide pills if needed (29), ensuring adequate risk communication and management of the psychosocial impact of radiation emergencies.</p> <p>Recovery follows the transition period and includes evaluation of the lessons learned of the past radiation emergencies, long-term follow up of the affected persons, ensuring access to social, health care and welfare services, and restoring the affected communities and environment and return to normality.</p>

 Guidance	 Sector principally involved in planning/ implementation	 Level of implementation	 Instruments
Policies and actions (23, 25, 27)			
<p>1. Develop or update national policies and plans for prevention, preparedness, monitoring, response and recovery after radiation emergencies.</p>	 National competent authority (NCA) with the mandate pertaining to nuclear safety and/or radiation protection  Environment  Emergencies  Health  Law enforcement  Civil defence	National	Regulation
<p>2. Implement international agreements into national laws.</p> <p>Selected international agreements include the following.</p> <ul style="list-style-type: none"> • IHR (2005) – a legally binding agreement providing a framework to better prevent, prepare for and respond to public health events and emergencies of potential international concern (27). • Convention on Early Notification of a Nuclear Accident (28). • Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (28). 	 Environment	National	Regulation
Core capacities required under the International Health Regulations (2005) (27, 30)			
<p>3. Establish designated focal points for IHR (2005) in all authorities that have an important role in the management of chemical events, for coordination and communication.</p> <ul style="list-style-type: none"> • Establish a multisectoral national radiation emergency coordinating body. • Ensure adequate capacity for health-sector preparedness for prompt and adequate response to radiation emergencies. 	 Health  NCA  Environment	National	Governance
<p>4. Implement a radiation monitoring system for the detection, verification and exposure assessment of environmental radiation, as part of a multi-hazard surveillance strategy and accompanied by specific criteria for activating emergency response.</p> <p>Important sources of radiological and nuclear emergency notification and alert include:</p> <ul style="list-style-type: none"> • non-health sector sources of ionizing radiation, such as industry, agriculture, academia and nuclear installations operators; • first responders and the public; • hospital emergency departments; • primary health care facilities. 	 Environment  NCA  Health  Civil defence  Emergency and disaster management sector	National	Assessment and surveillance

 Guidance	 Sector principally involved in planning/ implementation	 Level of implementation	 Instruments
5. Develop national emergency response plans that consider the country's risk profile and address possible event scenarios and the needs of vulnerable populations.	 NCA  Environment  Health	National	Other action
6. Ensure access to expertise, that is, maintain an updated list and roster of experts and specialized centres for: <ul style="list-style-type: none"> • environmental monitoring • exposure modelling • radiation dose and risk assessment • bio-dosimetry (31) • diagnosis and treatment of radiation injuries (32) • radiation emergency stockpile agents (33) • health surveillance • mental health and psychosocial support. 	 Environment  Health  NCA	National	Information, education and communication; other action

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