Radiation Protection Dosimetry
Vol. 36 No. 2/4 pp. 331–333 (1991)
Nuclear Technology Publishing

RADON AND LUNG CANCER IN SPAIN

L. S. Quindos†, J. Soto†, P. L. Fernández†, C. Rodenas†, J. Gómez†, J. Arteche‡, G. Romero§ and J. Madrid||
†Department of Physics and Medical Physics, Faculty of Medicine
University of Cantabria, Santander, Spain
‡Centro Meteorológico del Cantábrico, Santander, Spain
§Dirección Regional de Sanidad, Santander, Spain
||Instituto Social de la Marina, San Vicente, Spain

Abstract — It is known that the incidence of lung cancer is related to inhalation of radon and radon daughters. However, the magnitude of the risk and its dependence upon physiological and environmental factors are still not well defined either experimentally or epidemiologically. Occupational studies of underground miners are the only available human epidemiological information to estimate the risk of exposure to radon daughters in the indoor environment. The results are shown of a study carried out to determine whether lung cancer mortality rates in Spain are significantly correlated with the average indoor radon levels. For this purpose, we have used indoor radon data generated from the national survey carried out in 1989. Lung cancer distribution by cities and deaths, by year of death and sex, were retrieved for each of the different provinces of Spain for the period 1960–1985, showing the evolution and changes in the incidence of lung cancer in the population. Data referring to the evolution of lung cancer for males and females from 1940 until 1985 are also shown. Since cigarette smoking has been linked to lung cancer the effect of smoking habits in the Spanish population was also considered in this analysis. The first results of this study establish no clear evidence of any substantial association between lung cancer mortality rates and indoor radon for males. However, a relationship was evident for females.

INTRODUCTION

Research directed towards indoor air pollution and its adverse health effects began in the late 1960s and early 1970s. This was stimulated further by concern that reduced ventilation of buildings for the purpose of energy conservation would increase pollutant concentration and lead to adverse effects on health. Consequently, a large body of literature is now available on diverse aspects of indoor air pollution including source concentrations, health effects, mitigation and policy[1,2].

As information on indoor air quality accumulated, it became apparent that radon and its decay products are invariably present in indoor environments and that concentrations may reach unacceptable levels in some dwellings. Because radon progeny are known to cause lung cancer in underground miners, the recent recognition that some homes may have extremely high levels of radon has focused concern on lung cancer risk to the general public.

Because of the difficulties involved in extrapolating risk coefficients based on exposure in the mining environment to exposure in the indoor environment, at present, epidemiological investigation represents a satisfactory approach for describing the risks of indoor radon[3]. The results of a national survey of indoor radon in Spain is presented and the relationship of these values to the lung cancer mortality rates in the Spanish population are studied.

METHODOLOGY

During 1989, a national survey was carried out in more than 2000 homes throughout the country. The measurements were made during the winter under closed-house conditions employing modified Lucas cells calibrated at the NRPB in the third CEC intercomparison of active detectors[4] with a LLD evaluated as 17 $Bq.m^{-3}$ for a counting time of 10 min. Figure 1 shows the log–normal distribution of the measurements. The geometric mean was 40.7 $Bq.m^{-3}$ with a geometric standard deviation of 2.6.

Figure 2 represents the geographical distribution of the values. The higher radon levels are located

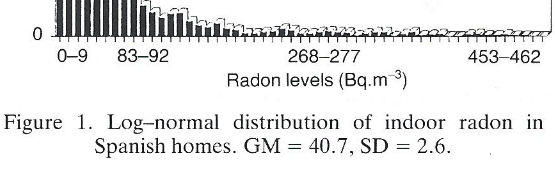

Figure 1. Log–normal distribution of indoor radon in Spanish homes. GM = 40.7, SD = 2.6.

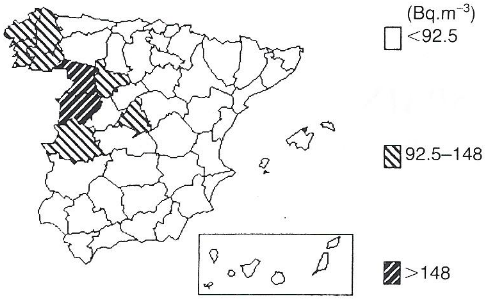

Figure 2. Geographical distribution of indoor radon in Spain.

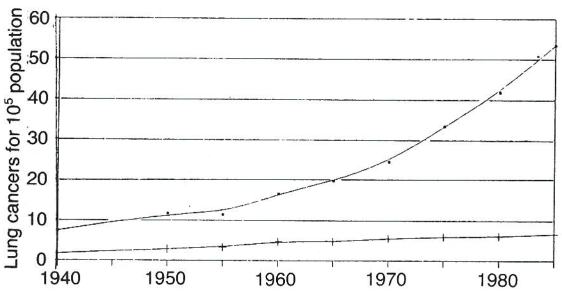

Figure 3. Lung cancer mortality rates for males (●) and females (+) in Spain from 1940 to 1985.

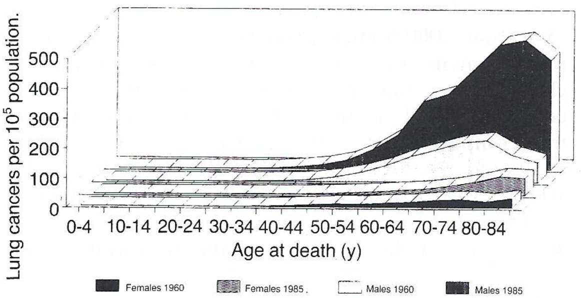

Figure 4. Lung cancer mortality rates by age of death for males and females for 1960 and 1985.

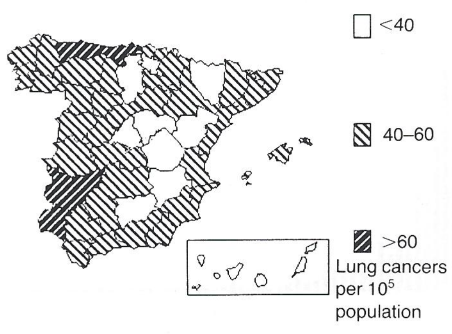

Figure 5. Geographical distribution of lung cancer mortality rates for males from 1980 to 85.

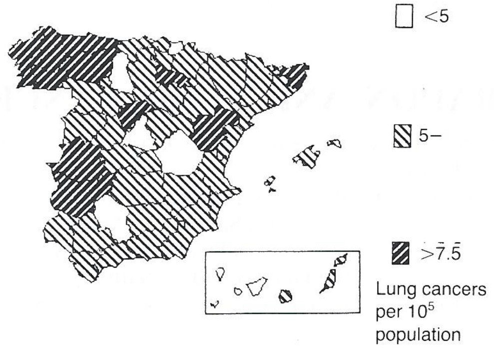

Figure 6. Geographical distribution of lung cancer mortality rates for females from 1980 to 1985.

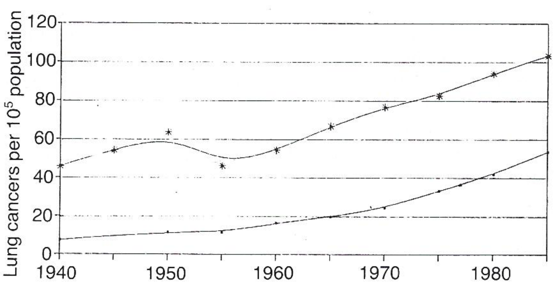

Figure 7. Lung cancer mortality rates for males (●) and smoking rates (*) expressed as packs of cigarettes per person per year.

principally in the west of the country, where we also measured higher radioactive contents in a total of more than 1000 soil samples collected from all over the country.

Figure 3 includes the evolution of lung cancer mortality rates for males and females from 1940 to 1985. Deaths from lung cancer are now 5% of the total annual deaths in Spain, and if we only consider cancer as a cause of death, then lung cancer represents 25% for males and 4% for females. It is important to see the notable increase of mortality from 1960, especially for males. A factor of four from that time to 1985 was found, data fitting an exponential function. For females, the factor was only of two and the increase responds to a linear function.

Figure 4 displays the lung cancer mortality for males and females in 1960 and 1985. Few lung cancer deaths occur below the age of 50; the highest incidence occurs in the age interval 70–74. The mean life expectancy for both sexes is around 71 years.

Figures 5 and 6 show the geographical distribution of lung cancer mortality rates for males and females. For males, if we compare Figure 5 with Figure 2, we see that it is very difficult to establish any relationship between radon and lung cancer. Nevertheless, when comparing Figure 6 with Figure 2 one might conclude that places with high radon levels have a higher incidence of lung cancer among females.

In both cases, though better in the case of males, a clear correlation is shown in Figure 7, where we illustrate the historic pattern of cigarette consumption together, with the lung cancer mortality rates. If we take into account a quarter of a century time lag for the latency period for lung cancer, mortality clearly parallels the pattern of cigarette consumption.

From these first results we may draw the following conclusions.

(1) The first database about indoor radon in Spanish homes and lung cancer mortality rates has been established.

(2) For males, no evidence for a relationship between lung cancer mortality rates and indoor radon levels has been found. Cigarette smoking makes it more difficult to prove any relationship for the environmental radon levels measured.

(3) The correspondence between an increase of the lung cancer mortality rates for females and areas of high radon levels suggests that more specific studies for this population in these areas might be worth pursuing.

ACKNOWLEDGEMENTS

This research was performed under contracts CEE (B16-0341-E), DGICYT (CE 88-0009), CSN (C89-001) AND FISss (S-89-0575). We are indebted to many of our colleagues for reviews and suggestions.

REFERENCES

1. Crawford, W. A. *On Air Pollution Environmental Tobacco Smoke, Radon and Lung Cancer.* J. Air Pollut. Control Assoc. **38**, 1386-1391 (1988).
2. Spengler, J. D. and Sexton, K. *Indoor Air Pollution: A Public Health Perspective.* Science **22** 1,9-17 (1983).
3. Samet, J. M. and Nero, A. V. *Indoor Radon and Lung Cancer.* N. Engl. J. Med. **320**, 591-598 (1989).
4. Miles, J. C. and Sinnaeve, J. *Results of the Third CEC Intercomparison of Active and Passive Detectors for the Measurement of Radon and Radon Decay Products.* Report EUR 11882 EN (Brussels: CEC) (1988).