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Indoor Air Quality: A Risk-based Approach to Health Criteria for Radon Indoors

Summary Report on a WHO Working Group

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ABSTRACT

The Working Group discussed to what extent exposure to radon is a public health risk. It reviewed data from epidemiological studies of the occupational exposure of miners and residential exposures, animal experiments and other relevant work. The Group confirmed radon to be a human carcinogen, and recommended that indoor situations where individual risks exceeded 10^{-3} per year should always be considered severe, and action to reduce the risk should always be taken. The Group also agreed that, when individual risks are less severe, further risk reduction must be sought based on procedures such as the optimization and evaluation of available control techniques. The Group considered what guidance could be offered to national authorities, and whether risks from radon should be considered solely within the present radiation protection framework policies or be handled as a part of a more integrated framework of all environmental risks; a three-step management scheme was proposed. The Group then discussed the problem of risk communication as a part of assisting policy-makers to arrive at strategies best suited to their socioeconomic conditions. The report concludes with 22 recommendations.



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TARGET 21

By the year 2000, air quality in all countries should be improved to a point at which recognized air pollutants do not pose a threat to public health.

Keywords

ENVIRONMENTAL HEALTH
AIR POLLUTION, INDOOR
RADON
RISK FACTORS
ENVIRONMENTAL EXPOSURE

Introduction

The Working Group was convened to assess the significance of risks to health associated with exposure to indoor radon, with a view to developing risk management policies and strategies based on health criteria. Twenty-two temporary advisers from 11 European countries, China, Israel and the United States were invited to participate. Representatives from the International Agency for Research on Cancer (IARC) and the WHO Regional Office for Europe also attended.

Discussion

The main question addressed was to what extent exposure to radon is a public health risk. Data available from epidemiological studies of the occupational exposure of miners and residential exposures, animal experiments and other relevant experimental work were reviewed. Based on these data, radon has been confirmed as a human carcinogen.

A number of recent case-control studies of non-occupational public exposure were reviewed. The Group also suggested that the results of several other large-scale case-control studies of residential exposure, expected to become available in the next 2-3 years will provide the best direct estimate of residential exposure for radiation protection, as well as a test of the adequacy of current extrapolation models.

Concerning risk management, it was queried as to what guidance could be offered to national authorities, and whether risks from radon should be considered solely within the present radiation protection policy framework or be handled as part of a more integrated approach to environmental risks. After defining the rationale and options for a radon control policy applied to different situations, and considering different regulatory and evaluation instruments, the Group came up with a three-step management scheme.

The first step would require the identification of potential sources of elevated exposure to radon. If a problem were found, the second step would comprise detailed surveys to identify populations at the highest risk and situations with the potential for leading to exposure. The last step would be the risk management strategy, dealing with the severity of the risk to health, the affordability of control measures and the preferred approach for control. It was agreed that the actual setting of indoor radon limits should be governed by two approaches: the "integrated risk approach", i.e. comparing the risk to health from radon with other potential radiological and non-radiological health risks, and the "conventional radiation protection

approach", i.e. using the ALARA principle in comparing between potential risks to health from radon and from other radiation sources.

The general apathy of the public with regard to the indoor radon issue creates a special challenge in the effort to communicate risk information. Hence, the Group took it upon itself to discuss the whole problem of risk communication as a part of the task of assisting policy-makers to arrive at strategies best suited to their socioeconomic conditions.

Conclusions

Risks to health

1. Radon, a human carcinogen, occurs in both mines and homes and poses an important public health problem.
2. The most powerful design for epidemiological studies for precisely quantifying the residential radon-related health risk is the case-control approach. However, few such studies with adequate statistical power are available at present.
3. Although residential exposures are generally lower than occupational levels, extrapolation is not made over a large range and cumulative residential exposures may even overlap occupational ones.
4. Despite differences in populations, methodology and exposure to other contaminants, studies on miners have consistently shown similar excess lung cancer risks from cumulative exposure.
5. A linear model for extrapolation of risk from miners to residential populations is considered a reasonable approach at present.
6. At present, the "time since exposure" model, as described in the BEIR IV report, modified to incorporate adjustments for uncertainties and differences in lung dosimetry, provides a reasonable basis for risk assessment and the setting of radiation protection guidelines and standards.
7. Although there are numerous uncertainties in radon risk assessment modelling, these are fewer than those associated with many other environmental and occupational carcinogens.
8. There is no conclusive evidence at present associating radon with effects on health other than lung cancer.

9. Smokers are at a higher total risk from radon exposure than nonsmokers because the combined risk of smoking and radon exposure is more than additive.

Risk management

10. Tools for controlling the risk from indoor radon are not being extensively used, and considerable effort is needed to create a proper basis for dealing with this task.
11. Management of the radon risk addresses questions both of radiation protection and of indoor air health concerns. This has resulted in different authorities being in charge of this question in different countries.
12. Some countries apply an "indoor radon action level" in the design of new houses, which is lower than the action level applied to existing houses.

Risk communication

13. An effective radon risk communication programme involves testing alternative messages with appropriate audiences, such as scientists and home owners, prior to public distribution, to ensure that such messages are clear and accurate and achieve their aims.
14. Effective radon risk communication programmes involve key issues, such as identifying target audiences, enlisting sources respected by the target audiences, and making use of the existing communications channels available to these sources.

Recommendations

Risks to health

1. Future epidemiological case-control studies aimed at precisely quantifying the effect of radon exposure in the home should be conducted in regions of high and varied radon concentrations and be controlled for age, sex, occupational exposure, site of exposure and especially tobacco smoking.
2. Pooled analysis of indoor radon studies should take place and the necessary methodology should be improved.
3. Pooled analysis of data on miners should proceed and address specifically the effects of dose rate and low doses.

4. In both indoor and mine studies, the question of the magnitude of risk to nonsmokers and the interaction between radon exposure and smoking should be addressed.

5. Laboratory investigations of the molecular and cellular effects of alpha-emitters in general, and radon in particular, should be carried out.

6. To help in the prediction of risk, especially at lower exposures not accessible to epidemiological studies, elucidation of the mechanisms by which radon and its progeny induce lung cancer, and the construction of biologically-based models, should be encouraged.

Risk management

7. A comprehensive radon policy, with a built-in evaluation programme, should be designed in which the regulatory approach comprises only a small part and into which other approaches such as risk assessment, measurement protocols, contractor training and mitigation should be integrated.

8. A national policy should be taken in a step-by-step manner, from characterization of the problem to implementation. Accordingly, different types of pilot studies should be carried out to identify potential sources of radon exposure, detailed national surveys should be initiated, and a national risk management strategy should be defined.

9. Construction materials that can be a source of radon should be avoided, and building codes and guidelines that apply especially to radon affected areas should be developed.

10. When addressing populations at risk, the risk reduction strategy should cover homes, schools and other public buildings.

11. The risk reduction strategy should also include places of work by applying occupational standards in industry, where applicable. Where radon exposure is incidental to the work situation (e.g. normal offices) the action levels and guidelines should be the same as those applicable to homes.

12. Priority should be given in risk reduction to individuals at high risk, while at the same time reduction of the risk to the overall population should be addressed.

13. Indoor situations where individual risks exceed 10^{-3} per year should always be considered severe, and action to reduce the risk should always be taken. When individual risks are less severe, further risk reduction must be sought based on procedures that include criteria such as optimization and evaluation of available control techniques. These procedures should not be limited to a cost-benefit analysis; social and equity considerations, as well as comparisons with radiation protection and other relevant risk management approaches, should also play a role.
14. The actual setting of indoor radon limits below the level of severe risk should be governed by the integrated risk approach and by the conventional radiation protection approach.
15. In future, the radon policy should be integrated into a global risk management strategy, for which the various policy tools are developed in a consistent way.

Risk communication

16. Countries should collect baseline information on existing attitudes and perceptions about radon before initiating a risk communication programme.
17. The goal of a radon communications programme should be to provide accurate scientific information to reduce radon health risks.
18. Continuous evaluation and improvement of the risk communication programme should be undertaken in order to achieve the overall communications goals.
19. For special target audiences, appropriate (and possibly different) radon risk communication messages should be prepared.
20. Radon risk communication efforts should be linked to key issues, such as the availability of qualified radon contractors and testing services.
21. Messages should be repeated and reinforced; a one-time message will not result in behavioural change.
22. Countries should be encouraged to share information and discuss new findings in the area of radon risk communication.