

### Lung Cancer Risk from Radon among European Uranium Miners - Modifying Effects of Time and Age at Exposure

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Epidemiological evidence of lung cancer risk from radon is known since the early 1960s, when first studies on uranium miners were published. The risk was modeled in terms of relative risk in dependence on cumulated exposure. Since then, follow-up of studies has been extended, which allowed the analysis of modifying factors such as time since exposure (TSE), age at exposure (AE), attained age, and exposure rate. The present analysis was conducted in the frame of the Alpha-Risk European research program and aimed at estimating the lung cancer risk associated to radon exposure among miners with low levels of exposure and good quality of exposure assessment. The large numbers of miners included in the joint study allow a simultaneous analysis of modifying effects using exposure windows, which are appropriate in studies with protracted exposures. The analysis is based on three European cohort studies of uranium miners: Czech, French and German, including 9979, 5086 and 35084 miners, respectively. By the end of follow-up, 921, 159, and 458 lung cancer deaths were observed in these cohorts, respectively. The excess relative risks per working level month (ERR/WLM) for the three studies were 0.0116 (95%CI 0.0076-0.0157), 0.0061 (95%CI 0.0018-0.0105), and 0.0043 (95%CI 0.0028-0.0057), respectively. The different estimates are caused mainly by the so-called inverse effect of exposure rate and by quality of exposure, which both are correlated with time since exposure. We evaluated simultaneously the effects of TSE in 3 windows (5-19 years before, 20-34, 35+) and of AE in 3 windows (-29 years, 30-39, 40+). The analysis showed a strong decrease of the ERR/WLM with TSE (28% in period 20-34 years and 11% after 35 years in comparison to window 5-19). The simultaneous effect of AE was also significant: ERR/WLM for AE more than 40 years was 53% of that for AE below 30). These results will permit to improve our knowledge on the long-term risks associated to radon exposure. The present work was supported by the European Commission (Contract FI6R 516483).