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ASSESSMENT OF INDOOR RADON CONCENTRATIONS IN TIRANA'S SCHOOLS AND WORKPLACES USING PASSIVE TECHNIQUES

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ABSTRACT

Radon monitoring in Albania has been focused on schools and workplaces, where radon is classified as an existing exposure risk. This study was conducted in Tirana, home to approximately one-third of Albania's population. The geological profile of Tirana comprising recent volcanic rocks, granitic formations, and permeable soils near seismic zones contributes to increased indoor radon potential and, consequently, in elevated health risks due to higher exposure levels.

The survey included 80 schools and 70 workplaces, with measurements taken on first floors and basements. Passive radon detectors (CR-39) were deployed for three-month periods in two different periods, winter and spring. These measurements were conducted by using passive monitoring methods. In schools, detectors were primarily installed in classrooms, libraries, and gymnasiums; meanwhile in workplaces, they were placed in offices, meeting rooms, and laboratories.

In many cases, indoor radon concentrations exceeded the recommended reference level of 300 Bq/m³. Detected radon levels ranged from 24 to 1000 Bq/m³ in schools and from 22 to 400 Bq/m³ in workplaces. A descriptive analysis revealed a positively skewed and peaked distribution, indicating that the data follow a log-normal distribution. Based on these results was performed the Natural Radiation Background Assessment and Determination in Tirana district and the average dose rate level was 0.063 µSv/h. The findings highlight the need for immediate mitigation measures, such as improving ventilation systems and conducting regular monitoring. Continuous radon surveillance is recommended to maintain safe levels and minimize health risks. Additionally, increasing public awareness especially among vulnerable groups is essential to address the health hazards of radiation exposure to radon.

INTRODUCTION

Radon in indoor dwellings has a special attention in many countries worldwide. Some countries have already established national radon plans for addressing such issue. However, this issue has not yet been approached in a systematic way in Albania. Also, Albania as a membership candidate for EU is obliged to harmonize its legislation, including radiation protection field in which the exposure due to radon has an important contribution [8-10]. The primary goal for the establishment and implementation of the radon national strategy is raising awareness about the harmful effects of public exposure to radon and implementing a set of measures for its reduction. It can be achieved through the collaboration between national organizations responsible for public health and radiation protection [3].

Exposure to radon and radon decay products in dwellings and workplaces constitutes one of the greatest health risks from exposure to ionizing radiation due to natural radioactivity [1-2].

. According to World Health Organization (WHO 2009) tens of thousands of deaths per year from cancer are caused by exposure to radon and its decay products. Therefore, it is important to develop a radon national strategy and raise the awareness of national authorities and the public about the risks related to radon exposure. The last is also envisaged in the action plan for the primary prevention of cancer, in the framework of the National Programme of Cancer Control 2011-2020 launched by the Ministry of Health.

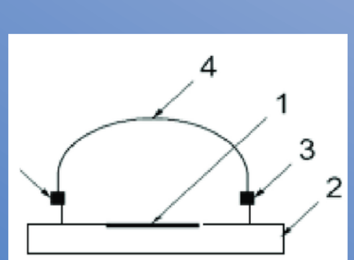
The relationship between the lung cancer risk and radon exposure is well known and the evidence of this relationship comes from epidemiological studies with miners, especially from uranium mines, who are potentially exposed to high levels of radon. .

METHODS and RESULTS

Studied area

The measurements of radon concentration at schools and workplaces are performed randomly in different areas of Tirana city, where lives about one-third of the population of Albania. In this survey are included 80 schools and 70 different workplaces on the first floors and basements. In schools the detectors were placed mainly in different cabinets, libraries and gym rooms, whereas in workplaces the detectors were placed in offices, meeting rooms and laboratories.

The geological structure of Tirana territory comprises recent volcanic rocks, granitic areas and high permeability soils located in the vicinity of seismic areas. The study area of this paper is located in a geological formation where dominate the depositions of Early Holocene (Holocene starts from 11,700 years), which are represented by the aluvions and proluvions deposits that build the entire field of Tirana and are products formed by the streams of Erzeni, Tiranë, Tërkuzë, Lana rivers. The thickness of these deposits is up to 70-80 m. Lithologically, they consist of clay, aleurolite, fine sand, and coarse, rounded gravel. Consequently, any increase in indoor radon concentration is associated with greater exposure, which in turn raises the risk of adverse effects on human health



This study presents the findings of the indoor radon concentration measurements in schools and workplaces in Tirana city, capital of Albania, where lives one - third of the population. In this survey are included 80 schools and 70 different workplaces on the first floors and basements during the periods December 2012 – February 2013 and February 2013 – April 2013.

The values of radon concentrations were found to vary from min value and max value, 24 Bq.m^{-3} to 677 Bq.m^{-3} in schools and 22 Bq.m^{-3} to 405 Bqm^{-3} in workplaces.

The value 1000 Bq.m^{-3} found in the basement of one of the schools is considered to be an outlier from statistical analysis distribution.

The geometrical mean (GM) was found to be 99^{-50}_{+103} Bqm^{-3} with geometric mean, standard dev (GSD) equal to 2.0 in workplaces and 153^{-84}_{+182} Bq.m^{-3} with geometric mean standard dev (GSD) equal to 2.2 in schools.

A descriptive analysis revealed a positively skewed and peaked distribution, indicating that the data follow a log-normal distribution. in both cases, checked by the Kolmogorov–Smirnov test (P > 0.05), that is shown in Figure 1.

The frequency distribution of radon concentration in schools is presented with blue color while the in workplaces is presented in red color.

RESULTS AND DISCUSSION

This study presents the findings of the indoor radon concentration measurements in schools and workplaces in Tirana city, capital of Albania, where lives one - third of the population. In this survey are included 80 schools and 70 different workplaces on the first floors and basements during the periods December 2012 – February 2013 and February 2013 – April 2013.

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Measurement	Workplaces		Schools	
category	Rn conc.	ln(Rn conc.)	Rn conc.	ln(Rn conc.)
	Bq m^{-3}		Bq m^{-3}	
No.	70		80	
Range	22-405	3.1-6.0	24-677	3.2-6.5
Average (AM)	126	4.6	208	5.1
Median	103	4.6	149	5.0
Standard dev.	91	0.7	163	0.8
Skewness	1.4	-0.1	1.3	<0.1
Kurtosis	1.7	-0.4	0.9	-0.5

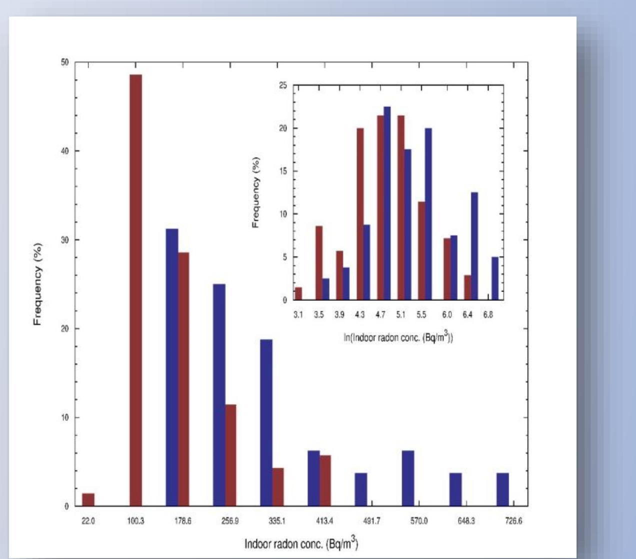

FIG. 1. The frequency distributions of indoor radon concentration in schools (blue color) and workplaces (red color). The inset figure shows the frequency distribution of the logarithmic transformation.

About 14 % of radon concentration measurements in schools exceeds the reference level of 300 Bq m^{-3} compared with 4% of radon concentration measurements in workplaces.

The arithmetic mean (AM) indoor radon concentration was found to be 208 ± 163 Bq/m³ in schools and 126 ± 91 Bq/m³ in workplaces. This difference in radon levels between schools and workplaces may be attributed to variations in occupancy time, ventilation practices, and building usage. In schools, limited window opening, less effective ventilation systems during the day, and prolonged closure during the winter holiday period could contribute to higher radon accumulation. However, these measurements are comparable to the indoor radon concentration in dwellings, measured in Tirana region, which were found to have an arithmetic mean (AM) of 112 ± 83 Bqm^{-3} and a geometrical mean (GM) of96+-48 Bq $^{m-3}$.

CONCLUSIONS

In this study, indoor radon concentration measurements were conducted in public buildings across Tirana, the capital of Albania, where lives approximately one-third of the national population. The survey included 70 workplaces and 80 schools. Based on the collected data, the arithmetic mean (AM) indoor radon concentration was determined to be 126 ± 91 Bq/m³ in workplaces and 208 ± 163 Bq/m³ in schools.

The distribution of radon concentrations in both building types was found to follow a log-normal distribution, consistent with findings from similar studies conducted in other countries of the region. These results underline the significance of building type, occupancy types, and ventilation practices in indoor radon levels.

Given the observed concentrations and the potential health risks associated with long-term radon exposure, it is recommended that the monitoring of indoor radon levels in public building particularly schools and workplaces to be expanded in all the country. Continued and comprehensive radon surveys will be essential for the development of a national radon strategy in Albania, aiming the exposure mitigation and public health protection.

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