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Georgian Individual Risks of Radon Induced Lung Cancer

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This study evaluates individual risks for the Georgian population exposed to indoor radon at different radon concentrations and for different periods of their lives. Based on the BEIR VI risk model modified by U. S. Environmental Protection Agency, individual risks of radon induced lung cancers are calculated using the European Group B age- specific rates for overall and lung cancer mortalities in 2004 as well as the Georgian smoking prevalence data in 2001. For the first time, convenient tables of lifetime relative risks are constructed for lifetime exposures, short exposures between any two age intervals from 0 to 110, and for various radon concentrations found in homes from 25 to 400 Bq/m^3. The risk of developing lung cancer from residential radon exposure increases with radon concentration and exposure duration. The detailed tables can help radiation protection practitioners to better communicate indoor radon risks to members of the public.

Key words: radon-222, lung cancer, indoor radon, radon exposure

1. Introduction

Radon is a naturally occurring radioactive gas. Radon and its short-lived progenies in the atmosphere are the most significant contributors to human exposure from natural sources[1, 2]. When inhaled, radon can cause mutations in lung tissue. Long-term exposure to radon has been associated with an increased risk of developing lung cancer, even at concentrations commonly found in the indoor environment[3]. Recent studies on indoor radon exposure and lung cancer incidence in Asia[4], Europe[5] and North America[6] provided strong evidence that radon causes a substantial number of lung cancers in the general population.

In recent years, there has been increased interest in the exposure of the general population to radon in Georgia. There are limited field studies on radon levels in some regions of Georgia[7]. Georgia has complex geological structure where a wide range of radon concentration can be expected. To better communicate indoor radon risks to members of the public, detailed risk tables covering such wide range of radon concentrations are needed for the Georgian population. Exposures for short periods of time are also of practical interest since exposure to elevated levels of radon may occur and end at any age. To meet this demand, risk tables have been generated using the most recent risk model and the most recent statistical data for Georgians.

2. Methods

The calculations are based on the risk model developed by U. S. Environmental Protection Agency (EPA)[8]. The EPA radon risk model is a modified model of the National Research Council, Biological Effects of Ionizing Radiations

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(BEIR) VI committee[9]. The EPA model is a single model which gives risk values midway between those obtained from the two BEIR VI preferred models. In summary, the mathematical form of the EPA model for the excess relative risk (*ERR*) at a given age, e_a, is described as

$$e_a = \beta W^* \phi_{age}(a) \quad (1)$$

where a is age in years. The parameter β (=0.0634) represents the slope of the exposure- risk relationship. For a given radon concentration, the total exposure, W^*, can be calculated as the weighted summation of three time-since-exposure windows, namely 5-14, 15-24, and 25 or more years before age a. Exposure in the last 5 years is not biologically relevant to cancer risk.

$$W^* = W_{5\text{-}14} + \theta_{15\text{-}24} W_{15\text{-}24} + \theta_{25+} W_{25+} \quad (2)$$

$W_{5\text{-}14}$ is the exposure incurred between 5 and 14 yr before age a; $W_{15\text{-}24}$ the exposure incurred between 15 and 24 yr before age a; and W_{25+} the exposure incurred 25 yr or more before age a. $\theta_{15\text{-}24}$ (=0.78) and θ_{25+} (=0.51) represent the weights of the 15-24 and ≥25 time-since-exposure windows. The parameter $\phi_{age}(a)$ describes the decrease of excess relative risk with increasing age. The continuous function of $\phi_{age}(a)$ given by the EPA is used in the current calculations.

The formulae for the calculation of lifetime relative risk of lung cancer are described in the BEIR IV report[10]. To calculate the probability of dying of lung cancer, suppose q_a is the probability of surviving year a when all causes are acting on surviving through year a-1; h_a^* is the mortality rate due to all causes; and h_a is the lung cancer mortality rate at year or age a. Then, the probability surviving year a is $q_a = exp(-h^*_a)$, and the probability of death in year a is $1 - q_a$. The probability of surviving up to age a is the product of surviving each prior year: $q_1 \times q_2 \times \cdots \times q_{a-1} = \prod_{k=1}^{a-1} q_k$.

The probability of surviving up to age a and dying at age a is then $\prod_{k=1}^{a-1} q_k (1 - q_a)$. Multiplying by the proportion of the cause of lung cancer among all causes, the probability of surviving up to age a and dying of lung cancer at age a is $\frac{h_a}{h^*_a} \prod_{k=1}^{a-1} q_k (1 - q_a)$. The lifetime probability of lung cancer mortality is the summation over all years where maximum life is assumed to be 110 years:

$$R_0 = \sum_{a=1}^{110} \frac{h_a}{h^*_a} \prod_{k=1}^{a-1} q_k (1 - q_a) = \sum_{a=1}^{110} \frac{h_a}{h^*_a} \prod_{k=1}^{a-1} \exp(-h^*_k)(1 - \exp(-h^*_a)) \quad (3)$$

The additional risk of lung cancer due to exposure to

Table 1. Overall mortality rates and lung cancer mortality rates per 10,000 in 2004 for regional category of EUR-B[11]

	Male		Female	
Age	All causes	Lung cancer	All causes	Lung cancer
0-4	98.56	0.02	81.31	0.00
5-14	4.97	0.01	3.35	0.01
15-29	12.78	0.08	5.79	0.02
30-44	28.59	1.05	14.26	0.33
45-59	103.82	9.18	49.55	1.80
60-69	311.64	29.20	164.38	4.22
70-79	676.68	38.86	455.26	6.74
80+	1570.68	35.44	1352.95	6.50

Table 2. Member states in regional category of EUR-B[11]

Regional Category	Member States
EUR B	Albania
	Armenia
	Azerbaijan
	Bosnia and Herzegovina
	Bulgaria
	Georgia
	Kyrgyzstan
	Montenegro
	Poland
	Romania
	Serbia
	Slovakia
	Tajikistan
	The former Yugoslav Republic of Macedonia
	Turkey
	Turkmenistan
	Uzbekistan

radon is incorporated into the risk calculation of Equation (3) through the age-specific lung cancer mortality rates. The lung cancer mortality rate for an exposed individual is $h_a(1 + e_a)$, and the overall mortality rate is $h^*_a + h_a e_a$, where e_a is the excess relative risk at age a as given in Equation (1). In the present of radon exposure, the probability of surviving year a becomes $\exp(-(h^*_a + h_a e_a))$, and the probability of death at age a is $[1 - \exp(-(h^*_k + h_k e_k))]$. The probability of surviving up to age a is the product of surviving each prior year from 1 to $a - 1$, i.e. $\prod_{k=1}^{a-1} \exp(-(h^*_k + h_k e_k))$. The probability of surviving up to age a and dying at age a is then $\prod_{k=1}^{a-1} \exp(-(h^*_k + h_k e_k))[1 - \exp(-(h^*_a + h_a e_a))]$. Corresponding to Equation (3), multiplying by the proportion of lung cancer among all causes $\frac{h_a(1 + e_a)}{h^*_a + h_a e_a}$ and summing over the lifespan of 110 years, the lifetime probability of lung cancer for an individual with excess risk profile $e_1, e_2, \ldots, e_{110}$ is:

Table 3. Smoking prevalence rates, results of 2001 survey[12)]

	Males		Females	
Age	Ever-smoker	Never-smoker	Ever-smoker	Never-smoker
18-29	64.9	35.1	8.1	91.9
30-39	69.2	30.8	13.0	87.0
40-49	66.0	34.0	9.1	90.9
50-59	61.1	38.9	3.4	96.6
≧ 60	48.4	51.6	3.4	96.6

Table 4. Estimated Lifetime risks R_e and lifetime relative risks *LRR* of lung cancer for lifetime exposure at various radon concentrations

Exposure[a]	Males						Females					
Bq/m^3	Population		Non-smokers		Smokers		Population		Non-smokers		Smokers	
	R_e	*LRR*	R_e	*LRR*	R_e	*LRR*	R_e	*LRR*	*Re*	*LRR*	R_e	*LRR*
0	0.0547	1.000	0.0075	1.000	0.096	1.000	0.0125	1.000	0.0088	1.000	0.099	1.000
25	0.0596	1.090	0.0088	1.169	0.103	1.075	0.0136	1.088	0.0102	1.163	0.106	1.073
50	0.0645	1.180	0.0100	1.338	0.111	1.150	0.0147	1.177	0.0117	1.325	0.113	1.145
100	0.0742	1.357	0.0126	1.676	0.125	1.296	0.0169	1.353	0.0146	1.649	0.127	1.287
150	0.0837	1.532	0.0151	2.012	0.139	1.440	0.0192	1.529	0.0174	1.972	0.141	1.426
200	0.0932	1.705	0.0176	2.347	0.152	1.580	0.0213	1.704	0.0202	2.294	0.155	1.563
300	0.1117	2.043	0.0226	3.014	0.178	1.852	0.0257	2.053	0.0259	2.934	0.181	1.829
400	0.1296	2.372	0.0276	3.676	0.203	2.112	0.0301	2.400	0.0315	3.570	0.206	2.084
600	0.1642	3.004	0.0374	4.988	0.250	2.601	0.0387	3.089	0.0426	4.829	0.254	2.567
800	0.1969	3.603	0.0471	6.282	0.293	3.049	0.0473	3.772	0.0536	6.071	0.298	3.015
1000	0.2280	4.171	0.0567	7.558	0.333	3.461	0.0557	4.447	0.0644	7.296	0.339	3.431

[a]Exposures are presented by concentrations in Bq/m^3 assuming to be constant for home occupancy at the 70% level and 40% equilibrium between radon and its progeny.

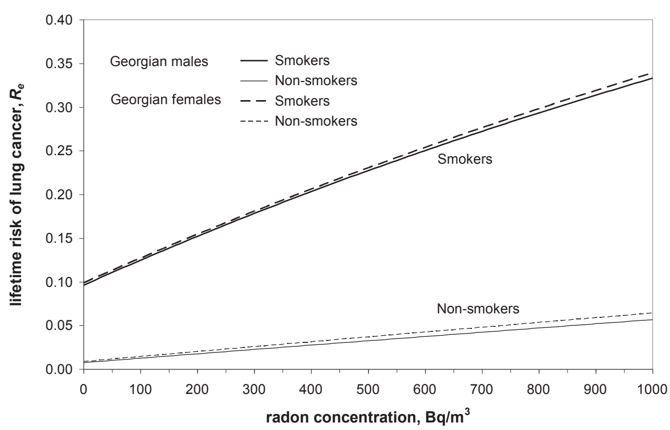

Fig. 1. Lifetime risk of lung cancer for Georgian males and females based on the EPA model and a submultiplicative interaction between smoking and exposure to radon progeny.

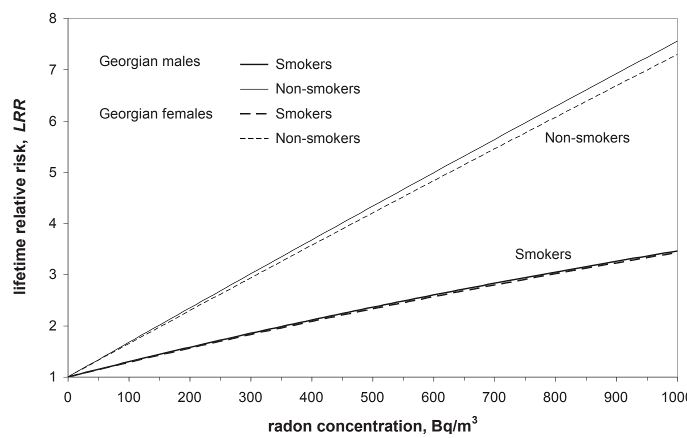

Fig. 2. Lifetime relative risk of lung cancer for Georgian males and females based on the EPA model and a submultiplicative interaction between smoking and exposure to radon progeny.

$$R_e = \sum_{a=1}^{110} \frac{h_a\,(1+e_a)}{h^*_a+h_a e_a} \prod_{k=1}^{a-1} \exp\,(-h^*_k+h_k e_k))\;[1-\exp\,(-(h^*_a+h_a e_a))] \quad (4)$$

where R_e is the lifetime risk of lung-cancer under a given radon exposure profile.

The computation of lifetime risk depends on the choice of the background age-specific lung-cancer and overall mortality rates, h_a and h^*_a. This study uses European Group B age-specific mortality rates[11)] in 2004 as given in Table 1. Georgia belongs to the European Group B in the WHO regional categories, as shown in Table 2.

Lifetime relative risk (*LRR*) is defined as $LRR = R_e/R_0$, where R_e is the lifetime risk of lung-cancer under a given exposure pattern (Equation 4) and R_0 is the baseline risk (Equation 3), i.e. the lifetime risk of lung cancer when exposed to background radon level, the outdoor radon level. The *LRR* describes the proportional increment in lung-cancer risk posed by indoor radon exposure beyond the background level of exposures from outdoor air. Individual risks of radon induced lung cancers for different exposure profiles are estimated in terms of *LRR*.

As in the BEIR VI report, it is accepted that smoking and radon exposure combine in a fashion that is sub-

Table 5. Lifetime relative risk (*LRR*) by age exposure started and age exposure ends for Georgian male smokers

	Age (yr) exposure ends								
Age (yr) exposure started	10	20	30	40	50	60	70	80	110
				radon concentration = 25 Bq/m^3					
0	1.012	1.021	1.032	1.045	1.059	1.070	1.074	1.075	1.075
10		1.011	1.023	1.036	1.049	1.060	1.065	1.066	1.066
20			1.012	1.025	1.039	1.049	1.054	1.055	1.055
30				1.013	1.027	1.037	1.042	1.043	1.043
40					1.014	1.024	1.029	1.030	1.030
50						1.011	1.015	1.016	1.016
60							1.005	1.006	1.006
				radon concentration = 50 Bq/m^3					
0	1.024	1.041	1.064	1.090	1.117	1.138	1.148	1.149	1.150
10		1.022	1.045	1.071	1.098	1.119	1.129	1.131	1.131
20			1.023	1.050	1.077	1.075	1.084	1.086	1.086
30				1.026	1.054	1.146	1.165	1.170	1.170
40					1.027	1.048	1.058	1.060	1.060
50						1.021	1.031	1.033	1.033
60							1.010	1.011	1.012
				radon concentration = 100 Bq/m^3					
0	1.047	1.082	1.128	1.180	1.223	1.274	1.292	1.296	1.296
10		1.044	1.090	1.142	1.195	1.237	1.255	1.259	1.259
20			1.047	1.099	1.153	1.194	1.213	1.216	1.217
30				1.053	1.107	1.149	1.167	1.171	1.172
40					1.055	1.097	1.116	1.119	1.120
50						1.042	1.061	1.065	1.066
60							1.019	1.023	1.024
				radon concentration = 200 Bq/m^3					
0	1.094	1.163	1.254	1.355	1.459	1.537	1.572	1.579	1.580
10		1.087	1.178	1.281	1.385	1.465	1.501	1.508	1.509
20			1.093	1.197	1.303	1.383	1.419	1.426	1.427
30				1.105	1.212	1.294	1.331	1.338	1.339
40					1.109	1.192	1.229	1.236	1.237
50						1.084	1.122	1.129	1.131
60							1.038	1.046	1.047
				radon concentration = 400 Bq/m^3					
0	1.187	1.322	1.498	1.693	1.889	2.035	2.098	2.110	2.112
10		1.172	1.353	1.551	1.751	1.900	1.966	1.978	1.980
20			1.184	1.388	1.593	1.746	1.813	1.826	1.828
30				1.209	1.419	1.576	1.645	1.658	1.661
40					1.216	1.378	1.450	1.463	1.466
50						1.168	1.242	1.256	1.258
60							1.076	1.091	1.093

multiplicative on the relative-risk scale, i.e., less than the anticipated effect if the joint effect were the product of the risks from radon and smoking individually, but more than if the joint effect were the sum of the two individual risks. It is further assumed that smoking-induced lung cancer has a 10 year latent period and the relative risks for smokers compared with that for non-smokers are approximately 14 for males and 12 for females. In the adjustment of age-specific lung cancer mortality rates to reflect smoking status, Georgian age-specific smoking prevalence data for males and females in 2001 are used[12]. The average age of smoking commencement is assumed to be 18 among Georgians, as shown in Table 3.

3. Results and Discussion

Lifetime risks and lifetime relative risks for lifetime exposure at various radon concentrations are given in Table 4. The first row of Table 4 gives the baseline risks without additional indoor radon exposure, i.e., $R_e = R_0$ and $LRR=1$. The risks are given for males and females and for smokers and non-smokers. The results under the “population” heading are the risks for a general population without any smoking effect adjustment. The population risk can be used to estimate the risk for people with unknown smoking status. Because the European Group B age-specific mortality rates were used in the risk calculation, the population lifetime risks and lifetime relative risks are not Georgian specific and are applicable to the population in various countries of the European Group B.

Table 6. Lifetime relative risk (*LRR*) by age exposure started and age exposure ends for Georgian male nonsmokers

	Age (yr) exposure ends								
Age (yr) exposure started	10	20	30	40	50	60	70	80	110
				radon concentration = 25 Bq/m^3					
0	1.012	1.047	1.073	1.102	1.132	1.156	1.167	1.169	1.169
10		1.025	1.051	1.080	1.110	1.133	1.144	1.147	1.147
20			1.026	1.055	1.084	1.109	1.119	1.122	1.122
30				1.029	1.059	1.083	1.094	1.096	1.096
40					1.030	1.054	1.065	1.067	1.067
50						1.024	1.035	1.037	1.037
60							1.011	1.013	1.014
				radon concentration = 50 Bq/m^3					
0	1.024	1.095	1.146	1.204	1.264	1.312	1.333	1.338	1.338
10		1.050	1.101	1.159	1.220	1.267	1.289	1.293	1.294
20			1.052	1.110	1.170	1.217	1.239	1.243	1.244
30				1.058	1.118	1.166	1.187	1.192	1.193
40					1.060	1.108	1.129	1.134	1.135
50						1.047	1.069	1.073	1.074
60							1.022	1.026	1.027
				radon concentration = 100 Bq/m^3					
0	1.047	1.189	1.292	1.408	1.528	1.622	1.665	1.674	1.676
10		1.100	1.203	1.319	1.439	1.533	1.576	1.585	1.587
20			1.103	1.219	1.339	1.436	1.477	1.486	1.487
30				1.116	1.237	1.331	1.374	1.383	1.385
40					1.121	1.215	1.259	1.267	1.269
50						1.095	1.138	1.147	1.149
60							1.044	1.052	1.054
				radon concentration = 200 Bq/m^3					
0	1.094	1.378	1.583	1.814	2.054	2.241	2.327	2.344	2.347
10		1.199	1.405	1.636	1.876	2.063	2.149	2.166	2.170
20			1.206	1.438	1.678	1.865	1.952	1.969	1.972
30				1.232	1.473	1.661	1.747	1.765	1.768
40					1.241	1.430	1.516	1.534	1.537
50						1.189	1.276	1.293	1.297
60							1.087	1.105	1.108
				radon concentration = 400 Bq/m^3					
0	1.187	1.755	2.164	2.622	3.097	3.466	3.636	3.669	3.676
10		1.399	1.808	2.268	2.744	3.115	3.286	3.319	3.326
20			1.411	1.873	2.351	2.723	2.894	2.928	2.935
30				1.464	1.943	2.317	2.489	2.523	2.530
40					1.482	1.857	2.030	2.064	2.071
50						1.377	1.551	1.585	1.593
60							1.174	1.209	1.216

The calculated risks for smokers and non-smokers are specific to Georgian males and females, because Georgian age-specific smoking prevalence data were used in the calculation. Lifetime risks of radon induced lung cancer are given in Figures 1 for lifetime exposures at different radon levels for Georgian males and females, respectively. The lifetime risks of lung cancer are much higher for smokers than for non-smokers. As shown in Figure 1, the lifetime risks of Georgian females are slightly higher than that of Georgian males at various radon concentrations.

As indicated in the BEIR IV report, lifetime relative risk is the most suitable risk quantity to characterize individual risks of lung cancer. Due to significantly different baseline risks (lifetime risks, R_0) for smokers and non-smokers, the lifetime relative risks are much higher for non-smokers than for smokers, as demonstrated in Figure 2. At various radon concentrations, Georgian women have slightly lower *LLR*s than Georgian men for both smokers and non-smokers.

It is of practical interest to determine the relative risks for shorter exposure periods between two selected ages, when exposure started and ended. Detailed tables of *LRR*s are generated for various exposure periods. Tables 5 and 6 are the *LRR*s for Georgian male ever-smokers and never-smokers, respectively. The *LRR*s for Georgian female ever-smokers and never-smokers are given in tables 7 and 8, respectively. All tables are given by ages when exposure started and exposure ended for various radon concentrations from 25 to 400 Bq/m^3. The tables are easy to use. For example, if a man who never smoked lived in a house from age 10 to 30 at a radon concentration of 400 Bq/m^3, his relative lifetime risk of lung cancer is estimated to be 1.808 which is 81% higher than the baseline risk (Table 6, the cell

Table 7. Lifetime relative risk (*LRR*) by age exposure started and age exposure ends for Georgian female smokers

Age (yr) exposure started	Age (yr) exposure ends 10	20	30	40	50	60	70	80	110
				radon concentration = 25 Bq/m^3					
0	1.012	1.020	1.031	1.044	1.057	1.066	1.071	1.072	1.073
10		1.011	1.022	1.035	1.048	1.057	1.062	1.063	1.064
20			1.011	1.024	1.037	1.047	1.052	1.053	1.053
30				1.013	1.026	1.035	1.040	1.042	1.042
40					1.013	1.023	1.028	1.029	1.029
50						1.010	1.015	1.016	1.016
60							1.005	1.006	1.006
				radon concentration = 50 Bq/m^3					
0	1.023	1.040	1.062	1.087	1.113	1.132	1.142	1.144	1.145
10		1.021	1.043	1.069	1.095	1.114	1.124	1.126	1.126
20			1.023	1.048	1.074	1.093	1.103	1.105	1.106
30				1.026	1.052	1.071	1.081	1.083	1.084
40					1.026	1.045	1.055	1.058	1.058
50						1.019	1.029	1.031	1.032
60							1.010	1.012	1.013
				radon concentration = 100 Bq/m^3					
0	1.046	1.079	1.123	1.174	1.225	1.262	1.281	1.286	1.287
10		1.042	1.087	1.137	1.189	1.226	1.245	1.250	1.251
20			1.045	1.096	1.147	1.185	1.204	1.209	1.210
30				1.051	1.103	1.141	1.160	1.165	1.166
40					1.052	1.090	1.110	1.115	1.116
50						1.038	1.058	1.063	1.064
60							1.020	1.025	1.026
				radon concentration = 200 Bq/m^3					
0	1.092	1.157	1.245	1.343	1.443	1.515	1.552	1.561	1.563
10		1.084	1.172	1.272	1.373	1.445	1.482	1.491	1.493
20			1.090	1.190	1.292	1.365	1.403	1.412	1.414
30				1.102	1.205	1.279	1.317	1.326	1.328
40					1.104	1.179	1.218	1.227	1.230
50						1.080	1.115	1.125	1.127
60							1.040	1.049	1.052
				radon concentration = 400 Bq/m^3					
0	1.185	1.311	1.482	1.672	1.862	1.996	2.064	2.080	2.084
10		1.167	1.341	1.534	1.728	1.865	1.934	1.951	1.955
20			1.178	1.376	1.573	1.713	1.785	1.802	1.806
30				1.202	1.404	1.547	1.621	1.638	1.642
40					1.208	1.354	1.430	1.448	1.452
50						1.151	1.229	1.247	1.252
60							1.079	1.098	1.103

with row of age 10 and column of age 30 under heading of 400 Bq/m^3).

It should be mentioned that the slope of the exposure-risk relationship in Equation (1) is a center estimate from combination of various case-control studies. It is an estimate averaged over several populations in the world. The uncertainty could be large when applying the population estimate to individuals. Radon risks presented here are the best estimates based on current knowledge and subject to large uncertainties for individuals.

4. Conclusions

For lifetime exposures, results for Georgian individuals demonstrate a pattern similar to the one in the BEIR VI report for the US population. The risk of developing lung cancer from residential radon exposure increases with radon concentration and exposure duration. Because Georgian age-specific mortality rates and smoking prevalence data are used, lifetime risks of radon induced lung cancer presented here are estimates for Georgian individuals either as smokers or non-smokers. They are the best estimates based on current knowledge, however, subject to large uncertainties for individuals. The detailed tables can help radiation protection practitioners to better communicate indoor radon risks to members of the public.

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Table 8. Lifetime relative risk (*LRR*) by age exposure started and age exposure ends for Georgian female nonsmokers

Age (yr) exposure started	Age (yr) exposure ends 10	20	30	40	50	60	70	80	110
				radon concentration = 25 Bq/m^3					
0	1.012	1.044	1.069	1.096	1.127	1.148	1.159	1.162	1.163
10		1.024	1.048	1.077	1.106	1.127	1.138	1.141	1.142
20			1.025	1.053	1.082	1.104	1.115	1.118	1.118
30				1.028	1.057	1.079	1.090	1.093	1.093
40					1.029	1.050	1.062	1.064	1.065
50						1.021	1.033	1.035	1.036
60							1.011	1.014	1.015
				radon concentration = 50 Bq/m^3					
0	1.023	1.089	1.139	1.195	1.253	1.296	1.318	1.324	1.325
10		1.047	1.097	1.153	1.211	1.254	1.276	1.282	1.283
20			1.050	1.106	1.165	1.207	1.230	1.235	1.237
30				1.057	1.115	1.157	1.180	1.185	1.187
40					1.058	1.101	1.123	1.129	1.130
50						1.043	1.065	1.071	1.072
60							1.023	1.028	1.030
				radon concentration = 100 Bq/m^3					
0	1.046	1.177	1.277	1.390	1.506	1.590	1.635	1.646	1.649
10		1.094	1.194	1.307	1.423	1.507	1.552	1.563	1.566
20			1.100	1.213	1.329	1.414	1.458	1.469	1.473
30				1.113	1.229	1.314	1.359	1.370	1.373
40					1.116	1.201	1.246	1.257	1.260
50						1.085	1.130	1.141	1.144
60							1.045	1.056	1.059
				radon concentration = 200 Bq/m^3					
0	1.092	1.354	1.553	1.778	2.009	2.177	2.266	2.288	2.294
10		1.188	1.387	1.612	1.843	2.012	2.101	2.123	2.129
20			1.199	1.425	1.656	1.825	1.915	1.937	1.943
30				1.226	1.458	1.627	1.717	1.739	1.745
40					1.232	1.402	1.492	1.514	1.520
50						1.170	1.260	1.282	1.289
60							1.090	1.112	1.118
				radon concentration = 400 Bq/m^3					
0	1.185	1.708	2.104	2.550	3.007	3.340	3.515	3.558	3.570
10		1.376	1.773	2.221	2.679	3.013	3.189	3.232	3.244
20			1.399	1.848	2.309	2.644	2.821	2.864	2.876
30				1.451	1.914	2.250	2.428	2.472	2.483
40					1.464	1.803	1.981	2.025	2.037
50						1.340	1.519	1.563	1.575
60							1.180	1.224	1.236

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