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Unraveling radon-related lung cancer mortality risks affected by smoking: a WISMUT cohort study

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We have developed a technique to account for missing information on smoking habits in the quantification of lung-cancer risks related to the exposure to radon and its progeny. Such risk calculations are often based on epidemiological miner-cohort studies, but contrary to the exposures to radon, cohort-wide information on the tobacco consumption –a crucial factor in lung-cancer induction –is generally missing.

As a proof of concept, we have applied our model to a large cohort of male uranium miners who were employed at the WISMUT Company in the former German Democratic Republic. The cohort comprises over 35,000 former employees among whom 461 died from lung cancer in the follow-up period 1955-1998. Most of them had been exposed to uranium ore dust, radon and its progeny, and to unknown quantities of tobacco smoke. The missing information on smoking has been partly retrieved in a case-control study. The relevant smoking parameters are assembled in so-called smoking-status spectra that are next projected onto the entire cohort using a Monte-Carlo sampling method. The randomly assigned smoking behavior serves as a proxy for the missing information and is used as an input for subsequent lung-cancer risk analysis by means of a two-mutation carcinogenesis (TMC) model.

An ensemble of 200 independent smoking-projections and subsequent TMC calculations yields frequency-density spectra of the TMC-model parameters. These are found to vary not much more than a factor ~2 from their respective mean values. Based on these mean parameter values, separate lung-cancer risk calculations with respect to the exposure to radon, tobacco-smoke or a combination of both can be performed. The presented mapping technique hence enables us to unravel risks related to the delicate interplay between radon and tobacco-smoke exposure.

In order to increase the statistical power of this study and to include higher radon exposures, we have also modeled an extended cohort of 58,987 former, male WISMUT employees with 3,016 lung-cancer deaths in the follow-up period 1946-2003. Preliminary results of this study seem to indicate some intriguing differences with respect to those of the smaller WISMUT cohort.

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