**Bayesian hierarchical approach to account for radon exposure measurement error when estimating the risk of death by lung cancer in an occupational cohort study.**

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**Abstract**:

**Introduction:** Despite its deleterious consequences for statistical inference and its ubiquity in observational research, exposure measurement error is rarely accounted for in epidemiological studies. Standard correction methods, like regression calibration or SIMEX, often lack the flexibility to account for complex patterns of errors whose type and magnitude may change over time.

**Methods:** We proposed several Bayesian hierarchical models, combining a survival submodel with time-dependent covariates, a measurement submodel and, when required, an exposure submodel, to obtain a corrected estimate of the potential association between chronic exposure to radon and lung cancer mortality in the French cohort of uranium miners. An adaptive Metropolis-Within-Gibbs algorithm was developed in Python to fit the proposed hierarchical models whose predictive performances were compared using the Widely-Applicable Information Criterion, A simulation study is underway to assess the impact of submodel misspecifications on risk estimates.

**Results:** In our application, one observed a marked increase in the excess risk estimate for lung cancer mortality when compared with an approach where radon exposure measurement error was not accounted for. As expected, the width of the credible intervals increased after accounting for measurement error but the estimated excess risk remained statistically significant. A sensitivity analysis showed that the posterior distribution of the excess risk were quite robust to the magnitude of the exposure measurement error.

**Conclusion:** Bayesian hierarchical models are an elegant way to account for exposure measurement errors in health risk estimates. Modelling exposure measurement error in a retrospective cohort study is often limited due to loss of information.

**Keywords**. Bayesian inference, Epidemiology, Hierarchical modelling, Measurement error, Survival model