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## Overview

# Comprehensive Health Risk Management after the Fukushima Nuclear Power Plant Accident

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## Abstract

Five years have passed since the Great East Japan Earthquake and the subsequent Fukushima Daiichi Nuclear Power Plant accident on 11 March 2011. Countermeasures aimed at human protection during the emergency period, including evacuation, sheltering and control of the food chain were implemented in a timely manner by the Japanese Government. However, there is an apparent need for improvement, especially in the areas of nuclear safety and protection, and also in the management of radiation health risk during and even after the accident. Continuous monitoring and characterisation of the levels of radioactivity in the environment and foods in Fukushima are now essential for obtaining informed consent to the decisions on living in the radio-contaminated areas and also on returning back to the evacuated areas once re-entry is allowed; it is also important to carry out a realistic assessment of the radiation doses on the basis of measurements. Until now, various types of radiation health risk management projects and research have been implemented in Fukushima, among which the Fukushima Health Management Survey is the largest health monitoring project. It includes the Basic Survey for the estimation of external radiation doses received during the first 4 months after the accident and four detailed surveys: thyroid ultrasound examination, comprehensive health check-up, mental health and lifestyle survey, and survey on pregnant women and nursing mothers, with the aim to prospectively take care of the health of all the residents of Fukushima Prefecture for a long time. In particular, among evacuees of the Fukushima Nuclear Power Plant accident, concern about radiation risk is associated with psychological stresses. Here, ongoing health risk management will be reviewed, focusing on the difficult challenge of post-disaster recovery and resilience in Fukushima.

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**Key words:** Fukushima; health management; health risk; mental care; radiation exposure

## Statement of Search Strategies Used and Sources of Information

This paper reflects expert opinion and current literature accessed by the authors; no formal search strategy has been defined.

## Introduction

Before the Fukushima Nuclear Power Plant (NPP) accident, we were, unfortunately, enchanted, without reserve, by the myth of the safety of nuclear power in Japan, although the importance of emergency radiation medicine was seriously discussed on the global radiation protection arenas, such as the International Atomic Energy Agency (IAEA) Incident and Emergency Center [1] and the World Health Organization (WHO) Radiation Emergency Medicine Preparedness and Response Network [2]. The WHO International Project on the Health Effects of the Chernobyl Accident had previously identified health issues as a result of the Chernobyl NPP accident [3]. A review of comprehensive health risk management after the Fukushima NPP accident

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[4] and useful information on the radiation risk of childhood thyroid cancer at the standpoint of rehabilitation and revival for Fukushima [5] have also been reported.

One of the most important lessons learned from Chernobyl was to avoid the initial exposure to radioactive iodines released from nuclear accidents, thus reducing or preventing the risk of radiation-associated childhood thyroid cancers [6,7]. Therefore, retrospective analysis of thyroid dose is of paramount importance in Fukushima, and the tentative data available so far have suggested no future possibility of increased risk of childhood thyroid cancer [8,9]. However, psychosocial and mental health consequences, including post-traumatic stress disorders, are very important issues to be solved in Fukushima and are similar to those seen after Chernobyl [10].

Previous epidemiological studies of human health risk from low dose and low dose rate exposure, as well as those on the atomic bomb survivors cohort form a background on which to develop a radiation health management programme. The identification of a cause-and-disease relationship, however, is very difficult after any radiological and nuclear accident because many confounding and modifying factors affect the chance of late occurrence of malignancy. Three recent papers included in the special issues of *The Lancet* commemorating 70 years of caring for survivors of the atomic bombing in Hiroshima and Nagasaki reviewed the health effects associated with exposure to radiation, which can be used to inform the probable consequences of the accident at Fukushima Dai-ichi [11–13]. The accidents at Chernobyl and Fukushima have highlighted similarities in potential public health effects of radiation, including health issues unrelated to direct radiation exposure. Long-term responses are needed in order to overcome the difficult tasks of risk management with respect to health in different categories of Fukushima's residents (evacuees, children, mothers and aged people), and these should be provided to achieve an effective care for the complex problem that people confront [14].

The recent progress of the Fukushima Health Management Survey project will be summarised and discussed here to identify the future direction of appropriate and well-balanced radiation risk management in Fukushima, including the model of recovery used in the village of Kawauchi [15].

## Fukushima Nuclear Power Plant Accident and Radiation Dose

The WHO promptly released its estimation of the doses received by the populations around Fukushima in May 2012 [16]. By applying incomplete data from the System for Prediction of Environmental Emergency Dose Information (SPEEDI) at first and then using the airborne monitoring survey data by the Ministry of Education, Culture, Sports, Science and Technology of Japan (MEXT), based on conservative and theoretical assumptions, not taking into account refuge and sheltering during 4 months after the accident in

the evacuation prepared area or the measures that were implemented to limit the consumption of food and restrictions on shipment, the WHO dose estimates were calculated from the viewpoint of protection. It has been not too surprising that these 'worse case scenario' assumptions resulted in overestimated values. According to these, a 1-year-old child's thyroid equivalent dose was estimated to be in the range of 10–100 mSv in Minami-soma, Iwaki and Iitate-mura, and 1–10 mSv in prefectures adjacent to Fukushima. However, these thyroid equivalent doses are markedly different from the actual values derived from the thyroidal screening and examination with a whole body counter.

According to the report on the thyroid internal exposure examination, which the Japanese Nuclear Safety Commission conducted from 26 to 30 March, just after the accident, a thyroid equivalent dose of 100 mSv was considered to be an overestimate [17]. As a result, there would hardly be any increase in thyroid cancer. On the other hand, according to the report by Hirosaki University [18], the thyroid equivalent dose might have reached several 10 mSv in the infants who stayed within a distance of 20 km from the reactor site at the time of the accident and it is necessary to observe them for a long period of time.

Furthermore, using theoretical assumptions on the preliminary dose estimates mentioned above, the WHO has subsequently reported the projected health risk assessment in Fukushima [19]. The estimates stemming from inappropriate retrospective dose assumptions are far above the reality and may mislead the public into thinking there is a more serious radiation health risk than actually exists. By contrast, according to the United Nations Scientific Committee on the Effects of Atomic Radiation 2013 report [20] and the IAEA Fukushima report [21], no discernible increased incidence of radiation-related health effects is expected on the basis of more accurate dose estimates in Fukushima. Unfortunately, however, the public concern over the fear of childhood thyroid cancer risk due to the Fukushima accident has never disappeared. From now on, it is necessary to develop a consensus of the accurate dose estimation based on the actual conditions, together with the continuation of regular health check-ups in Fukushima.

## Outline of the Fukushima Health Management Survey

Following the Fukushima NPP accidents in March 2011, it became apparent that the residents of Fukushima Prefecture were unavoidably exposed to some amount of radiation fallout, even if this might be comparable with the natural yearly background levels in other areas of the world. Thus, the Fukushima Mimamori Project (Health Management Survey) was initiated in May 2011 to treat and manage residents' long-term health [22]. Owing to the vigorous efforts of the Fukushima Health Management Survey Group, the study protocol reached a mutual agreement with Fukushima Prefecture and was endorsed by international radiation medicine and radiation protection experts [23]. Fukushima

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