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A study of seasonal variations of radon levels in different types of dwellings in Sri Ganganagar district, Rajasthan

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ABSTRACT

An indoor radon survey has been carried out in 50 dwellings situated in Sri Ganganagar district of Rajasthan using a time-integrated passive technique containing LR-115 type II solid state nuclear track detectors exposed for four seasons of 3 months each covering a period of 1 y. Indoor radon concentration values varied from 144 ± 20 to 259 ± 67 Bq m^{-3} in winter, 111 ± 23 to 156 ± 64 Bq m^{-3} in rainy, 97 ± 13 to 156 ± 19 Bq m^{-3} in summer and 103 ± 17 to 213 ± 76 Bq m^{-3} in autumn time and the average values were found to be 182 ± 31, 126 ± 15, 119 ± 20 and 146 ± 30 Bq m^{-3}, respectively. The annual average indoor radon concentration varied from 114 ± 18 to 194 ± 45 Bq m^{-3} with an average of 143 ± 21 Bq m^{-3}, which is less than the lower limit of the action level (200–300 Bq m^{-3}) recommended by International Commission on Radiological Protection. The annual exposure to occupants, annual effective dose and lifetime fatality risk in dwellings varied from 0.50 to 0.85 WLM with an average of 0.63 WLM; 1.95 ± 0.31 to 3.32 ± 0.78 mSv y^{-1} with an average of 2.45 ± 0.36 mSv y^{-1} and 1.51 × 10^{-4} to 2.56 × 10^{-4} with an average of 1.89 × 10^{-4}, respectively. Measured values for winter/summer, winter/rainy and winter/autumn radon ratios were found as 1.54 ± 0.29, 1.48 ± 0.35 and 1.28 ± 0.24. An effort has been made to find possible relationships of indoor radon levels with building construction materials and ventilation condition of dwellings.

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1. Introduction

Radon is a chemically inert, naturally occurring, cancer-causing radioactive gas. Radon gas has no smell, color, or taste and is produced from the natural radioactive decay of uranium which is found in rocks and soil. Radon gas escapes easily from rocks and soils into the air and tends to concentrate in enclosed spaces, such as underground mines, houses, and other buildings. Soil gas infiltration is recognized as the most important source of residential radon (WHO, 2009a, p. 94). The radiation dose from inhaled decay products of radon (^{222}Rn) is the dominant component of radiation exposure to the general population and causes an increased risk of lung cancer (UNSCEAR, 2000).

Radon was classified as a human carcinogen by International Agency for Research on Cancer (IARC, 1988). In general, residential radon is regulated by a reference level of radon concentration between 200 and 300 Bq m^{-3} based on International Commission on Radiological Protection recommendations (ICRP, 2010). About the action level of radon, the World Health Organization has suggested that homeowners take actions when radon levels exceed 100 Bq m^{-3}. This is much more conservative figure than the Environmental Protection Agency (EPA) action level of 148 Bq m^{-3} (EPA, 1991), which has been the U.S. standard for many years (WHO, 2009b). The concentration of indoor radon and its decay products shows large temporal and local fluctuations in the indoor atmosphere due to the variation in topography, house construction type, soil characteristics and weather (Duggal, Rani, & Mehra, 2013; Mehra, Singh, & Singh, 2006). Relatively higher indoor radon levels are observed in winter season (Rani, Singh, & Duggal, 2013). The seasonal variation of the indoor radon levels depends on several parameters such as type of house, radon source, living habits of the inhabitants, ventilation system of the house, heating of the house and outside climate (Durrani & Ilic 1997).

Human beings are exposed to radon through inhalation and ingestion. Radon monitoring has been increasingly conducted worldwide because of the hazardous effects of radon on health of human beings. In many situations such as showering, washing clothes and flushing toilets, radon is released from the water and mixes with the indoor air. The radon from water contributes to the total inhalation risk associated with radon in indoor air. Although radon in drinking water does not pose a direct health risk (Cross, Hartley, & Hoffmann, 1985).

Seasonal variation of indoor radon concentration and some influencing factors have been studied during a 1 y period in the dwellings made of different building materials in Sri Ganganagar district of Rajasthan. The annual exposure to occupants, the annual effective dose received by them, and their lifetime fatality risk estimates were assessed in light of guidelines given by International Commission on Radiological Protection (ICRP, 1993). An effort has been made to find possible relationships of indoor radon levels with building construction materials and ventilation condition of dwellings.

2. Materials and methods

2.1. Study area

Rajasthan is located in northwest of India. The Sri Ganganagar district is situated in the northern most region of the state and forms a part of Indo-Gangatic plain. It is located between 28° 42′ and 30° 11′ North latitudes and between 72° 38′ and 74° 17′ East longitudes. It has a geographical area of 10,978 km^2. The population of Sri Ganganagar district is approximately 20 lakh. It is bounded on the south by Bikaner district and on the east by Hanumangarh district and on the north by Faridkot & Ferozpur districts of Punjab and on west by Bahawalpur district of Pakistan (Fig. 1). The climate of the district is marked by the large variation of temperature, extreme dryness and scanty rainfall. The area is covered by windblown isolated sand and alluvium except few patches of recent calcareous and sandy sediments associated with gypsite. The oldest

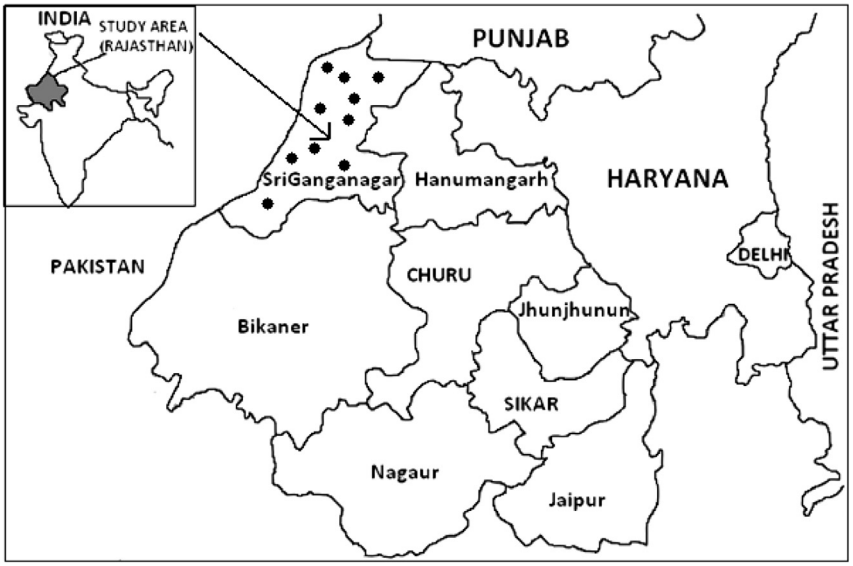

Fig. 1 – Map of Rajasthan showing the surveyed area during the present investigations.