INDOOR GAMMA CONTRIBUTION TO NATURAL RADIATION EXPOSURE IN ITALY

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ABSTRACT

In the context of the National Survey on natural radiation indoors, based on a representative sample of 5000 dwellings, absorbed dose rates to air have been measured. Thermoluminescent dosemeters have been used and a well detailed measurement protocol has been elaborated. The paper analyzes the results obtained in 30% of the national sample. The arithmetic mean value obtained is 86 nGy/h. The distribution of absorbed dose rates in most of the Districts is well fitted by a Gaussian curve. The effective dose for the population has also been assessed, taking into account the occupation factors of dwellings.

INTRODUCTION

The influence of gamma and cosmic radiation on the effective dose received indoors by members of the public is generally far less important than that of radon concentration. However, measurements of the radioactive content of some natural and man-made building materials and surveys in certain areas, undertaken in Italy(1,2), indicated that a better evaluation of this irradiation source would be important. For this reason, in organizing the National representative survey on natural radiation indoors(3), it was decided to carry out measurements both of radon concentration and of absorbed dose rate to air. Moreover, the gamma measurements could also give information about the building materials as a source of indoor radon.

The survey is performed in each Italian District, in cooperation with local Health Services and Laboratories and involves a sample of 5000 dwellings selected through a two-stage stratified sampling technique.

METHODOLOGY

Due to the considerable number of District Laboratories involved, each one using different equipment and operators and having a wide spectra of thermoluminescent experience, it was decided to standardize - as far as possible - the whole measuring procedure by means of a detailed protocol. The use of the protocol should allow both to assure comparability of the data obtained in the different laboratories and to minimize dose uncertainties, so as to achieve an overall expected uncertainty in the range of (30÷40)% at 95% confidence level.

According to results in ref.4, LiF synthered chips, either doped with Mg and Ti or with Mg, Cu and P, belonging to the same batch, have been used. The dosemeter is made of two pairs of TL chips, enclosed in light-tight plastic containers, 100 $mg \cdot cm^{-2}$ thick. It is located, like the radon detectors, on a cupboard in one bedroom of each sampled dwelling.

The thermal cycles for re-use anneal, pre-heat and readout were defined, according with refs.4-7. In addition, two initialization cycles have been suggested for new detectors.

A check of sensitivity and zero signal of the reader at the beginning and the end of each daily reading cycle is required.

In order to further improve the homogeneity of the results obtained in the different laboratories, a number of preliminary tests are recommended in the protocol. Some of them regard just the detectors (individual sensitivity, batch homogeneity and fading), some others the whole TL system (reproducibility and linearity) (8).

QUALITY ASSURANCE

A first intercalibration was carried out by exposing a sample of dosemeters prepared by each participating laboratories, to the beam of a Cs-137 source. Secondly, another set of dosemeters was exposed to the environmental radiation characterizing a selected high-background room, where dose rate had been previously evaluated. Both sets of detectors were read by the laboratories involved in the experiment, which ignored the actual value of the administered doses.

The results of the intercalibrations (see Fig.1) show good agreement among the different laboratories and confirm the reliability of the respective dosemeter systems.

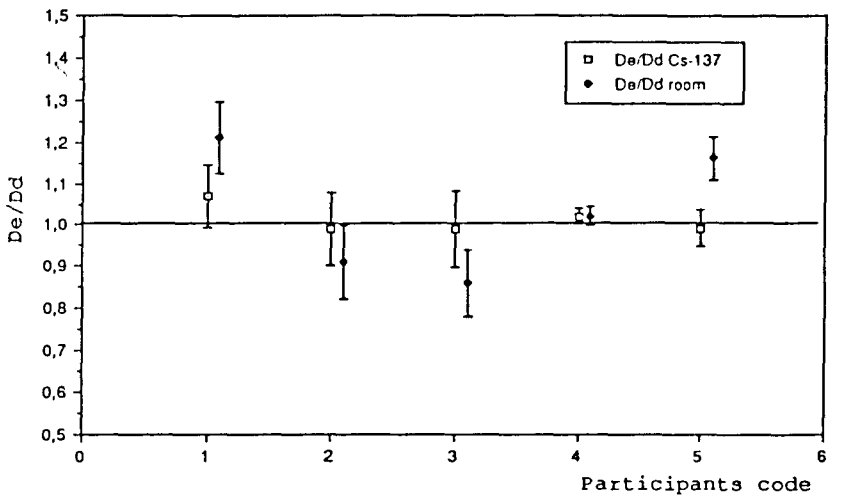

Fig.1 Results of the intercalibration tests (ratio between evaluated and delivered doses)

At the end of the 6-month period of indoor exposure, an analysis of readout values was made. The aim was to identify the possible outliers, by statistical comparison of readout values of the four detectors placed in each dwelling.

RESULTS

The survey is still in progress. At present the absorbed dose measurements have been completed in 7 Districts, corresponding to about 30% of the whole representative sample.

Figure 2 shows the best fits of absorbed dose rates to air evaluated in different Italian Districts. The goodness of the Gaussian fit is generally acceptable.

Figure 3 illustrates the absorbed dose rate distribution in all the dwellings considered. The values higher than 250 nGy/h all belong to one District and are also connected with the use of high-radioactivity building materials (e.g.tuffs).

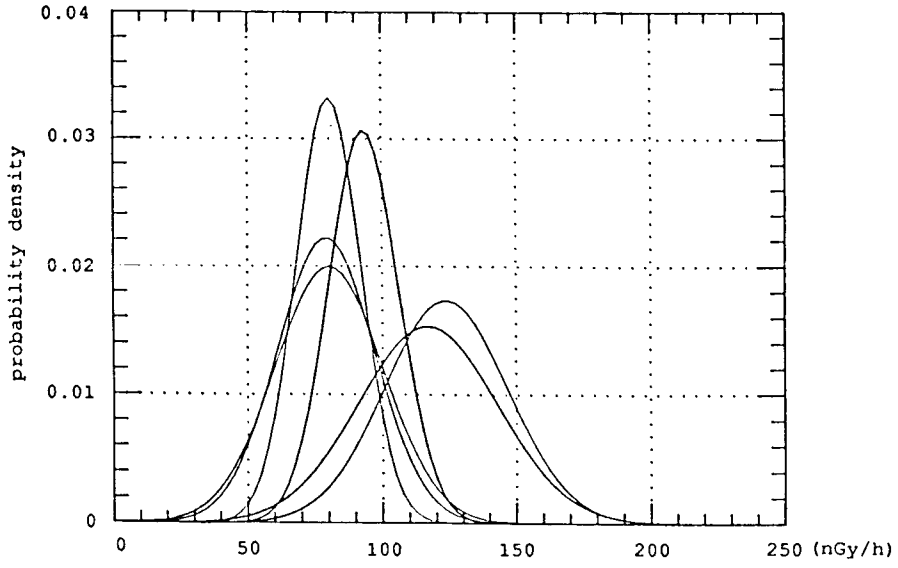

Fig.2 Best fits of absorbed dose rate to air evaluated in different Districts

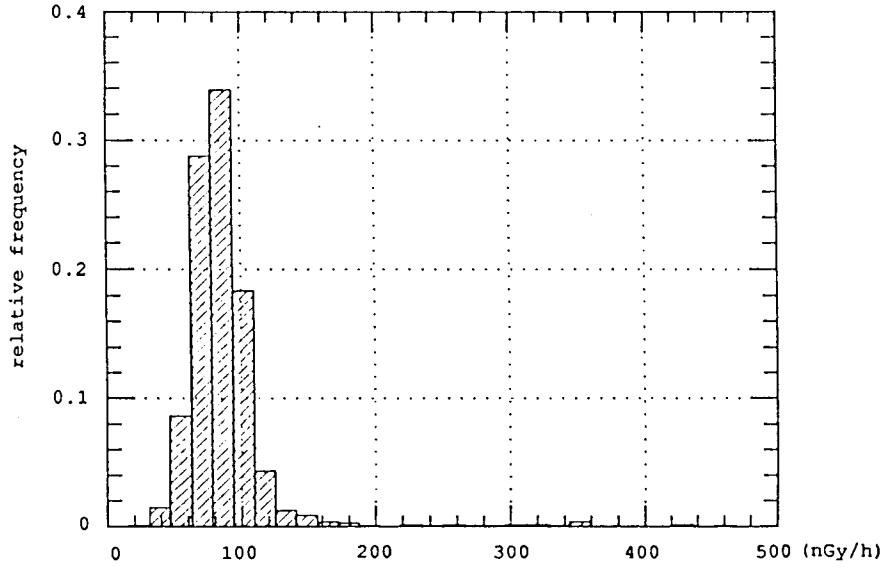

Fig.3 Absorbed dose rate distribution in 30% of the national sample

CONCLUSIONS

The mean value of the absorbed dose rate to air, weighted over the dwellings under consideration, is equal to 86 nGy/h. Mean values in the different Districts range from 75 to 165 nGy/h. The occupation factors indoors at home and elsewhere, in each District, obtained through questionnaires(3) filled by the families in the sample, have been taken into account. For the same purpose a rough evaluation of cosmic radiation

contribution has been made and this value has been subtracted for all dwellings. The mean effective dose for the population associated to γ indoors was thus assessed as 0.33 mSv per year.

The values obtained confirm that - in the radiation exposure of the population - the γ absorbed dose contribution is far less relevant than radon concentration.

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