

Response to the Letter to the Editor: ‘Absorbed radiation doses in the thyroid as estimated by UNSCEAR and subsequent risk of childhood thyroid cancer following the Great East Japan Earthquake’, by Ohira et al.

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We thank the authors for indicating the comments to be addressed in our manuscript entitled, ‘Absorbed radiation doses in the thyroid as estimated by UNSCEAR and subsequent risk of childhood thyroid cancer following the Great East Japan Earthquake’ [1].

In our study, no dose-dependent pattern emerged from the geographical distribution of absorbed doses per municipality, based on the estimation using UNSCEAR and the detection of thyroid cancer among participants within 4–6 years of the accident, and Scherb *et al.* pointed out that the null finding may in part be attributed to a too coarse exposure stratification and/or the neglect of the pronounced non-linearity of the association [2]. However, analyses should not be performed for exposure stratification with a small number of thyroid cancer cases and a small population size of each municipality, which were too small to enable meaningful stratification analyses in the Fukushima Health Management Survey (FHMS). As shown by Yamamoto *et al.*, the number of thyroid cancer cases was ≤ 9 in 56 of the 59 municipalities and ≤ 4 in 48 of the 59 municipalities in Fukushima [3]. This increases the risk of Type I error, the rejection of a true null hypothesis, leading to false positive. Furthermore, previous studies [3–5], except for ours [1, 6–8], that have explored the associations between radiation doses and thyroid cancer in Fukushima were ecological trials that have used the results of aggregate calculation of the FHMS; therefore, it is impossible to adjust for the confounding factors. Therefore, methodological differences may modify the results.

In the FHMS, the participation rate for the secondary confirmatory examination was different among municipalities (50–100%), and the municipalities exposed to lower doses tended to have a lower participation rate in the confirmatory examination. Moreover, the rate of the aspiration biopsy cytology in the confirmatory examination differed among municipalities, and the municipalities exposed to lower doses tended to have a lower rate of aspiration biopsy cytology. The participation rate in the confirmatory examination and the rate of the aspiration biopsy cytology showed a strong association with the thyroid cancer detection rate [8]; therefore, the prevalence of thyroid cancer in municipalities exposed to lower dose must have been underestimated, leading to ecological fallacy.

As Scherb *et al.* have pointed out, the association between absorbed radiation doses and thyroid cancer in our study was not linear. Compared with the lowest quartile, age- and sex-adjusted relative risks for the 6- to 14-year-old group (95% confidence intervals) with respect to the low-middle, high-middle and highest quartiles were 2.00 (0.84–4.80), 1.34 (0.50–3.59) and 1.42 (0.55–3.67), respectively. The corresponding values for those aged ≥ 15 years were 1.99 (0.70–5.70), 0.54 (0.13–2.31) and 0.51 (0.12–2.15), respectively. Therefore, a consistent dose-dependent pattern was not observed in either the 6- to 14-year-old group or the >15 -year-old group. A previous study analysed pooled data from nine cohort studies on childhood external radiation exposure and thyroid cancer where radiation doses

of <0.2 Gy showed a dose-dependent association between low-dose radiation exposure and childhood thyroid cancer risk [9]. However, the thyroid cancer patients in the study were diagnosed on clinical grounds, and the median age at exposure and diagnosis was 4.9 and 42 years, respectively [9]. In contrast, FHMS diagnosis is on screening grounds and the median age of diagnosis was 12 years. Therefore, a comparison of the findings between the previous study and the FHMS should be avoided. The FHMS performed a short-term study on thyroid cancer; thus, long-term follow-up surveys are needed to clarify the effects of low-dose radiation exposure on thyroid cancer in Fukushima.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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