Assessment of radon concentrations and environmental correlations in public schools of Safi, Morocco: a spatial and statistical analysis

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INTRODUCTION

Radon is a naturally occurring radioactive gas that is imperceptible, scentless, and devoid of color. It originates through the decomposition of uranium present in soil and lithological formations, subsequently infiltrating enclosed environments, particularly inadequately ventilated areas. Radon is acknowledged as the second foremost contributor to lung carcinoma subsequent to tobacco consumption, signifying a considerable public health menace on a global scale. This peril is especially amplified in educational establishments where learners and personnel engage in prolonged durations. Consequently, it is imperative to systematically assess radon concentrations within academic institutions to protect the well-being of school inhabitants and alleviate extended exposure hazards.

METHODS AND MATERIALS

This investigation was executed over a duration of five months, spanning from September 21, 2024, to February 21, 2025, encompassing thirty public educational institutions situated in Safi, Morocco. Radon concentrations were evaluated utilizing passive detectors (DSTN LR-115), augmented by real-time monitoring apparatuses (Airthings View Plus and View Radon), which documented radon levels, temperature, and humidity. The spatial distribution of radon concentrations was examined employing ordinary kriging methodologies within QGIS software. Also, rigorous statistical studies were implemented to delve into the links between radon levels and environmental aspects such as humidity and temperature.

	mean	std
Radon (Bq/m³)	34	23
Temperature (˚C)	19	2
Humidity (%)	60	9

Table: Average and standard deviation of temerature, humidity and radon in classrooms during study perdiod.

RESULTS & DISCUSSION

The analysis disclosed that the average radon concentration within the examined educational establishments stood at 34 ± 23 Bq/m³, with a maximum concentration observed at 138 Bq/m³. About 31% of the evaluated radon readings went beyond the internationally advised cap of 39 Bq/m³, which corresponds with results from comparable studies done in diverse geographic areas (WHO, 2021; EPA, 2016). The environmental parameters within the educational facilities exhibited an average temperature of 19 ± 2 °C and a humidity level of 60 ± 9% (table). Findings from the research revealed strong inverse links between radon amounts and temperature ($p < 0.001$), and weak positive connections to humidity ($p = 0.03$), pointing to the idea that increased temperature and humidity are tied to reduced radon presence. This research corroborates prior academic literature that maintains temperature and humidity greatly affect radon dynamics in indoor locations (Singh et al., 2016). The negative correlations identified may be elucidated by the phenomenon of enhanced ventilation and increased moisture content, which collectively mitigate the accumulation of radon gas (Akbari et al., 2013; Ivanova et al., 2021).

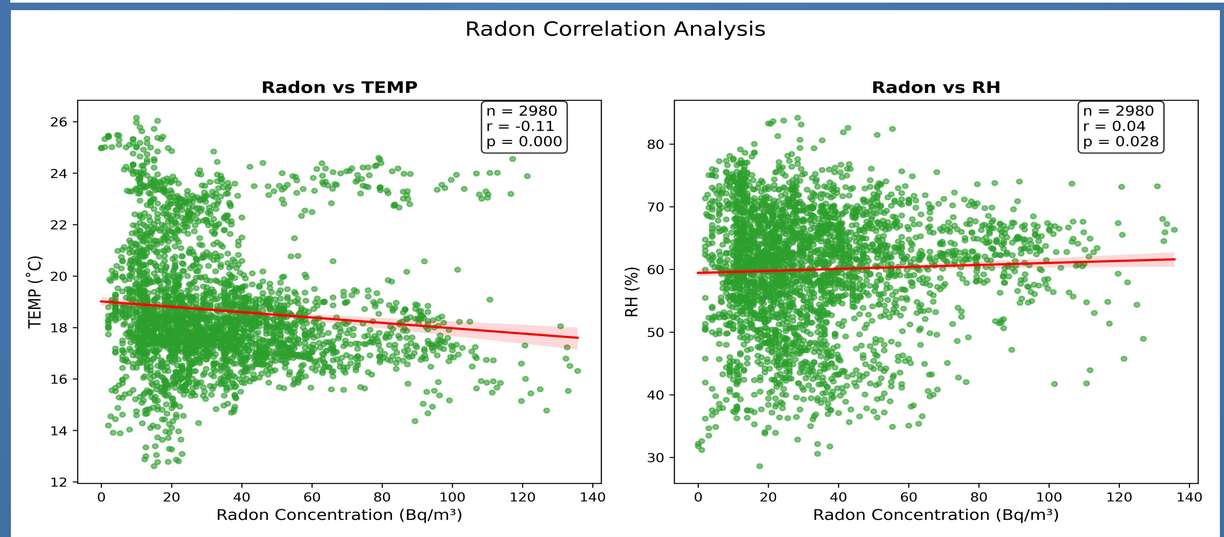

Fig 1: Correlation of radon to temperature and moisture levels throughout the investigation period.

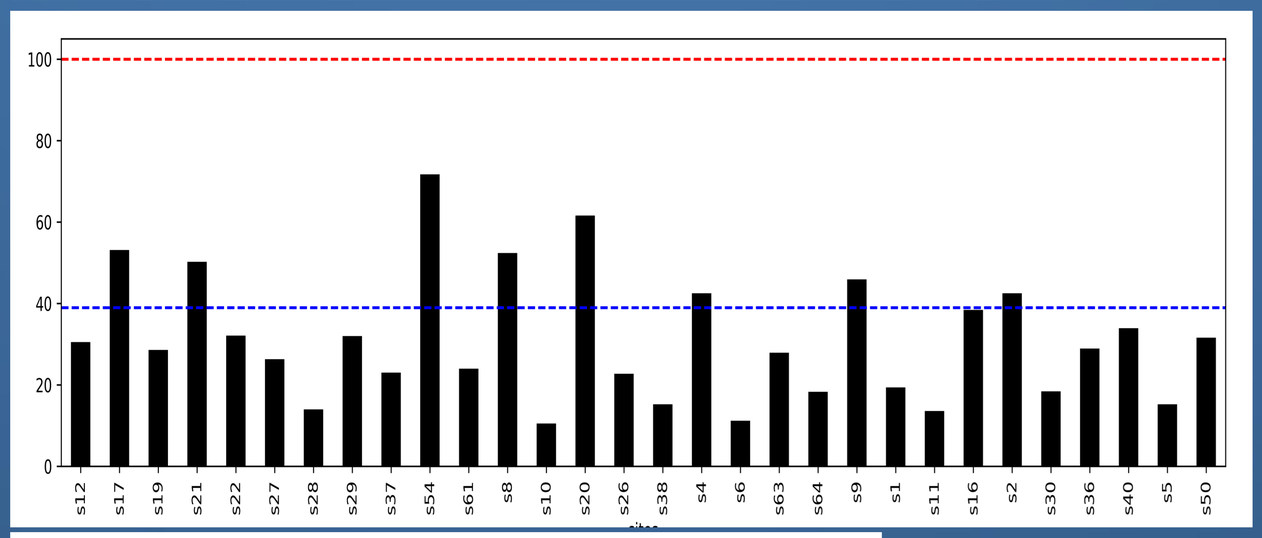

Fig 2: Radon levels (Bq/m³) in various elementary schools during the study period

CONCLUSIONS

This study delineates a fundamental reference point concerning radon exposure within the public educational institutions of Safi. The findings highlight an immediate necessity for specific preventive measures, particularly in establishments exhibiting heightened radon concentrations. Furthermore, the notable environmental associations revealed accentuate the necessity of integrating indoor climate regulation within radon reduction frameworks. Subsequent investigations are imperative to enhance our comprehension and refine health and safety protocols for both students and educational personnel.

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