

# Risk from Occupational and Environmental Radon and Role of Smoking



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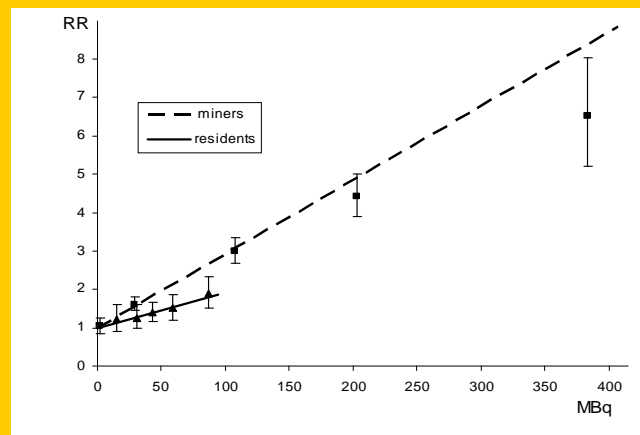
Cohort of uranium miners (N=9978)

Residential cohort (N=11 842)

Period	PY	All		Lung		PY	All		Lung	
		causes	SMR	cancer	SMR		causes	SMR	cancer	SMR
1952-59	15 323	102	1.46	18	4.78	61 030	717	0.92	32	0.87
1960-69	39 375	521	1.84	212	9.15					
1970-79	70 993	934	1.66	246	5.39					
1980-89	74 852	1140	1.33	253	3.28					
1990-99	62 253	1295	1.30	202	2.24					
2000-10	46 174	1287	1.29	210	2.37					
<b>Total</b>	<b>308 911</b>	<b>5279</b>	<b>1.40</b>	<b>1141</b>	<b>3.47</b>	<b>378 234</b>	<b>5114</b>	<b>0.97</b>	<b>293</b>	<b>1.19</b>

Time since exposure specific estimates of excess relative risk per unit exposure

Uranium miners		
	ERR/WLM	90% CI
5-19	0.0283	0.0237 - 0.0338
20-29	0.0105	0.0076 - 0.0139
30+	0.0059	0.0040 - 0.0083
Residential radon		
	ERR/kBq m <sup>-3</sup> Y	
5-19	0.0585	-0.0229 - 0.1482
20-29	0.0002	-0.1223 - 0.1227



Relative risk in dependence on cumulated intake (MBq) using

1 kBq/m<sup>3</sup> Y = 1000 Bq/m<sup>3</sup> × 0.4 × 7000 h × 0.8 m<sup>3</sup>/h = 2.24 MBq  
 1 WLM = 37 Bq/m<sup>3</sup> × 170 h × 1.2 m<sup>3</sup>/h = 0.755 MBq

## Smoking radon interaction

Multiplicative and additive models of relative risk

$$RR = c_s(1 + b W) \quad \text{model M}$$

$$RR = c_s + b W \quad \text{model A}$$

$c_s$  = baseline RR at zero exposure in smoking categories

Geometric mixture models (BEIR VI)

mixing parameter  $\lambda = 0$  (additive model)  
 $\lambda = 1$  (multiplicative model)

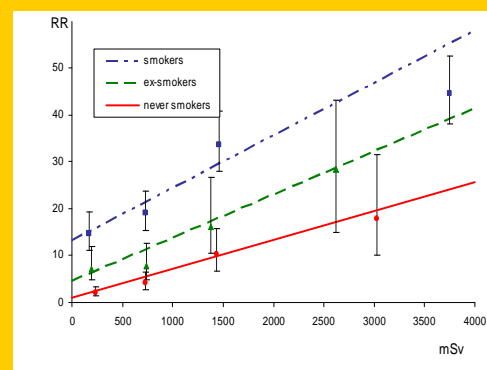
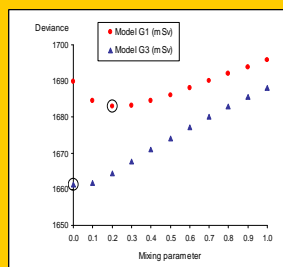
$$RR = (c_s(1 + b W))^\lambda (c_s + b W)^{1-\lambda} \quad \text{model G}$$

Best model G3 for  $\lambda=0$

$b_{5-19} = 0.0200$	$c_{\text{never}} = 1$
$b_{20-34} = 0.0021$	$c_{\text{ex-sm}} = 5.5$
$b_{35+} = 0.0013$	$c_{\text{smoker}} = 17$

Smoking specific effective doses  
 1 WLM = 13.3 mSv smokers  
 6.8 mSv ex-smokers  
 7.2 mSv never-smokers  
 thickness of mucosis, airways obstruction → impaired mucociliary clearance

Baias, Hofmann, Winkler-Heil  
 Radiat Prot Dosim 2010



## Conclusions:

The study confirms the additive role of smoking and radon, particularly when temporal factors and smoking specific estimates of radiation doses are used in the model.

Smoking specific relative risks by cumulated effective dose (mSv)