The merits and limits of pooling data from nuclear power worker studies

Nuclear power plant workers are exposed to various sources of occupational radiation and are a suitable population to investigate the effects of low and protracted exposure. Thus, since the 1970s, analyses have been done of data from a single power plant from one country, several plants from one country, and several plants from several countries. However, comparisons between results are hampered by different designs and different inclusion criteria. Risk estimates vary between studies and larger studies or pooled analyses are needed to increase precision.

International pooling started in 1995, with a study that included data from Canada, the UK, and the USA. Data were later added from a further 12 countries. In The Lancet Haematology, Klervi Leuraud and colleagues present results of extended follow-up for the INWORKS study, including cohorts from France, the UK, and the USA, and by contrast with the previous pooled analysis, included individuals exposed (or likely to have been exposed) to internally deposited radionuclides or to neutrons were included, which tripled the person-years available and increased the number of deaths despite a reduced number of workers included.

The results show an increased risk for leukaemia, with an excess relative risk of 2.32–3.68 per Gy depending on the latency period, whether socioeconomic status and internal deposition were adjusted for, whether the analysis was restricted to different dose ranges, and whether all or only two countries were included in the analysis. Most of these excess risks were statistically significant, but they were based on 90% CIs. In total about 70 CIs were presented in the paper. With this high number of statistical tests the chance of finding statistically significant results is high, so the danger of false positives is not negligible and should be taken into consideration when interpreting the results.

The study provides supportive evidence on the radiation risks of leukaemia after exposure to low doses, using a large dataset and adequate statistical analysis. But limitations of this type of cohort study of nuclear workers have been discussed by Leuraud and colleagues and other investigators before, and they somewhat hamper the study’s conclusions.

Heterogeneity between countries is present but not well understood, and its assessment can be a major challenge for a pooled analysis. The contribution of errors in the outcome variable (death certificates from different countries covering more than 50 years are included) is not known. Confounding by socioeconomic status and other lifestyle factors cannot be assessed completely. Additional risk factors, such as exposure to benzene and medical exposure to ionising radiation are not taken into account. Internal exposure to radionuclides, uranium, and plutonium are neither qualitatively nor quantitatively evaluated.

Background radiation exposure might be larger than occupational exposure and was not incorporated into the analysis.

In my view, to properly understand the mechanisms and effects of low-dose radiation, we need new data collected by comparable methods for all participants: excellent dosimetry for internal and external exposure, including organ doses, data for exposure to ionising radiation from other sources such as medical and background exposure, data on other known occupational risk factors, lifestyle factors, biological material, genetic markers, and medical history, including information on screening and medical care. We need longitudinal (prospective) data (as we have from atomic-bomb survivors in Japan) to help us understand the dose–response relationship, interaction and confounding, and outcome pathways. We also need more sophisticated statistical analyses: not only for dose measurement errors, but also to deal with confounding, with errors in the outcome variable, with heterogeneity, multiple testing, and to model the dose–response relationship.

Workers and the public can be protected from radiation by controlling the dose to prevent adverse health effects, mainly cancer; however, a better understanding of the effect of low-dose radiation is warranted. Large studies like INWORKS support current risk estimates, but new, creative prospective studies that include biological material and collaboration between radiation biologists and radiation epidemiologist are needed to clarify how low-dose radiation affects human beings.
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I declare no competing interests.

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8 Boice J. The importance of radiation worker studies. J Radiol Pro 2014; 34; E7–12.
