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Original article

Preliminary assessment of excess life time cancer risk due to radon exposure in small scale Tanzanite mines in Tanzania

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ABSTRACT

Objective: To assess the excess life time cancer risk (ELCR) due to radon exposure in small scale Tanzanite mines in Northern Tanzania.
Methods: Radon concentrations were measured using the solid state nuclear track detectors (SSNTD) type CR-39. Three to six CR-39 detectors were placed in the underground working environment of each mine for a period of four months then removed and sent to Niton laboratory in Italy for processing and determination of radon concentrations. The obtained radon concentrations were used to estimate exposure to radon progenies, excess relative risk (ERR) of developing lung cancer, total lung cancer risk (TCR) and excess lifetime cancer risk (ELCR) using standard equations.
Results: The radon levels in 58% of the assessed mines were below the action level of 300 Bq/m^3 recommended by the International Commission on Radiological Protection (ICRP) while 42% were above this limit. The estimated mean exposure to radon and its progenies ranged from 0.08 to 1.18 WLM corresponding to annual effective doses of 0.8 and 11.8 mSv/year, for the minimum and maximum values respectively. These values are below the annual limit of 20 mSv for occupational exposure recommended by the ICRP. The ELCR estimated using simplified linear model from BEIR IV report ranged from 0 to 0.03% which is below the U.S. EPA action level of 1.3% due to radon exposure of 148 Bq/m^3.
Conclusion: The ELCR due to exposure to radon in the assessed mines is negligible. However, follow up studies are recommended as the depths of the mines increase especially in the mines were radon concentrations exceeded the action level.

1. Introduction

^{222}Rn is a radioactive gas which is formed naturally by the decay of ^{238}U bearing minerals in rocks and soils. It is the immediate daughter of ^{226}Ra which is present at varying degrees in soils and rocks. ^{222}Rn decays by emitting alpha particles (5.590 MeV) to produce short-lived progenies namely ^{218}Po, ^{214}Po, ^{214}Bi, and ^{214}Pb. Studies have long concluded that exposure to radon and its short-lived progenies in air is the second leading cause of lung cancer after tobacco smoking.[1–4] Several studies have consistently demonstrated significant associations between cumulative radon exposure and lung cancer mortality.[5–7] Also, epidemiological studies of occupational exposures of miners and domestic exposures of the public have provided strong and complementary evidence of the risks of lung cancer following inhalation of radon and its progenies. According to the reports of United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), exposure to radon represents the most significant contribution to occupational radiation exposure in underground mining operations.[8,9]

The risk of developing lung cancer increases as the radon exposure increases. Similarly, the excess lifetime cancer risk (ELCR) is higher with higher radon levels. According to literature, excess lifetime cancer risk refers to the increased chance of developing cancer due to exposure to carcinogens, beyond the natural background risk of cancer. It is an additional possibility that a person may develop cancer if that person is exposed to additional cancer-causing materials for a longer time.[10] From the radiation protection point of view, ELCR is the possibility of developing cancer because of radiation exposure, considering that the average age of a human is 70 years.[11] ELCR is among the most important parameters to indicate a radiological health risk for the members of the public and workers. The small-scale mining sector in Tanzania employ hundreds of small scale miners and it is a source of livelihood for the surrounding communities and beyond. A study by Mbuya et al.[12] has indicated that the tanzanite small scale miners in Mererani are highly exposed to respirable crystalline silica (RCS), which increases the risk of

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