Global Burden of Disease Associated with Ionizing Radiation
What is Environmental Burden of Disease?

EBD is the quantification of health impacts caused by various environmental risk factors at population level, using a comparable and internally consistent framework, definitions and outcome measures.

EBD estimated for all world regions for a certain risk factors is Global Burden of Disease.
WHO’s GBD 2000 Project

Three major goals:

- To decouple epidemiological assessment of the magnitude of health problems from stakeholders advocacy of particular health policies and interventions

- To include into international health policy consideration of non-fatal health outcomes along with information on mortality

- To undertake the quantification of health problems in time-based units that can also be used in economic appraisal of cost-effectiveness of interventions and resource distribution
World Regions Serving as Calculation Basis for GBD Assessment

Legend:
- Afr D
- Afr E
- Amr A
- Amr B
- Amr D
- Eur A
- Eur B
- Eur C
- Sear B
- Sear D
- Wpr A
- Wpr B
- Emr B
- Emr D

Radiation and Environmental Health Program
Department of Protection of the Human Environment
World Health Organization
What Do We Want to Achieve?

- Draw a global picture of health impacts from risks associated with environmental and man-made (+medical?) sources of ionizing radiation (IR)
- Assist countries in drawing more precise national picture of disease burden caused by IR
- Provide a tool for monitoring progress in environmental management
- Provide a tool for identifying intervention measures
How do we achieve that?

Burden of disease concept

• Quantify disease burden from IR exposure
  ■ Use **health summary measures** (disability, mortality)
  ■ Use same methodology for comparison between populations

• Quantify impact of interventions
  ■ Estimate health gains after specific interventions
  ■ Estimate health gains for different policy scenarios
Health Summary Measures

- Combine information on mortality and morbidity to represent population health in one single indicator

- Indicators – Healthy life expectancy (HLE), Active life expectancy (ALE), Healthy life loss (unit - DALYs), etc.

  - Allow to compare different health outcomes
  - Compare health of several populations
  - Estimate health trends of one population
Disability-Adjusted Life Years - DALY as a Unit for Healthy Life Loss

DALY = YLL + YLD

- years of life lost because of premature death (YLLs)
- years of life lived with disability (YLDs)

Burden = Mortality + Disability

- One DALY = one lost year of healthy life
  - Death of a male at 50 = 30 DALYs
**DALY = YLL + YLD**

- **YLL** = \[ \sum_{x=0}^{L} N_x (L - x) \]
  - Where:
    - \( YLL \) = years lost due to premature mortality
    - \( N_x \) = number of death at age \( x \)
    - \( L \) = standard life expectancy, years

- **YLD** = \[ \sum I_i \times DW \times l \]
  - Where:
    - \( YLD \) = years lived with disability
    - \( I_i \) = number of incidence cases of \( i \) condition
    - \( DW \) = disability weight (0-1)
    - \( l \) = duration of disability, years
Approaches to GBD Assessment

- Choice of indicators (UNSCEAR, 2000)
- Exposure Assessment (National? Regional?)
- Dose-Response Relationships, RR models
- Extrapolation to data-poor population groups
  - make reasonable assumptions
  - cannot always extrapolate
- DALY calculations by gender and age categories
- Peer review the results and reports
Categorizing Risk Factors:

- **By origin**
  - Natural background radiation
  - Radioactive pollution
  - Medical applications
  - Occupational exposure

- **By exposure way/radiation type**
  - external (gamma, X-ray)
  - internal (beta, alpha)
  - combined

- **By effect**
  - lung cancer (Rn-222)
  - thyroid cancer (I-131)
  - other
Method for GBD assessment

Exposure distribution

Dose-response relationship

Proportion of the population

50  100

Effective equivalent dose, mSv

Relative risk

%
Formula for Impact Fraction

\[
IF = \frac{\sum (Pe_x \cdot RR_x) - 1}{\sum (Pe_x \cdot RR_x)}
\]

Where:
- \( X \) = exposure level / dose
- \( Pe_x \) = prevalence of exposure at level \( x \)
- \( RR_x \) = RR at exposure level \( x \)

And finally:

Attributable burden = Disease burden \( \times \) IF
Exposure-based approach

IF = \frac{\sum (Pe_x \cdot R_x) - 1}{\sum (Pe_x \cdot RR_x)}

WHO: Attributable fraction or incidence

IAEA: exposure distribution in the population

UNSCERAR: dose-response relationship

WHO & NHS: Disease burden estimates per disease

Proportion of the population

Relative risk

End point:
Estimation of disease burden attributable to IR, DALYs

Incidence
Mortality
Summary

- Basic methodology is relatively simple
- Accuracy will depend on quality and quantity of data assessment
- Approximate (or preliminary) and more refined assessments are possible, depending on data input
- Assessment may be done at regional or national levels