Uncertainties in radiation exposure assessment in the Wismut cohort: a preliminary evaluation

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1 Background

The German "Wismut" cohort is one of the largest cohort studies of uranium miners who have been occupationally exposed to radon [1]; the cohort includes 58,974 males accumulating over 2 million person years at risk (follow-up period 1946-2013). A job-exposure matrix (JEM, [2, 3]) was created for exposures to radon and its progeny, external gamma radiation and long-lived radionuclides. According to the availability of radiation measurements, different approaches of exposure assessment were developed. Individual radiation exposure in the Wismut cohort was calculated based on the JEM and individual job histories.

The elaborated exposure assessment procedure provides well-grounded exposure estimates, but may involve potential uncertainties. Numerous risk analyses for lung cancer mortality (e.g. [4]) and other diseases have been performed depending on radiation exposure, but so far without adjustment for such uncertainties. This work is a first step towards accounting for uncertainties in radon exposure in risk analyses for lung cancer mortality in the Wismut cohort. Potential sources of uncertainty were identified and preliminarily evaluated.

2 Identification and preliminary evaluation of the sources of uncertainties in exposure assessment

The exposure assessment procedure for the Wismut cohort can be structured as shown in Figure 1, pointing out two main types of uncertainty.

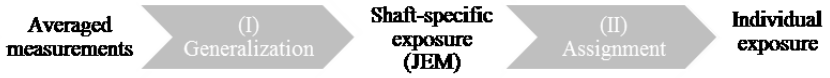

Fig. 1. Main steps in exposure assessment for the Wismut cohort.

The structure of uncertainties is complex because the multi-stage exposure assessment varies over time and depends on the working conditions and thus, involves different types

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and sizes of errors. Errors in the exposure assessment may arise from the generalization of single exposure measurements (generalization error), from the assignment of general exposure estimates to single miners (assignment error) and from estimation errors (procedural measurement error, documentation error, parameter uncertainties, experts' evaluation error, transfer error, approximation error) in all stages of the exposure estimation process. The preliminary evaluation of the relevance of the uncertainties is shown in Table 1.

Tab. 1. Preliminary evaluation of the potential sources of uncertainties in the exposure assessment for the Wismut cohort.

Type of uncertainty	Details	Relevance
Generalization error	Usage of averages of single values for shaft-specific exposure assessment	major
Parameter uncertainties	Uncertainties in the determination of parameters, e.g. evaluation factor, activity factor	major
Assignment error	Assignment of group-specific values to an individual	medium
Transfer error	Data transfer to another calendar year or object	medium
Documentation error	Documentation of measurements and occupational histories	medium-minor
Experts' evaluation error	Determination of exposure values by experts	minor
Procedural measurement error	Human and technical errors in the measurement procedure	minor
Approximation error	Approximation through estimation equations and rounding	minor

These findings contribute towards the specification of a measurement error model, which is necessary for the estimation of lung cancer risk depending on radon exposure taking measurement error into account.

References

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