Unsustainable Energy - nuclear energy: women and men's different health risks from nuclear radiation

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Health damage from ionizing radiation

Nuclear energy presents a highly significant health and environmental risk. Human health is impacted negatively by exposure to nuclear materials at all stages of the nuclear cycle, from the mining of uranium, through to the production of atomic weapons, the generation of nuclear power and the storage of nuclear waste.

Ionizing radiation is able to damage chemical structures of human cells. When cells or their DNA are damaged, the natural cellular process tries to repair the damaged areas. The mutated cell may die, or if successfully repaired and survives, the mutated DNA can accumulate in the body through subsequent cell divisions that can potentially lead to cancer.

Low levels of radiation and health damage

The way in which radiation affects health is dependent on several factors relating to exposure, the type and intensity of radiation, as well as the length of stay in radiated areas. The level of exposure relates to the proximity to the source of radiation and to weather conditions (such as rain and wind). After nuclear accidents most health effects appear a number of years later, often in the next generation. In fact, the lower the levels of radiation a person is exposed to, the longer the latency period, and the later the disease is likely to be detected.

Ionizing radiation has both direct and indirect health effects, which are known as 'deterministic' and 'stochastic' effects respectively. For deterministic effects there is a direct link between cause and effect. For example, in Chernobyl, 28 power plant workers died after massive exposure to radiation (0.8-16 Gy). Stochastic (or chance) effects entail a latent response in which the probability of developing a disease, such as cancer, cataracts, heart or vascular disease, increases later in life. However, the origin of the disease is difficult to trace back to radiation, because these diseases can also have other causes. The largest stochastic effect in Chernobyl was the dramatic increase in thyroid cancer in the area surrounding the power plant.

Reproductive health damage from radiation

Equally dangerous impacts include non-carcinogenic diseases. For example, the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) estimates that between 30,000 and 207,500 children have been born with genetic mutations due to nuclear radiation from the Chernobyl disaster.

One specific consequence of radiation is its effect on reproductive health. After Chernobyl a lower fertility rate was observed in affected areas, while the number of stillbirths increased dramatically. Additionally in remote areas of Poland, there were fewer live births in 1986 compared to previous years. In the Chernobyl region there were also indications of many miscarriages (natural aborted pregnancies), and the number of miscarriages in Western Europe also increased as a result of the Chernobyl disaster.

Women and Children's greater health risk

It is notable that women and children suffer greater health damage from radiation. For example, cancer incidence and death as a result of exposure to radiation is higher for women as it is for men.[1]
The NAS[2] report 2011 finds that harm to women (cancer) is 50% higher than the comparable harm to men from radiation doses that fall within the legal limit to the public over a lifetime [p.1]. The risk depends on both sex and age at exposure, with higher risks for females and for those exposed at younger ages [p.7].The excess risks appear to be higher in populations of women treated for benign breast conditions, suggesting that these women may be at an elevated risk of radiation-induced breast cancer. Radiation sensitivity depends on age and gender, and is especially high for the unborn child and female organs. The higher sensitivity of women is a result of, among others, hormones and cell growth in certain tissue, for example in breasts.

The latest research clearly shows that current radiation protection is insufficient to protect the unborn child effectively. Radiobiological research focuses mainly on malformations that may occur during the organ formation in weeks three to seven[3]; mental retardation, which usually occurs during week eight to 15 or in a weaker form in weeks 16 to 25[4]; and cancer in children, especially leukaemia, which may occur anytime during the pregnancy and is induced by low radiation doses[5].

Perinatal mortality due to Chernobyl and above ground nuclear tests

A number of academic research projects have shown that the effects of low-level radiation on a foetus can be terminal. After the accident in Chernobyl, Germany witnessed a highly significant correlation between exposure of pregnant women to caesium and perinatal mortality seven months later[6]. A local connection between caesium soil exposure in Bavarian districts and increase in rates of perinatal mortality in 1987 was reported[7]. In one particular area of Bavaria, where there was a 0.5 mSv per year increased background radiation, the infant mortality was significantly higher (15.7 %) than in the rest of Bavaria[8]. As a consequence of above-ground nuclear tests, West Germany also showed a marked increase in perinatal mortality around the year 1970, against an otherwise steady downwards trend. The deviation from the trend correlates with the calculated strontium concentration in the pregnant women[9].

[1] Biological Effects of Ionizing Radiation (BEIR) VII, Phase 2 report, "Health Risks from Exposure to Low Levels of IonizingRadiation," published by the National Academy Press in 2006, Washington, D-C.
[2]Mary Olson, NIRS Briefing Paper October 2011 - www.nirs.org/radiation/radhealth/radiationwomen.pdf
[3]Körblein A. 2001. Malformation in Bavaria Following the Chernobyl Accident. 3rd Inter. Conf. Health Effects of the Chernobyl Accident: Results of the 15-year Follow-Up Studies. Abstracts. Intern. Journal of Radiation Medicine, 4 - 6 June 2001, Kiev, Ukraine.Special Issue, Vol.3, No. 1-2, 2001.Pg 66
[4]Douglas A., Eglund L., Palme M., Chernobyl´s Subclinical Legacy: Prenatal Exposure to Radioactive Fallout and School Outcomes in Sweden, Preprint: Chemistry World, August 11, 2007
[5]seefootnotes 5 and 6
[6]Körblein A., Küchenhoff H., Perinatal Mortality in Germany Following the Chernobyl Accident. Radiation and Environmental Biophysics (1997) 63: 3-7
[7]Scherb H., Weigelt E.,Brüske-Hohlfeld I., Regression Analysis of Time Trends in Perinatal Mortality in Germany 1980–1993. Environmental Health Perspectives (2000), 108: 159-165
[8]Körblein A., Hoffmann W., Background Radiation and Cancer Mortality in Bavaria: An Ecological Analysis. Archives of Environmental & Occupational Health (2006) 61: 109-114
[9]Körblein A., Perinatal Mortality in West Germany Following Atmospheric Nuclear Weapons Tests. Archives of Environmental Health (2004) 59: 604-609

Children are especially at risk from radiation, because there is more cell division during childhood growth and development. Dividing cells are more susceptible to mutation than resting cells. Furthermore, cells only acquire the ability to recognize and repair damaged cells during childhood — embryos do not yet have this function. In addition, growing children assimilate more nutrition into the body than is released, therefore substances which are contaminated will be more readily incorporated. For example, the thyroid gland of growing children quickly takes up iodide. UNSCEAR suspects that the consumption of radioactive iodide in milk is responsible for the high number of thyroid cancer cases diagnosed between 1991 and 2005 in children who were younger than 18 years when the Chernobyl disaster occurred.

In an epidemiological investigation, the KiKK study focuses on childhood cancer in the proximity of nuclear power plants. Mandated by the Federal Office for Radiation Protection, the KiKK study is conducted by the German Childhood Cancer Registry and is the most extensive study on these types of cancer cases. A main conclusion of the study is that the risk of developing leukaemia increases in relation to one's proximity to a nuclear power plant.

Case-Control-Study: increased child leukaemia near nuclear power plants

The cancer rate in children under five living within 5 km of German nuclear power plants is highly significant at 60%[10], and the leukaemia rates are also significantly high at 120%[11]. The risk increases significantly in relation to proximity to the site. These are the results of a case-control-study, the so-called German KiKK-study (Children near Nuclear Plants study: **K**inderkrebs in der Umgebung von **K**ern**K**raftwerken = Childhood Cancer in the Vicinity of Nuclear Power Plants)[12]. This study pinpointed the distance of individual case-homes from each of the 16 German nuclear power plants, meaning that it was better able to classify exposure than former ecological studies, which used approximate distances. When using the weaker ecological approach with the same data, one finds only a non-significant increase[13] in leukaemia, in comparison to the highly significant 120 % increase in risk found in the superior case-control analysis. Subsequent studies from other European countries suggest that children living near nuclear sites are at no greater risk than other children. The combined analysis of data from Great Britain, France, Switzerland and Germany yields a highly significant 44 % increase of leukaemia risk in young children within 5 km of nuclear power plants and a significant increase of risk with proximity to the site[14].

Radiation harm includes not only cancer and leukaemia, but reduced immunity and fertility, increases in other diseases including heart disease, and birth defects including heart defects and other mutations. For example, radioactive contamination of pregnant women in Chelyabinsk, Russia, has resulted in mutations of chromosomes which have been transmitted through three or four generations.[15]

Reproductive health risk from radiation exposure is different for men and women. Men's

[10]Spix C., Schmiedel S., Kaatsch P. et al., Case-Control Study on Childhood Cancer in the Vicinity of Nuclear Plants in Germany 1980 – 2003. European Journal of Cancer (2008) 44: 275-284

[11]Kaatsch P., Spix C., Jung I., Blettner M., Leukaemia in Young Children Living in the Vicinity of German Nuclear Power Plants. International Journal of Cancer (2008) 122: 721-726

[12]Kaatsch P., Spix C., Jung I., Bletttner M., Childhood Leukaemia in the Vicinity of Nuclear Power Plants in Germany. DeutschesÄrzteblatt International (2008 Oct.) 105(42): 725-732 *and also footnote 7*

[13] See foonote 9.

[14]Körblein A., Fairlie I., Letter to the Editor: French Geocap Study Confirms Increased Leukemia Risks in Young Children Near Nuclear Power Plants. International Journal of Cancer (2012 Apr 11) doi: 10.1002/ijc.27585

[15] Tomsk research quoted in WECF factsheet on nuclear industry and health: www.wecf.eu/english/publications/index.php

reproductive health must also be affected radiation but there is a need for more gender based research in this area.

Nuclear industry workers and health risk

The effect of low exposure is doubly underestimated. Recent studies confirm increased cancer development in nuclear plant workers. The life span working doses, that are permitted within the current threshold limits, lead to increased cancer rates (ICPR 2007)[16]. Increasingly workers in nuclear power-plants are hired on a casual basis from subcontractors, most of them are men and difficult to trace, so that the health impacts from radiation are not registered.

Radon and health risk

Lung cancer risk also increases in response to exposure to radioactive radon gas in houses, which exists in many areas in the world but far too often inhabitants are not informed nor aware of the risks. Radon is also often found in regions where uranium is mined. The risk from radon increases by roughly 8% per 100 Bq/m^3. An increase of between 100 and 200 Bq/m^3 shows additional cancer illnesses (ICPR 2007).

Uranium and health risk

Uranium mines also pose a health risk for workers and surrounding communities, and can impact trans-boundary pollution. Although uranium mining releases less radiation than a nuclear accident, small doses of radiation can still affect health in the long run. The danger is magnified in cases where safety measures are inadequate (eg. there are underground mines with a lack of ventilation, radioactive raw metals, high amounts of uranium in drinking water, and open mining dumps). A study in Kazakhstan showed that the frequency of chromosomal anomalies in uranium miners was positively correlated with the duration of exposure.

"Stalkers" in area of uranium tailing: Kadzhi-Saj (Kyrgyzstan).
Locals gather metal at the old mines of uranium to survive in

Heaps of low grade uranium ores in Taboshar, Tajikistan, 2004
Photo: University of Joseph Stefano, Slovenia (Stegnar)

[16]ICPR recommendations presented 19th of June 2007 in Berlin, Germany. The International Commission for Radiation Protection (ICRP) presented new basic recommendations and the latest academic research results into radiation induced cancer and connections to radiation sensitivity.

Case study - *Nuclear Waste and uranium tailings*: Inadequate storage of nuclear waste is a particularly prevalent problem in Central Asia. In Kazakhstan, Kyrgyzstan, Uzbekistan and Tajikistan, more than 812 tons of radioactive waste is stored in open and closed uranium mines. These tailings should be cleaned up, but are not as it is extremely costly. Tailings are often found in the immediate vicinity of residential areas and some are even used as playgrounds, pastures or farmland. Unfortunately, people living in poverty are seen to scavenging for scrap metal in uranium tailing areas. The metal is radioactive but is then sold and used by people who are not aware of the health risks, which they are bringing into their lives. Unfortunately, the Kazakh government has ambitious plans to increase mining of uranium and nuclear power plants construction, thus further increasing the health risk and damage to livelihoods of people living in the proximity to these nuclear sites.

Radioactive waste and health risk

Another large risk exists in relation to the storage of radioactive waste and slurry. In the production of yellowcake (yellow uranium concentrate), waste by-products called tailings are left over. Consisting of heavy metals, arsenic and other chemicals, tailings still retain 85% of the original radioactivity. When improperly covered, the surface of the tailings dries up, and uranium- and arsenic-laced dust can be blown across the landscape. Additionally, radon gas, a decomposition product, is released from reprocessing facilities and radioactive waste dumps in significant quantities. As explained above, long exposure to radon gas can increase the risk of developing lung cancer and other types of cancer.

Case Study – Pollution from nuclear weapon testing in Central Asia

During the Soviet period, Kazakhstan's steppes with rural indigenous population were used as the nuclear weapons test site - the Semipalatinsk Polygon. The cumulative dose of radioactive fallout is estimated as equivalent of 2500 bombs dropped on Hiroshima by the US Army. In fact, the real levels of radiation are not known till present days as most of the data was classified as secret and cannot be retrieved up to date. As this catastrophic legacy of the Soviet Union continues, the victims of radiation in the second generation suffer even more than the first generation victims. The mutated DNA structures carry on from one generation to another. Shockingly, a recent study in the villages around the Polygon area shows that in addition to high rates of deaths from cancer, thyroid problems, and other diseases high levels of suicide cases among young men are reported by the villagers. Recently there were attempts by the Kazakh government to proclaim the lands of the former Polygon again suitable for agriculture and inhabitation. Luckily, this initiative was stopped by civil society organisations. The current radiation and problems continue and will be borne by future generations for ages to come.

Use of depleted uranium by military – inacceptable health risk

Military operations using depleted uranium (DU), which is a by-product of enriched uranium production, also have significant impacts. Uranium itself is a toxic heavy metal, which accumulates in the bones and can induce a variety of diseases such as cancer, genetic disorders, and the disruption of function in the kidney, liver, and lungs. DU induces both

chemotoxic and radiotoxic effects on the body. The former predominantly disrupts liver and kidney functions, while the latter can induce chromosomal and genetic disorders, for example, chromosome breakage. People mainly affected by this are soldiers and civilians in war zones. Projectiles that do not reach their target stay in the ground where the effects are unknown. In addition, after the use of uranium munitions in military operations, radioactive DU particles are released into the air and water. These particles affect people directly, but also enter into the food chain and bio-accumulate in animals and people. The exact effect on human health is uncertain.

Lack of radiation protection

Regulations and institutions mandated to deal with radiation protection are weak. In most countries, radiation protection regulation is based on the recommendations of the International Commission for Radiation Protection (ICRP). Unfortunately, the ICRP is too slow when it comes to updating its recommendations in relation to new scientific evidence concerning radiation health damage. Also, a 50-year old agreement between the World Health Organisation (WHO) and the International Atomic Energy Agency (IAEA), which has turned into a lobby group for the nuclear industry, means that there is now a lack of international guidelines on the protection of health from radiation.[17]

In general, the ICRP bases its recommendations on the dose reduction factor DDREF (dose and dose-rate effectiveness factor). The factor (DDREF = 2) halves the risk per unit dose at low doses or low dose rates. Unfortunately, the use of dose reduction factor DDREF is not based on scientific findings and not based on observed data of cancer induction. The rate of cancer induction at low doses and low dose rates is estimated by extrapolation from observations at high doses. A simple extrapolation estimate is provided by the widely adopted no-threshold "linearity hypothesis", according to which the risk is proportional to the radiation dose. Only linearity allows averaging the dose, which is widely practised in radiation protection.

For example, the ICRP has only provided an estimation of the slow-burn stochastic radiation risk of induced cancer and leukemia (and it has not even provided this for other diseases). New data on atomic bomb survivors, on the population exposed by the accident in Chernobyl, and on patients who received therapeutic exposures, has led to reconsideration of possible impacts, such as radiation-induced cardiovascular disease and circulatory disease. It is also known that the threshold dose of radiation-induced eye cataracts is now considered to be about 10-times lower than formerly estimated; it may now be recognised as a malignant stochastic effect of radiation exposure.

Women's rights and radiation protection

It is critical that women have equal protection under the law. In all countries, regulation of radiation and nuclear activity ignores the disproportionately greater harm experienced by both women and children.[18] Current radiation protection fails to take into account the fact that women have a 50% higher risk from radiation then men. Instead, an 'average' sensitivity is calculated which is considered equally applicable to men and women. In reality this means that women are being afforded less protection than men. A more sensible approach would be to differentiate between men, women and children within the calculation.

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[17] Appeal by Health Professionals for the Independence of WHO, launched in 2007, http://www.cwhn.ca/en/node/40679

[18] The background for some recommendations include calculations of the different radiation effects on women and children but the final 'allowable' doses to the public do not incorporate this information.

Women should have equal protection under the law, and regulation should be strengthened to protect those most at risk from ionizing radiation: women and children.

Women's right to know about the health risks they are faced with when exposed to ionizing radiation and how to protect themselves from this harm, should also be implemented.

It is wrong to argue — as some regulators do — that if women were subject to different threshold limits they would be discriminated against in their profession. The right to equal opportunity would be breached. This is absurd. Correctly interpreted equal rights can only be achieved through better protection of women. Women are being discriminated against if the variation in radiation sensitivity is *not* included in radiation protection.

Conclusions

Energy policies decisions, especially on nuclear energy, should take into account the costs and risks in the entire process from mining to final disposal. Externalities have to be included. Women and the developing child have a high risk of developing cancer from exposure to radiation. Considering the lessons-learnt from nuclear accidents it has become evident that nuclear energy can not respect the human right to life and to a healthy environment, not for todays generations nor for future generations. Women play vital role in all these areas. Women's voices need to be equally reflected in energy policy decisions.

Radiation risks resulting from unsustainable economic and political activities can be and should be reduced. It is vital for legislators to realize that there is no 'safe' level of radiation. It harms people and all living beings for centuries, and no short-term economic or political benefits can justify the sacrifice of life and health. Therefore, a global phase-out of nuclear energy and prevention of nuclear arms proliferation is the only acceptable path to true sustainable development of the global community. The following steps have to be taken by the governments immediately:

Recommendations

- **Strengthen radiation protection legislation**, taking into consideration the higher radio-sensitivity of the developing child and of women working within radioactive areas, and the likelihood of other non-malign illnesses being caused by chronic radiation exposure.
- **Revise the threshold dose limits** in line with current radiobiological knowledge especially in relation to radiation-induced cancers.
- **Abolish the scientifically unproven dose-reduction-factor** DDREF in low-dose ranges as used by ICRP. Instead adopt a linear dose-response-relationship (until the scientific knowledge brings new evidence).
- **Implement women's right to know about the health risks** associated with women's exposure to ionizing radiation and how they might protect themselves from this harm.
- **Regulate the nuclear energy sector** to increase protecting of workers in particular interim workers from subcontracting companies
- **Provide full information on costs** including externalities of the entire nuclear energy cycle, including the costs of decommissioning nuclear power plants and long-term safe storage of nuclear waste, as a basis for energy policy decisions
- **Hold nuclear polluters accountable, ensure full redress** and damage payment to affected populations, apply the precautionary principle, abolish legislation which frees nuclear industry from insurance payments for accidents and ensure equal participation of women and men in decision making.

Sources:

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