RADIATION EXPOSURE OF THE MOLDAVIAN POPULATION FROM RADON AND THORON PROGENY

Olga Iacob , C. Grecea , L. Clain

Institute of Public Health and Medical Research Iasi,RO-6600

INTRODUCTION

The aim of this paper is to provide un updated, completive review of the data available for assessing the Moldavian population exposure from radon and thoron progeny inhalation and the potential risk of radiation-induced lung cancer. According to our last estimate (1), the short - lived decay products of radon and thoron make the most significant contribution to exposures from natural radiation background (2.5 $mSva^{-1}$).

METHODS

The radon and thoron daughters concentrations have been measured in 348 typical Moldavian dwellings from urban and rural areas using the active method by sucking air through filter and counting the deposited activity by means of a ZnS alpha scintillation counter. Measurement and calculation procedures have been described previously (2).

The exposure of individuals resulting from radon and thoron progeny inhalation has been expressed in terms of effective dose (E), the new indicator of the total detriment due to the stochastic effects in the exposed individual and his descendents, as defined by ICRP in Publication 60 (3).

The annual effective doses have been derived from the average Equilibrium Equivalent Concentration (EEC) of radon and thoron using the dose coefficients adopted in the UNSCEAR 1993 Report (4) and assuming the average occupancy factors of 0.75 indoors and 0.25 outdoors.

The radiation-induced risk estimates have been performed from the annual collective effective doses by applying the risk factor of $5x10^{-2}$ per Sv for fatal cancers for a population of all ages and both sexes,recommended by ICRP Publication 65 (5).

RESULTS AND DISCUSSIONS

Table 1 shows the arithmetic means and the range of values for both EEC of radon and thoron and the resulting annual effective doses. The average value of the equilibrium equivalent concentrations of radon have been estimated at 8.7 Bqm^{-3} in block of flats and at 28.0 Bqm^{-3} in detached houses. The highest value found has been of 564 Bqm^{-3}, in a rural house. It is evident from estimates given in table 1 that EEC of radon levels are about three times higher in detached house than in block of flats. The explanation is that in detached houses the major source of indoor radon is the subjacent ground but, in the upper storeys of tall block of flats, the building materials might be expected to be the main source.

The resulting annual effective dose of an individual living in a detached house is 1656 µSv on average while in a flat, un individual receives only 514 µSv.

Table 1. Equilibrium Equivalent Concentrations (EEC) of radon and thoron in dwellings and the resulting annual effective doses

Source of exposure	Location	EEC (Bqm^{-3}) Average	EEC (Bqm^{-3}) Range	Annual Effective Dose (μSv) Average	Annual Effective Dose (μSv) Range
^{222}Rn daughters	Detached house	28.0	10.2-564	1656	603 -33340
	Block of flats	8.7	3.8- 19.4	514	225 - 1147
^{220}Rn daughters	Detached house	1.3	0.2- 6.4	273	42 - 1345
	Block of flats	0.6	0.1- 2.8	126	21 - 589

Regarding thoron progeny inhalation, the annual effective doses are of 273 μSv and 126 μSv for detached house and block of flats, respectively.

The population-weighted averages of EEC of radon and thoron, the corresponding annual effective doses as well as collective doses and risk estimates, are given in Table 2.

Table 2. Radiation exposure of the Moldovian population from radon and thoron progeny inhalation

Source of exposre	Location	EEC* (Bqm^{-3})	Annual effective doses per capita (μSv)	Annual effective doses collective (man Sv)	Potential annual no of lung cancer
^{222}Rn daughters	indoors	20.2	1195	6214	311
	outdoors	4.6	90	468	23
Total radon			1285	6682	334
^{220}Rn daughters	indoors	1.0	200	1040	52
	outdoors	0.2	5	26	1
Total thoron			205	1066	53
TOTAL radon+thoron			1490	7750	387

*) population - weighted average

The values are of 20.2 Bqm^{-3} indoors and 4.6 Bqm^{-3} outdoors for EEC of radon and of 1.0 Bqm^{-3} and 0.2 Bqm^{-3} for EEC of thoron indoors and outdoors, respectively.

From these values and applying the dose coefficients, the annual effective dose per capita from inhalation of radon progeny was estimated at 1285 μSv and at 205 μSv from thoron progeny inhalation. From the total of 1490 μSv, more than 90 per cent are received indoors.

Taking into account the annual collective effective dose of about 7750 manxSv it is possible to estimate that 387 lung cancer

each year in Moldavian population (5.2 mill. inhabitants) may be attributable to radon and thoron short-lived decay products inhalation.

Radon and thoron progeny are the dominant source of human exposure to ionising radiation contributing about 60 per cent of the total dose from natural background of Moldavia, as Fig.1 illustrates.

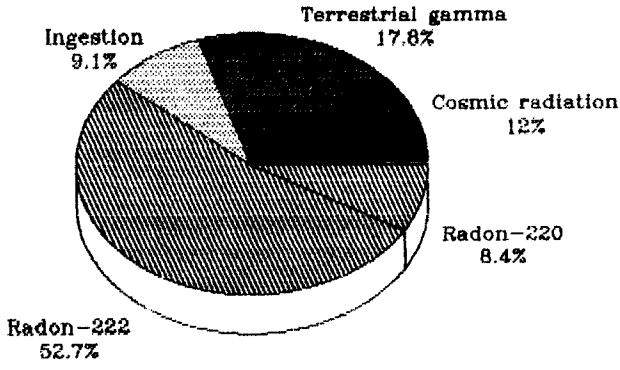

Fig.1 Contribution of natural radiation sources to annual effective dose

CONCLUSIONS

1. The population-weighted averages of EEC of radon and thoron are of 20.2 Bqm^{-3} and 1.0 Bqm^{-3} indoors and of 4.6 Bqm^{-3} and 0.2 Bqm^{-3} outdoors.

2. The annual effective dose per capita due to radon and thoron progeny inhalation are of 1285 μSv and 205 μSv, respectively.

3. The resulting annual collective dose of about 7750 manSv may be responsable for 387 potential lung cancers induced annually in Moldavian population.

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AUTHOR(S) NAME(S) J. Peter

SUBMITTING AUTHOR

LAST NAME Peter FIRST NAME Josef TITLE Dr.

AFFILIATION Bundesamt für Strahlenschutz TEL 0049-89-31603-357

STREET Ingolstädter Landstr. 1 FAX 0049-89-31603-331

CODE D-85764 CITY Oberschleißheim COUNTRY Germany

PRESENTING AUTHOR (IF DIFFERENT)

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ABSTRACT (See instructions overleaf)

Continuous measurements of the potential alpha-energy of thoron progeny have been carried out in 23 dwellings in the south-east of Germany over time periods from two month to over one year. Mean values of the equilibrium equivalent concentration of thoron decay products were found to range from 0.1 to 1.0 Bq/m^3 with an overall average of 0.5 Bq/m^3.

Results show that there is a seasonal variation of the concentration with a minimum in summer. This can be attributed to increased ventilation in this time period.

Exposure from thoron progeny was compared to the exposure from radon progeny which was measured simultaneously. The contribution to the annual effective dose equivalent of the inhabitants by inhalation of radon progeny is about 5%.