PUBLIC HEALTH RISKS
OF
HIGH INDOOR RADON LEVELS

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PUBLIC HEALTH RISKS OF HIGH INDOOR RADON LEVELS

What is radon?

Radon is a naturally occurring radioactive gas which is given off when the minute particles of uranium, which are present in all rocks, decay. The amount of emitted radon which is present in air, soil or water, depends on the rock structure of the area concerned. Radon - 222 in dwellings is the dominant source of exposure to ionising radiation in most countries.

Is radon dangerous?

The danger of radon gas and its short-lived progeny (often termed radon daughters) is primarily derived from the finding of a high number of cases of lung cancer in miners working in uranium mines, in West Bohemia (1) (the border areas of Germany and Czechoslovakia). In these miners who have been followed-up for an average of 25 years, a four-fold radon-related excess of lung cancer has been found. There is an assumption made that because radon causes lung cancer in exposed workers, that it will also cause lung cancer, but to a much lesser extent, in those exposed to radon in the environment such as the home.

Although the relationship of radon exposure to lung cancer in the West Bohemian miners was highly significant, other cancers overall, including leukaemia, showed no increased risk or relation to radon (2). There are several uncertainties associated with the estimation of risks of indoor radon exposure on the basis of studies in miners. For example the radiation dose to the lung for a certain level of exposure in miners might differ from that associated with exposure in dwellings. Many of the studies are ecological in design (3) (i.e. looking at associations between lung cancer rates in different geographical areas and comparing these with radon levels in the areas as opposed to examining causality) and therefore it is difficult to attribute risk, as other factors, not measured in the studies, might also influence the lung cancer rates (4).

Some of these ‘other’ factors include active and passive smoking, occupation, family history of cancer and diet (5). Other studies, although reporting increased risk of lung cancer with increased levels of residential radon suggest caution with wide extrapolation of their findings, as there may have been biases in selection of their subjects (6) who could well have had other risk factors.

Lung cancer - increased risk

The main finding coming through from these studies is that there is a significantly raised mortality from lung cancer associated with exposure to radon (about 5 times increased mortality in the uranium miners in the West Bohemian occupation setting) (1), and that this risk is multiplied if there is co-existence of smoking (7). In the West Bohemian miners the risk of lung cancer was significantly positively related to duration of working in the uranium mines, equating to duration of radon exposure (1).
Other cancers - no evidence of increased risk

Cancers, other than lung cancers, have also been investigated as being casually related to radon exposure. In the West Bohemian cohort other cancers overall showed no increased risk in relation to radon (2). However Henshaw (8) has estimated that 12% of the incidence of acute myeloid leukaemia might be linked to radon exposure in homes but further goes on to say that other unmeasured potential carcinogens may contribute to this percentage by simultaneous exposure. Others report a significant correlation between registration of monocytic leukaemia in England and radon concentration by county (3). However, Miller et al (9) failed to find any significant correlation between radon levels and the incidence of salivary gland tumours in their ecological study in the United States.

Radon in houses.

Factors that have been suggested to increase the radon risk in the domestic setting include the practice of constructing modern energy efficient homes with double-glazing which harbours higher radon levels. Residents of new housing schemes and those in higher social classes might be exposed to higher radon levels than those in poorer housing who may be less financially able to insulate their homes (8). Residential exposure to radon has been shown to be an important risk factor for lung cancer in the general population (7). This study, conducted in Sweden, included household radon measurements as well as smoking status of respondents and the latter risk factor showed a multiplicative risk in those with dual exposure.

Researchers are discussing plans for pooling the various indoor studies of radon risks which should provide more precise risk estimates (10). However, for average residents exposed to indoor concentrations of 200 Bq/m$^3$ the estimated lifetime risk of premature death from lung cancer, due to radon, is about 2%. This is in addition to the prevailing lifetime risk of 3% of contracting fatal lung cancer in Ireland.

Reducing indoor radon.

However, sufficient information currently exists to conclude that radon is a risk to the public health especially in the causation of lung cancer. What can we currently do to reduce levels of indoor radon and thereby reduce this risk? A World Health Organisation (WHO) working group has put forward recommendations for management of this risk (11).

Firstly, a national policy should characterise the problem. In this regard the Radiological Protection Institute of Ireland (RPII) has identified locations, which includes areas on the west coast of Ireland, as having significantly high radon levels.

New houses.

Construction materials that can be a source of radon should be avoided and buildings which it is suggested should comply with such guidelines include homes, school and "other public buildings".
Existing houses.

'Action levels' which relate to the annual mean concentration of radon in a building have been drawn up. The internationally accepted 'action level' for individual households is 200 becquerels per cubic metre (Bq/m³). Remedial measures against radon in dwellings are recommended when those levels occur (12).

Remedial and Preventive Measures for radon reduction in dwellings (12)

The principal methods for reducing high radon concentrations indoor are as follows:

(a) To reduce the radon supply by reversing the pressure differential between the building and the soil, often called soil depressurisation. This can be achieved by using a small fan to withdraw the radon from the region under the floor either in a porous area under (or close to) the dwelling or in the space under a suspended floor.

(b) Treating material in building foundations to reduce radon escape into the building. This is difficult in existing buildings.

(c) To remove the radon source. This is likely to be feasible only for the water supply.

(d) To dilute the radon and its progeny by increasing the ventilation rate. This may be of limited effect as increasing ventilation, especially in Irish winters, will increase heating costs.

(e) To reduce the concentration of radon progeny e.g. by filtration or by increased movement of indoor air to enhance deposition of radon progeny.

Consideration should be given to not building further in radon-proven areas. A radon proven area might be defined as one in which about 1% of dwellings had a radon concentration of more than ten times the national average value. However, if this is not possible it is essential that appropriate radon reduction techniques should be stringently applied to new dwellings.

Applications to new dwellings:

(a) Radon measurements should be conducted on prospective dwelling sites not just for estimation of naturally occurring radon but also to ensure that any radium-bearing wastes previously dumped (for which there should be maps) is detected.

(b) Building foundations in a radon-proven area should be modified appropriately to prevent elevated radon levels.

(c) With a radon-resistant approach soil gas will be prevented from entering the building. Alternatively the floor may be laid to ensure a radon exhaust duct withdraws any gas.
These radon reduction and prevention approaches in both existing and future dwellings are technical areas which acquire specialist consultation with appropriate experts such as architects and engineers.

Conclusions:

Radon in dwellings poses a health risk. Excess lung cancer and lung cancer mortality have been shown to be associated with radon exposure. This lung cancer risk is increased by smoking. Some parts of the country have higher radon levels in dwellings than others due to emission of natural occurring radon gas from underlying rock. Radon measurement in individual dwellings can be carried out by the Radiological Protection Institute of Ireland. From the public health perspective, the main ways of reducing or eliminating indoor radon levels are by technical and/or structural methods under specialist guidance. Planning authorities should take cognisance of the fact that some areas have high naturally occurring radon levels and thereby decide not to build dwellings in such areas or at least ensure the strict ‘radon prevention’ guidelines are followed during construction.

References:


Background:

Results of a population-weighted radon survey carried out by the Experimental Physics Department of University College Dublin between 1985 and 1989 estimated that 4% of the housing stock in Ireland have radon concentrations above the reference level of 200 Bq/m³. The probability of finding a house with elevated indoor radon levels was greatest in western counties. In 1989 household radon surveys commenced in counties Galway and Mayo. Most but not all areas of these counties were surveyed.

In the period 1990 - 1992 the Radiocigcal Protection Insititue of Ireland (RPPI) undertook an intensive indoor radon monitoring programme in the village of Moynullen, Co. Galway and in the Glenard - Devon - Dalton areas of Salthill, Galway.

The RPPI in 1992 initiated a national geographically based radon survey. The results of this survey allow the classification of the whole county on the basis of the predicted percentage of dwellings within 10km grid squares of the Irish National Grid System which are above the reference level of 200 Bq/m³. Areas in which this value is 10% or greater are designated High Radon Areas. This designation was also used for the earlier studies in Galway and Mayo.

Results

Galway and Mayo.

In Mayo 9% of the dwellings tested had indoor radon concentrations above the reference level of 200 Bq/m³. Testing in Mayo comprised radon measurement in 151 dwellings throughout much, though not all, of the county. The estimated annual average radon concentration was 118 Bq/m³. Galway was found to have higher levels with 14% of dwellings tested being above 200 Bq/m³. In County Galway six of the 10 km grid squares are predicted, based on this survey, to have more than 20% of houses with radon concentrations in excess of 200 Bq/m³ (Figure 1). Salthill in particular has high proportion of dwellings with elevated radon levels with more than 30% of monitored houses being above the reference level.

Roscommon.

In this most recent phase of the survey, a total of 3482 dwellings in the 14 counties were chosen by random sample from the electoral register and measured. 167 houses were measured in Roscommon in which the average annual radon concentration was 95 Bq/m³. While the maximum annual radon concentration was 1387 Bq/m³ in one dwelling in Roscommon (this one measurement was the second highest in the 14 counties measured and was only exceeded by a higher maximum level in Carlow), only 13 (8%) dwellings in Roscommon were in excess of the reference level of 200 Bq/m³ (comparable proportions from selected counties are as follows: Sligo 20%, Carlow 15%, Wexford 12% Longford 6%, Donegal 4% and Offaly 3%). A map of county Roscommon showing area grids which exceed the reference level (Figure 2).
Recommendations of RPII for householders in High Radon Areas.

In all High Radon Areas the RPII would encourage householders to have radon measurements made in their homes in order to identify the individual dwelling with elevated indoor radon levels (at present the RPII will measure radon levels in houses for a small fee by placing a small testing device in the house for a period of 3 months or more - from 1999 this survey will be free of charge).

Where High Radon Levels are found, householders are encouraged to take remedial action to reduce the indoor radon level concentrations.

The RPII advises that all new dwellings built in high radon areas include some radon preventative measure. Advice on the most appropriate measures to be taken in either new or existing dwellings is available in the publication: “Radon in Buildings” (3).

Government support for householders with High Radon Levels:

1. A Remediation grant scheme: to commence in January 1998 was announced by Minister Stagg, Minister of State at the Department of Transport Energy & Communications on the 24th of April, 1997. This comprises a 50% grant (up to a maximum grant of £800 per dwelling) in respect of both private and local authority dwellings.

2. In Relation to radon protection measures for new houses: Minister Howlin, Minister for the Environment on the 4th of June, 1997 announced that the relevant Technical Guidance Document (TGD) of the Building Regulations will be amended to require the following:

   * New House in High Radon Area: foundations to incorporate measures such as sealed membrane of low permeability and a potential means of extracting radon from the sub-structure (e.g. a passive sump with an outlet)

   * New House outside High Radon Area: foundations must incorporate a potential means of extracting radon from the sub-structure.

Reducing exposure to indoor radon in the Western Health Board:

1. The public should be informed of the geographical location of the High Radon Areas.

2. Householders in High Radon Areas should arrange for their individual dwellings to be tested by the RPII at a cost of £15.00 per household.

3. Remediation grants for householders whose dwellings exceed the reference level of 200 Bq/m³ will be available from the Department of the Environment from January, 1998.

4. Planning Authorities should ensure that radon protection measures for new houses comply with the Department of the Environment Building Regulations.
References:


Figure 1

Map showing percentage of houses predicted to exceed 200 Bq/m² in each 10 km grid square

(Counties: Galway and Mayo)

(Adapted from Figure 6, page 16 RPII - 94/3)
Figure 2:

Map of County Roscommon showing the percentage of dwellings predicted to exceed 200 Bq/m² in each 10 km grid square.

Legend:
- > 20%
- 10 - 20%
- 5 - 10%
- 1 - 5%
- < 1%
- Insufficient Data

Grid: Irish National Grid

(From RPII - 97/1, Figure 10).

JF / Department of Public Health, Western Health Board

June 19th, 1997