



# **Health Risk Assessment from the nuclear accident after the 2011 Great East Japan Earthquake and Tsunami based on a preliminary dose estimation**

## **EXECUTIVE SUMMARY**

### ***Introduction***

The earthquake and tsunami in Japan on 11 March 2011 led to releases of radioactive material into the environment from the Tokyo Electric Power Company's Fukushima Daiichi nuclear power station.

A major release of radioactivity to the environment is always of concern, owing to potential acute and long-term health effects. Evidence from historic events confirms that any major uncontrolled release of radiation should be cause for immediate response and scientific assessment of potential health effects.

When such an event occurs, the World Health Organization's mandate, as described in the Joint Radiation Emergency Management Plan of the International Organizations, is to assess and respond to public health risks.

The primary purpose of this health risk assessment of the Fukushima Daiichi nuclear accident is to estimate its potential public health impact so that future health needs can be anticipated and public health actions can be taken. This assessment is based on a preliminary estimate of radiation doses, as described in a WHO report published in May 2012.

### ***Methods***

This health risk assessment was conducted by independent international experts who were selected by WHO for their expertise and experience in radiation risk modelling, epidemiology, dosimetry, radiation effects and public health. All experts completed a declaration of interests form. The group met in December 2011 and March 2012. At both meetings, observers were in attendance from the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), the International Labour

Organization, and the Government of Japan. The observers participated in discussions and sharing of data but were not involved in the decision making process.

The risk assessment was made using four steps:

- The specific radiation sources, such as different radionuclides and pathways of exposure, were identified (hazard identification).
- The types of harmful effects that could result were identified based on scientific knowledge about the relationships between radiation dose and biological effects (dose-response relationships).
- Based on the preliminary dose assessment, lifetime organ doses were estimated for the general population within geographical locations ranging from the most affected areas of Fukushima prefecture to the rest of the world. Based on available data on occupational exposure assessed by the operator of the nuclear power station, lifetime organ doses were also estimated for emergency workers (exposure assessment).
- The lifetime risk of cancer was estimated for all solid cancers combined, and also for individual cancer sites most closely associated with radiation exposure and with a known dependence of the magnitude of risk on age-at-exposure (leukaemia, thyroid cancer and female breast cancer). The lifetime risks were estimated for both sexes and three different ages at exposure (1 year [infant], 10 years [child], and 20 years [adult]). Calculations of the cumulative risks for the 15 years following the accident were also performed. Health risks for male emergency workers were estimated for three different ages (20 years, 40 years, and 60 years) (risk characterization).

## ***Findings***

In view of the estimated exposure levels, an increased risk of cancer is the potential health effect of greatest relevance. The relationship between radiation exposure and lifetime risk of cancer is complex and varies depending on several factors, mainly radiation dose, age at time of exposure, sex and cancer site. These factors can influence the uncertainty in projecting radiation risks, in particular when assessing risks at low doses.

Outside of the geographical areas most affected by radiation, even in locations within Fukushima prefecture, the predicted risks remain low and no observable increases in cancer above natural variation in baseline rates are anticipated.

Some health effects of radiation, termed deterministic effects, are known to occur only after certain radiation dose levels are exceeded. The radiation doses in Fukushima prefecture were well below such levels and therefore such effects are not expected to occur in the general population.

The estimated dose levels in Fukushima prefecture were also too low to affect fetal development or outcome of pregnancy and no increases, as a result of antenatal

radiation exposure, in spontaneous abortion, miscarriage, perinatal mortality, congenital defects or cognitive impairment are anticipated.

In the two most affected locations of Fukushima prefecture, the preliminary estimated radiation effective doses for the first year ranged from 12 to 25 mSv. In the highest dose location, the estimated additional lifetime risks for the development of leukaemia, breast cancer, thyroid cancer and all solid cancers over baseline rates are likely to represent an upper bound of the risk as methodological options were consciously chosen to avoid underestimation of risks. For leukaemia, the lifetime risks are predicted to increase by up to around 7% over baseline cancer rates in males exposed as infants; for breast cancer, the estimated lifetime risks increase by up to around 6% over baseline rates in females exposed as infants; for all solid cancers, the estimated lifetime risks increase by up to around 4% over baseline rates in females exposed as infants; and for thyroid cancer, the estimated lifetime risk increases by up to around 70% over baseline rates in females exposed as infants. These percentages represent estimated relative increases over the baseline rates and are not absolute risks for developing such cancers. Due to the low baseline rates of thyroid cancer, even a large relative increase represents a small absolute increase in risks. For example, the baseline lifetime risk of thyroid cancer for females is just three-quarters of one percent and the additional lifetime risk estimated in this assessment for a female infant exposed in the most affected location is one-half of one percent.

These estimated increases presented above apply only to the most affected location of Fukushima prefecture. For the people in the second most affected location, the estimated additional lifetime cancer risks over baseline rates are approximately one-half of those in the highest dose location. The estimated risks are lower for people exposed as children and adults compared to infants.

In the next most exposed group of locations in Fukushima prefecture, where preliminary estimated radiation effective doses were 3 to 5 mSv, the increased lifetime estimates for cancer risks over baseline rates were approximately one-quarter to one-third of those for the people in the most affected geographical location.

Among Fukushima-Daiichi nuclear power station emergency workers, the lifetime risks for leukaemia, thyroid cancer and all solid cancers are estimated to be increased over baseline rates, based upon plausible radiation exposure scenarios. These scenarios and their corresponding estimated risks are detailed in the body of this report. A few emergency workers who inhaled significant quantities of radioactive iodine may develop non-cancer thyroid disorders.

## **Conclusions**

This health risk assessment is based on the current state of scientific knowledge. The assessment models used were derived from previous radiation events and experience, which do not match exactly the pattern of exposure seen in Fukushima; thus,

adjustments were required. The dose estimates and assumptions used in this assessment were deliberately chosen to minimize the possibility of underestimating eventual health risks. The values presented in the report should be regarded as inferences of the magnitude of the health risks, rather than as precise predictions. Moreover, it is also important to note that the exposure data upon which this report is based are preliminary and include only data that were available as of September 2011. Because scientific understanding of radiation effects, particularly at low doses, may increase in the future, it is possible that further investigation may change our understanding of the risks of this radiation accident.

This health risk assessment concludes that no discernible increase in health risks from the Fukushima event is expected outside Japan. With respect to Japan, this assessment estimates that the lifetime risk for some cancers may be somewhat elevated above baseline rates in certain age and sex groups that were in the areas most affected. These estimates provide valuable information for setting priorities in the coming years for population health monitoring, as has already begun with the Fukushima Health Management Survey.

On the basis of these findings, the continued monitoring of food and the environment remains important. When additional dose estimations become available from studies undertaken by UNSCEAR and others, such data can be used to further refine these risk estimates.

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