Status of Levels and Effects of Non-Ionizing Radiation

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World Health Organization
Outline

- Introduction

- Sources and health effects
  - Static fields
  - Extremely low frequency fields
  - Radiofrequency fields
  - UV radiation

- Recommendations
HIGHLIGHTS

Somalia is again polio-free
25 March 2008 -- With no new cases reported in a year, Somalia is again polio-free, the Global Polio Eradication Initiative announced today. Some 10 000 volunteers and health workers vaccinated more than 1.6 million children under the age of five to wipe out the disease.
News release on polio in Somalia

Poor sanitation threatens public health
20 March 2008 -- Six out of every 10 Africans do not have access to a proper toilet, according to preliminary data on sanitation in Africa released today. About 2.6 billion people around the world have no access to a toilet at home and thus are vulnerable to a range of health risks.
News release on sanitation

KEY WHO INFORMATION

Director-General
Director-General and senior management

Governance of WHO
WHO Constitution, Executive Board and World Health Assembly

Media centre
News, events, fact sheets, multimedia and contacts

International travel and health
Publication on travel risks, precautions and vaccination requirements

World Health Report
Annual report on global public health and key statistics

World TB Day
How much disease could be prevented by modifying the environment?

Current evidence - best conservative estimate 24%
What is the modifiable environment?

- Pollution
- Occupational risks
- Built environment, incl. housing, land use, roads
- Agricultural methods, irrigation schemes
- Man-made climate change, ecosystem change
- Related behaviour, e.g. handwashing
- UV and ionizing radiation, noise, EMF
- ...
Figure 6  Environmental disease burden in DALYs per 1000 people, by WHO subregion (2002)

DALYs / 1000 Pop.
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200
Radiation

Public Health
- Radon
- UV
- X-rays
- EMF

Public Concern
- EMF
- X-rays
- UV
- Radon
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  - Ultraviolet radiation
RESEARCH

Balance of studies needed

Interaction Mechanisms

- **Induced currents**
- **Induced currents and heating**
- **Surface heating**

Frequency scale:
- 0 Hz
- 100 kHz
- 300 MHz
- 10 GHz

The diagram illustrates the interaction mechanisms at different frequencies, with induced currents and heating occurring across a range of frequencies.
Static Fields (0 Hz)

- **Static electric fields (V/m)**
  - thunderstorms, spark discharges, DC electricity

- **Static magnetic fields (T)**
  - Natural sources, e.g. earth's magnetic field (0.035-0.07mT)
  - Man-made sources:
    - Maglev trains (2 mT)
    - Particle physics (2 T)
    - MRI (0.2 to 8T)
Static Fields
Interaction mechanisms

- Static electric fields
  - Surface charge, no internal fields

- Static magnetic fields
  - Electrodynamical interactions with moving charges such as ions, leading to induced electric fields and currents
  - Magnetomechanical interactions with magnetically anisotropic structures, leading to orientation effects
  - Interactions with electron spin states of some chemical intermediates, leading to possible metabolic changes
Acute effects only likely when there is movement in the field (e.g. motion of a person) or internal body movement (e.g. blood flow or heart beat).

Forces exerted on moving charges in the blood generating electrical fields and currents around the heart and major blood vessels that can slightly impede the flow of blood.

No experimental/epidemiologic evidence is available regarding long-term effects.
Static Fields
Recommendations (EHC 232, 2006)

- Adopt international science-based standards
- Implement protection programs
- Consider licensing of MRI units > 2T
- Fund research on effects of
  - high T machines, pregnancy and interventional practices
- Fund MRI units to collect information on exposure
Extremely Low Frequency Fields
(>0 – 100 kHz)

Sources

- Exposure to power frequencies (50-60 Hz) - Geometric mean values in homes (0.025-0.07 $\mu$T in Europe and 0.055-0.11 $\mu$T in the US)
- Instantaneous values up to a few 100's $\mu$T
- Near power lines, up to 20 $\mu$T
- 1 to 4% children have mean exposures above 0.3 $\mu$T and 1-2% > 0.4 $\mu$T

Industrial Sources

Residential Sources
External ELF magnetic fields induce **electric fields and currents** in the body which, at very high field strengths, cause nerve and muscle stimulation and changes in nerve cell excitability in the central nervous system.
ELF Magnetic Fields
Health Effects

- **Short-term effects**
  - Established biological effects from acute exposure at high levels (well above 100 µT) that are explained by recognized biophysical mechanisms

- **Long-term effects**
  - Consistent epidemiological evidence suggests that an increased risk for childhood leukaemia is associated with chronic low intensity ELF magnetic field exposure
  - However, the evidence for a causal association is weak and the impact on public health uncertain
ELF Magnetic Fields
Health Effects

Long-term effects (Cancer)

- Childhood leukemia
  - ELF magnetic fields classified as Group 2B “Possibly Carcinogenic” based on limited human data (epidemiologic studies) of childhood leukemia and inadequate animal data
  - Other exposures and outcomes considered “inadequate to classify”
    - IARC Monograph (vol. 80, 2002)
    - WHO EHC Monograph (vol. 238, 2007)
- Breast cancer
  - The evidence has been weakened considerably and does not support an association
- Adult brain cancer and leukaemia
  - Overall evidence for an association between ELF fields and risk for remains inadequate
ELF Fields
Recommendations (EHC 238, 2007)

High-level short-term exposures

- Adopt international exposure guidelines
- Develop EMF protection programs, including exposure measurements from high sources

Long-term effects

- Government and industry should monitor science and promote research
- Member States are encouraged to establish effective and open communication programmes
- Low-cost ways of reducing exposures may be explored for new facilities and equipment
Radio Frequency Fields (100 kHz – 300 GHz)

- Telecommunications
- Wi-Fi
- Residential sources
- Commercial
- Broadcasting
- Navigation/Radar
- Emerging technologies

World Health Organization
RF Fields
Interaction mechanisms

● Thermal effects
  – Radiofrequency waves can cause tissue heating, so-called **thermal effects**
  – Heating >1°C activates physiological processes, which can influence activity of the nervous system, influence fertility, fetal development, cause cataracts
  – All established health effects of RF exposure are clearly related to heating

● Non-thermal effects (?)
  – While RF energy can interact with body tissues at levels too low to cause any significant heating, no study has shown adverse health effects at exposure levels below international guideline limits
RF Fields
Health Effects

● Laboratory studies
  – A large number of experimental studies have been performed
  – The majority of studies show no effect of RF at non-thermal levels
    • Several studies that initially have shown effects did not reproduce the results
    • Certain experimental findings indicate effects and need careful follow-up (blood-brain barrier permeability, increased breast tumour development in DMBA treated rats, induction of gliosis in rats)

● Epidemiological studies
  – INTERPHONE (case-control study on link between use of mobile phone in adults and head/neck cancers, led by IARC, 13 countries, final analysis expected 2009)
  – CEFALO (case-control study on link between use of mobile phone in children and head/neck cancers, 5 countries, started in 2005, expected 2009)
  – COSMOS (cohort study, 5 countries, started in 2008, expected to last 20-30 years)
RF Fields
Health Risk Assessment

2006

2007

RF Fields
20.. ?
RF Fields
Recommendations

- **Strict adherence to health-based guidelines**

- **Precautionary measures**
  - **Government**: If regulatory authorities have adopted health-based guidelines but, because of public concerns, would like to introduce additional precautionary measures to reduce exposure to RF fields, they should not undermine the science base of the guidelines by incorporating arbitrary additional safety factors into the exposure limits. Precautionary measures should be introduced as a separate policy that encourages, through voluntary means, the reduction of RF fields by equipment manufacturers and the public.

  - **Individuals**: Present scientific information does not indicate the need for any special precautions for use of mobile phones. If individuals are concerned, they might choose to limit their own or their children's' RF exposure by limiting the length of calls, or using "hands-free" devices to keep mobile phones away from the head and body.

- **Obey local restrictions on mobile phone use to avoid EMF interference**

- **Driving safety**

- **Simple protective measures around base stations**

- **Consultations with the community in siting base stations**

- **Providing information**
Ultraviolet Radiation

Sources of natural and artificial UV radiation
- Solar radiation
- Artificial UV radiation (arc lamps, fluorescent lamps)

Occupational exposure

General Public exposure

80% of UV is received between 10 am and 2 pm daily.

Clean snow reflects up to 80% of sunburning UV.

Over 90% of UV can penetrate light cloud.

UV increases by 4% for each 300 meter increase in altitude.

Shade can reduce UV by 50% or more.

Indoor workers receive 10% to 20% of outdoor worker's yearly UV exposure.

At half a meter depth UV is still 40% as intense as at the surface.

Sand reflects up to 25% of UV.
UV Radiation
Health Effects

- **Beneficial effects**
  - Vitamin D formation by photosynthesis
  - Phototherapy (psoriasis)

- **Detrimental effects**
  - Established as cause of:
    - Skin cancers
    - Erythema - Sunburn
    - Cataracts
    - Other ocular damage
    - Immune system suppression
  - May be responsible for:
    - Increased susceptibility to infectious diseases
    - Reduced efficiency of vaccination programmes
UV Radiation Recommendations

1. Select sunglasses with UV protection
2. Wear a hat for protection
3. Cover up when the sun is strongest
4. Reapply sunscreen after swimming
5. Pack your bag with healthful snacks
6. Longer shorts offer more protection
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Challenges

- Technologies on the market before health evaluation
- Climate change