

LUNG CANCER RISK FROM INDOOR EXPOSURES TO RADON DAUGHTERS

Report from a Task Group established by the International Commission on Radiological Protection (ICRP Publication 50)

In 1981, the Commission established a Task Group to analyse the possible lung cancer risk associated with the natural radiation exposure of populations to inhaled radon daughters.

This report of the Task Group relates specifically to the risk associated with indoor exposure, particularly that resulting from inhaled ^{222}Rn -daughters. This type of exposure contributes the largest fraction of the natural radiation dose to populations living in the temperate regions of the world. A major part of this indoor exposure depends strongly on social factors and individual living habits. For this controllable fraction of natural radiation exposure, the principles for limiting exposure of the public to natural sources of radiation which have been previously recommended by the Commission (ICRP Publication 39, Pergamon Press 1984) should be observed. In this context, the results presented in this report may provide guidance to the competent national authorities for the setting of action levels in existing houses and for the optimization procedure in the planning of future houses.

The review of the Task Group on radiogenic lung cancer lead to the following general conclusions.

- 1) A linear exposure-risk relationship is a good fit to the available epidemiological and experimental data on lung cancer from inhaled radon daughters, if exposures above about 500 WLM are excluded.
- 2) The appearance rate of radiation-induced lung cancer as a function of time is similar to the age-dependent distribution of the normal lung cancer rate in a comparable non-exposed population.
- 3) Consequently, estimation of the attributable lifetime risk on the basis of a relative risk concept seems to be more appropriate than an absolute risk model that

assumes no temporal correlation with the normal lung cancer rate.

- 4) The relative lung cancer risk for adults is independent of the age at exposure and seems to be nearly equal for both sexes. For children and juveniles (age at exposure <20 years), the relative lung cancer risk is probably somewhat higher than for adults.
- 5) With respect to bronchial cancer from inhaled radon daughters, the epidemiological and experimental findings suggest a more than additive influence of smoking. This influence can be approximated by a multiplicative model with respect to the age-specific lung cancer rate.

The observed time invariance of the relative risk can be interpreted on the basis of two-stage and multi-stage models for the development of lung cancer. If radiation is considered mainly as an initiator in the formation of intermediate or potentially malignant cells, then the expression rate is determined by other factors (e.g. age, smoking) which influence the tissue kinetics and the final tumour growth. Proceeding from the above mentioned, empirically founded, conclusions, the Task Group has developed a proportional hazard model for the estimation of the possible life-time risk of lung cancer among populations due to the inhalation of radon daughters in the environment.

On the basis of a mean equilibrium-equivalent ^{222}Rn concentration indoors of 15 Bq/m^3 and 4 Bq/m^3 outdoors, the total bronchial dose equivalent for the average person is estimated to be 18 mSv a year corresponding to an effective dose equivalent of 1.2 mSv a year.

The attributable life-time risk under these exposure conditions is about 10% of the total observed lung cancer frequency in populations, corresponding to about 70 and 14 excess lung cancers per million per year for males and females respectively. These estimates should be compared with a spontaneously occurring lung cancer frequency in most countries with populations of high life expectancy of 400–800 or 80–200 cases per million per year for males and females respectively.

The risk analysis described in this report should be regarded as an attempt to quantify the possible lung cancer risk associated with the natural exposure to radon daughters. The results indicate that, although it is considered that cigarette smoking remains as the major cause of lung cancer in many countries, a significant fraction of the observed lung cancer frequency in populations may be attributed to the indoor exposure to ^{222}Rn daughters.

Further investigations are necessary to confirm, or to

improve, this risk assessment. In several countries, epidemiological pilot studies on lung cancer among population groups exposed to enhanced ^{222}Rn levels in houses have been started or are planned. The main problems of such studies concern the retrospective estimation of the exposure and the competing influence of other occupational and environmental pollutants, and particularly of smoking.