

The logo for IRSN, Institut de Radioprotection et de Sûreté Nucléaire, is displayed in a white box with a red border. The letters 'IRSN' are in a bold, sans-serif font, with 'I' and 'R' in red and 'S' and 'N' in blue. Below the acronym, the full name of the institution is written in a smaller, blue, sans-serif font.

INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

High radon levels in French homes (Bessines-Limousin)

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Radiological assessment of IRSN

■ Individual and environmental measurements:

- ❑ Whole-body countings of exposed individuals
- ❑ Individual urine bioassays
- ❑ Radiological measurements (including radon) in the house and the garden

■ A two-steps risk assessment:

- ❑ Estimation of radon exposure for each individual and for typical profiles of individuals (for communication purposes without privacy issues)
- ❑ Risk calculation based on a health risk assessment approach



Radon exposure estimates (1 / 2)

■ Retrospective radon exposure ($\text{Bq}\cdot\text{h}\cdot\text{m}^{-3}$) estimates based on:

- ❑ Average radon activity concentration ($\text{Bq}\cdot\text{m}^{-3}$) measured in each room
- ❑ Duration of exposure (h) in each room (estimated through individual inquiries)

	Annual average radon concentration ($\text{Bq}\cdot\text{m}^{-3}$) *	
	Day-time	Night-time
Bedroom 1	9,000	9,000
Bedroom 2	14,300	16,000
Bedroom 3	9,300	9,300
Living room	14,700	18,700
Kitchen	8,500	10,000

* For comparison: the average radon concentration in the department of Haute-Vienne is $204 \text{ Bq}\cdot\text{m}^{-3}$

Radon exposure estimates (2/2)

■ Retrospective radon exposure ($\text{Bq}\cdot\text{h}\cdot\text{m}^{-3}$) estimates based on:

- ❑ Average radon activity concentration ($\text{Bq}\cdot\text{m}^{-3}$) measured in each room
- ❑ Duration of exposure (h) in each room (estimated through individual inquiries)

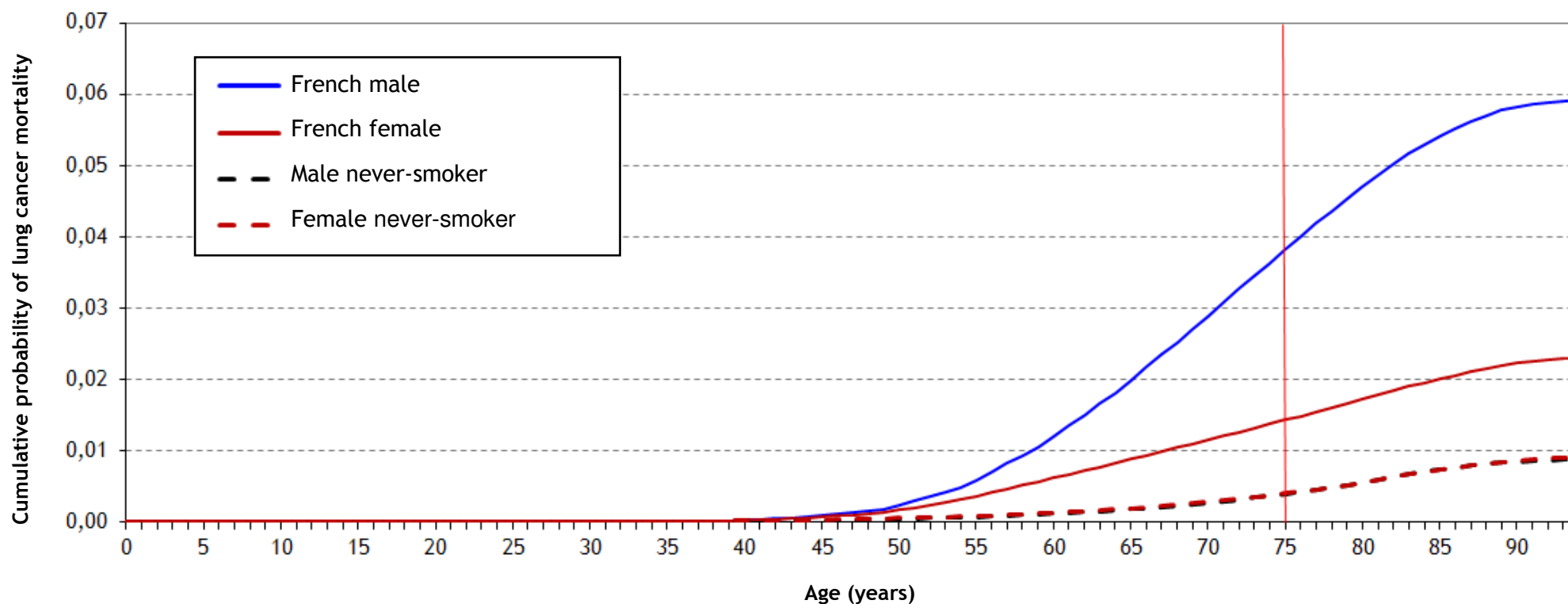
	Annual duration of exposure (h)	Cumulative exposure ($\text{Bq}\cdot\text{m}^{-3}\cdot\text{h}$)
Adult resident, working at home	8,030	110×10^6
Adult resident, working outdoors	5,660	79×10^6
Young adult resident, student	6,570	64×10^6
Child resident, schoolchild	6,570	64×10^6
Infant resident	6,935	66×10^6
Child, at home for child-minding	400	6×10^6
Infant, at home for child-minding	2,000	25×10^6

Assessment of the risk of lung cancer attributable to radon exposure

Basic data used for the assessment

- Mortality rates of lung cancer in the general population (age, gender)
 - ❑ Baseline Lifetime risk of lung cancer (up to age 75 years)
 - ❑ Individuals considered = never-smokers
- Cumulative radon exposure estimates
 - ❑ Concentration in each room (measurements)
 - ❑ Period of exposure (family inquiries)
- Risk model
 - ❑ Excess relative risk (ERR) of 0.16 per 100 Bq.m⁻³ during 25 years of residence (Darby et al., 2005)
 - ❑ Adults: ERR ≈ 0 after 30 years following the end of exposure
Children: ERR supposed to be constant over their lifetime

Baseline lifetime risk of lung cancer



Cumulative probability up to age 75 years

- Whole population : Male = 3.6 % ; Female = 1.4 %
- Never smokers : Male = 0.36 % ; Female = 0.37 %

Results of the risk assessment

	Age at the end of exposure	Duration of exposure	Lifetime risk of the general population	Lifetime risk due to radon exposure	Lifetime risk ratio
Adult resident working at home	50 y	20 y	0.32 %	4.08 %	13,0
Adult resident working outdoors	50 y	20 y	0.32 %	3.13 %	10,0
Young adult resident, student	20 y	20 y	0.36 %	0.51 % (4.49 %)	1.4 (12.4)
Child, at home for childminding	7 y	4 y	0.36 %	0.37 % (0.43 %)	<1.01 (1.2)
Infant, at home for childminding	3 y	3 y	0.36 %	0.37 % (0.58 %)	<1.01 (1.6)

Ratio > 10

Ratio < 2

Assuming that the ERR \approx 0 after 30 years following the end of exposure

Assuming that the ERR \approx constant all over the lifetime

Lung cancer with radon and smoking

- ❑ Lifetime probability of lung cancer for smokers and non-smokers
- ❑ Typical profile of resident = « adult 50 years old, working outdoors »

		Radon	
		General population	Living 20 years in the house
Smoking	Never-smoker	0.32 %	3.2 %
	Regular smoker	3.2 %	6 % to 32 %*

* Considering either additive or multiplicative effects

Conclusions of the risk assessment

- **Situation remarkable (if not unique):** concentrations about 50 times higher than average in this region
- **High increase of the excess of risk of lung cancer mortality for those individuals exposed for more than 15 years**
(risk comparable to the one for a regular smoker)
- **Lower increase of risk for kids in the house for child-minding**
(The lifetime probability remains below 1 %)
- Risk was assessed for non-smokers.
As and when appropriate, **the risk due to smoking must be considered in addition**
- More information on www.irsn.fr

Recommendations

- Inform the physician of the exposed individual
- Medical follow-up recommended by a Group of experts set-up by the *Institut National du Cancer* (www.e-cancer.fr/)
depends on the relative risk of lung cancer
 - $RR < 2$ → No follow-up recommended
 - $2 < RR < 10$ → case by case basis - decision by a pneumologist
 - $RR > 10$ → regular follow-up after the age of 45 y (low dose lung CT scan)
- **Avoid smoking** (combined effects of radon and smoking) and exposure to any other risk factor of lung cancer