Natural radioactivity: A public health perspective

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Content

• Introduction
• Existing exposure situations
• Inhalation of natural radioactivity: Radon
• Ingestion natural radioactivity: Drinking-water and food
• Discussion
The World Health Organization

THE WORLD HEALTH ORGANIZATION: WORKING FOR BETTER HEALTH FOR EVERYONE, EVERYWHERE

HEALTHIER POPULATIONS

1 billion more people enjoying better health and well-being

HEALTH EMERGENCIES

1 billion more people better protected from health emergencies

UNIVERSAL HEALTH COVERAGE

1 billion more people benefitting from universal health coverage

GPW13 (2019-2023)
HEALTH

a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity"

(WHO Constitution, 1948)
WHO's core functions

1. Articulating ethical and evidence-based policy positions
2. Setting norms and standards, and promoting and monitoring their implementation
3. Shaping the research agenda, and stimulating the generation, translation and dissemination of valuable knowledge
4. Providing technical support, catalysing change and developing sustainable institutional capacity
5. Monitoring the health situation and assessing health trends
6. Providing leadership on matters critical to health and engaging in partnerships where joint action is needed
The WHO 3-level structure

Netherlands (97), Germany (98), Belgium (01), Poland (04), Spain (07)

USA (19)

Morocco (10)

China (13)

Brazil (16)
HOW THE ENVIRONMENT IMPACTS OUR HEALTH

People are exposed to risk factors in their homes, work places and communities through:

- **Air Pollution** including indoors and outdoors
- **Inadequate Water, Sanitation and hygiene**
- **Chemicals and biological agents**
- **Radiation** ultraviolet and ionizing
- **Community Noise**
- **Occupational Risks**
- **Climate Change**
- **Built Environments** including housing and roads
- **Agricultural Practices** including pesticide-use, waste-water reuse
23% of all global deaths are linked to the environment. That's roughly 12.6 million deaths a year.

WHERE IS IT HAPPENING?

- 3.8 million in South-East Asia Region
- 3.5 million in Western Pacific Region
- 2.2 million in Africa Region
- 1.4 million in European Region
- 854,000 in Eastern Mediterranean Region
- 847,000 in the Region of the Americas

TOP 10 CAUSES OF DEATH FROM THE ENVIRONMENT

1st: Stroke - 2.5 million
2nd: Ischaemic Heart Disease - 2.3 million
3rd: Intentional Injuries - 1.7 million
4th: Cancers - 1.7 million
5th: Chronic Respiratory Diseases - 1.6 million
6th: Diarrhoeal Diseases - 846,000
7th: Malaria - 507,000
8th: Neonatal Conditions - 210,000
9th: Intentional Injuries - 246,000
10th: Respiratory Infections - 239,000

WHO IS MOST IMPACTED BY THE ENVIRONMENT

Children under five and adults between 50 and 75 years old are most affected by the environment.
Public health through the life course
Integrating Radiation Protection through the life course

The exposure situations and categories of exposure are combined in the same individual through the life course.
Content

- Introduction
- Existing exposure situations
International Standards

IAEA Safety Standards
for protecting people and the environment

Radiation Protection and Safety of Radiation Sources:
International Basic Safety Standards

Jointly sponsored by
EC, FAO, IAEA, ILO, OECD/NEA, PAHO, UNEP, WHO

General Safety Requirements Part 3
No. GSR Part 3
5. EXISTING EXPOSURE SITUATIONS

SCOPE

5.1. The requirements for existing exposure situations in Section 5 apply to:

....

(c) Exposure due to natural sources, including:

(i) $^{222}$Rn and its progeny and $^{220}$Rn and its progeny, in workplaces other than those workplaces for which exposure due to other radionuclides in the uranium decay chain or the thorium decay chain is controlled as a planned exposure situation, in dwellings and in other buildings with high occupancy factors for members of the public;

(ii) Radionuclides of natural origin, regardless of activity concentration, in commodities, including food, feed, drinking water, agricultural fertilizer and soil amendments, and construction materials, and residual radioactive material in the environment;
Naturally occurring sources in our environment

Worldwide annual average doses of ionizing radiation per person, by source (mSv)

<table>
<thead>
<tr>
<th>Source</th>
<th>Worldwide average annual effective dose (mSv)</th>
<th>Typical annual effective dose range (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>External exposure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cosmic rays</td>
<td>0.39</td>
<td>0.3–1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Terrestrial radiation</td>
<td>0.48</td>
<td>0.3–1&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Internal exposure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inhalation (mainly radon)</td>
<td>1.26</td>
<td>0.2–10&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Ingestion (food and drinking-water)</td>
<td>0.29</td>
<td>0.2–1&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2.4</td>
<td>1–13</td>
</tr>
</tbody>
</table>

<sup>a</sup> Range from sea level to high ground elevation.
<sup>b</sup> Depending on radionuclide composition of soil and building material.
<sup>c</sup> Depending on indoor accumulation of radon gas.
<sup>d</sup> Depending on radionuclide composition of foods and drinking-water.

Source: Adapted from UNSCEAR (2008)
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NORM IX theme: “Science – Awareness – Solutions”


with IAEA

Radon training material
Scientific evidence suggests 3-14% of lung cancers are due to exposure to indoor radon.

Annually **around 100,000 deaths** from lung cancer are due to indoor radon exposure worldwide.

Most lung cancer deaths related to radon are associated with **low / moderate concentrations** in normal dwellings.

Epidemiological studies do not support the evidence of a "safe" threshold level.

WHO recommends a reference level as low as reasonably achievable:

- **100 Bq/m³** justified as an effective reduction of radon-associated health hazards expected.
- If this level cannot be implemented because of country-specific conditions, the reference level should not exceed **300 Bq/m³**.

**Note:** Recent miners studies show a statistically significant risk of lung cancer after low radon exposures, which is compatible with radon in homes.
An evolving approach

Reference levels for radon

<table>
<thead>
<tr>
<th>Publication</th>
<th>Year</th>
<th>Public</th>
<th>Workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHO handbook</td>
<td>2009</td>
<td>100-300 Bq/m³</td>
<td>N/A</td>
</tr>
<tr>
<td>International BSS</td>
<td>2011 (2014)</td>
<td>300 Bq/m³</td>
<td>1000 Bq/m³</td>
</tr>
<tr>
<td>EC Council Directive</td>
<td>2013</td>
<td>300 Bq/m³</td>
<td>300 Bq/m³</td>
</tr>
<tr>
<td>ICRP 126</td>
<td>2014</td>
<td>300 Bq/m³</td>
<td>300 Bq/m³</td>
</tr>
</tbody>
</table>

Conversion factors from concentrations to dose

Bq/m³ → mSv/y
Radon - a contributor to indoor air pollution

Figure 3. NCD deaths attributable to environmental risks by income level

Sources: Air pollution: (4) for 2012; other risks: (3) for 2015.
1st WHO Global Conference on Air Pollution and Health
Clean Air for Health - Geneva Action Agenda

First WHO Global Conference on Air Pollution and Health – Conference summary report:
CLEAN AIR FOR HEALTH: Geneva Action Agenda

Geneva, 1 November 2018 – At the conclusion of the first WHO Global Conference on Air Pollution and Health, participants agreed an aspirational goal of reducing the number of deaths from air pollution by two-thirds by 2030. Leaders from national and city governments, intergovernmental organizations, civil society, philanthropy, research and academia considered the scientific evidence on air pollution and health and emphasized the urgent need for bold and prompt action to address this health crisis.

- Urgent need for bold and prompt action
- Aspirational goal of reducing the number of deaths from air pollution by 2/3 by 2030
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Radioactivity in food and water
BSS reqs. 5.22 and 5.23

The regulatory body or other relevant authority shall establish specific reference levels for exposure due to radioactivity in food, drinking water, and other commodities, each of which shall typically be expressed as, or be based on, an annual effective dose that does not exceed a value of about 1 mSv.

They have to consider the guideline levels for:

• Radionuclides contained in drinking water published by WHO (i.e. GDWQ)
• Radionuclides in food traded internationally published by the Joint FAO/WHO Codex Alimentarius Commission (i.e. Codex Alimentarius)
Drinking-water quality

Guidelines for Drinking-water Quality

Framwork for Safe Drinking-water

- Introduction (Chapter 1)
- Health-based targets (Chapter 3)
- Water safety plans (Chapter 4)
- Surveillance (Chapter 5)
- Application of the Guidelines in specific circumstances (Chapter 6)

A conceptual framework for implementing the Guidelines (Chapter 2)

Public health context and health outcome

- Radiological aspects (Chapter 9)

Supporting information

- Microbial aspects (Chapters 7 and 11)
- Chemical aspects (Chapters 8 and 12)
- Acceptability aspects (Chapter 10)

System assessment, Monitoring, Management and communication

Climate change, Emergencies, Rainwater harvesting, Desalination systems, Travellers, Planes and ships, etc.
WHO Guidelines for Drinking-Water Quality

- For use for an **existing exposure situation**, not for an emergency exposure situation

- Applies to radionuclides of both **natural and artificial** origin

- Uses a **conservative approach** providing an “Individual Dose Criterion” (IDC) of **0.1 mSv/y** from ingestion of drinking water – this represents a **very low level of health risk**, and should not be interpreted as mandatory

- Regulatory authorities may establish a national standard at the **IDC** level or greater, but generally less than the BSS **reference level** of 1 mSv per year, depending on the prevailing circumstances

- Gives practical ways of measuring radionuclide content
Guidance for implementation of GDWQ Chapter 9

Purpose
Provide practical guidance to support interpretation and implementation of the GDWQ in order to take appropriate action

Audience
Organizations that set or enforce standards related to, or manage risks from, radioactivity in drinking-water

Format
Written in the style of Q&As to enable easier reading of the issues of interest
Putting radiation risks in perspective

- Radiological risks are normally small compared with the risks from microorganisms and chemicals that may be present in drinking-water.
- Except in extreme circumstances, the radiation dose resulting from the ingestion of radionuclides in drinking-water is much lower than that received from other sources of radiation.
Food safety contributes to food security, human health, economic prosperity, agriculture, market access, tourism and sustainable development.

First ever **UN World Food Safety Day** celebrated on 7 June 2019 with the theme: “**Food safety is everyone’s business**”.

- FAO and WHO were designated to lead efforts in promoting food safety, joining forces to assist countries to prevent, manage and respond to risks along the food supply chain, working with food producers and vendors, regulatory authorities and civil society stakeholders.
CODEX guidelines for radionuclides in food in international trade

- Applies only to **food with contamination following a nuclear or radiation emergency**
- Applies only to **international trade**
- CODEX guideline levels defined in terms of 4 radionuclide groups for 2 categories of foods (infant and non-infant foods)
  - Activity concentrations derived by assuming 10% of the diet is imported contaminated food (equivalent to 1 mSv ingestion dose over a year)
  - Adult consumption rate of 550 kg/y and infant 200 kg/y
Radionuclides in Food and Drinking Water in Non-Emergency Situations
A IAEA/FAO/WHO Joint Project

To address several gaps and inconsistencies

- Drinking water (tap water) is the only commodity where specific reference levels for radionuclides are established at national level worldwide. Packaged water, natural mineral water are handled differently.

- For radionuclides in food, no international guidelines have yet been produced to support the establishment of specific reference levels equivalent to an annual dose of 1000 μSv/year in non-emergency situations.

- Competent Authorities for food safety and quality tend to address human made radionuclides in food but not natural radionuclides in food. However, it is the natural radionuclides in food that dominate the radiation exposure by ingestion in normal circumstances.

- Lack of an authoritative reference data set for levels of natural radionuclides in food since the UNSCEAR 2000 report.
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Discussion

The WHO public health perspective

• Aims to reduce the overall population risk and the individual risk for people exposed to high radioactivity concentrations
• Follows a conservative approach

• Includes a worker’s health perspective
• Is inclusive of informal industries
• Promotes clear risk communication strategies
• Promotes health research

NORM IX theme: “Science – Awareness – Solutions”