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Chronic exposure to volcanic air pollution and DNA damage in Furnas Volcano (São Miguel Island, Azores, Portugal) inhabitants

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Many studies in volcanic air pollution only have in consideration the acute toxic effects of gas or ash releases however the impact of chronic exposure to ground gas emissions in human health is yet poorly known. In the Azores archipelago (Portugal), São Miguel island has one of the most active and dangerous volcanoes: Furnas Volcano. Highly active fumarolic fields, hot springs and soil diffuse degassing phenomena are the main secondary volcanic phenomena that can be seen at the volcano surroundings. One of the main gases released in these diffuse degassing areas is radon (222Rn), which decay results in solid particles that readily settle within the airways. These decay particles emit alpha radiation that is capable of causing severe DNA damage that cumulatively can eventually cause cancer. Previous studies have established that chronic exposure to chromosome-damaging agents can lead to the formation of nuclear anomalies, such as micronuclei that is used for monitoring DNA damage in human populations. The present study was designed to evaluate whether chronic exposure to volcanic air pollution, associated to 222Rn, might result in DNA damage in human oral epithelial cells.
A cross sectional study was performed in a study group of 142 individuals inhabiting an area where volcanic activity is marked by active fumarolic fields and soil degassing (hydrothermal area), and a reference group of 368 individuals inhabiting an area without these secondary manifestations of volcanism (non-hydrothermal area).
For each individual, 1000 buccal epithelial cells were analyzed for the frequency of micronucleated cells (MNc) and the frequency of cells with other nuclear anomalies (ONA: pyknosis, karyolysis and karyorrhexis), by using the micronucleus assay. Information on lifestyle factors and an informed consent were obtained from each participant. Assessment of indoor radon was performed with the use of radon detectors. Data were analyzed with logistic regression models, adjusted for confounding factors (age, gender, smoking and drinking status, and number of cigarettes smoked per day).
Results demonstrated that levels of radon in the environment were significantly different in study and reference groups (115 Bq/m3 vs. 47 Bq/m3, respectively; $p<0.001$); in winter, radon measurements reached the highest values both in the study and the reference groups (809 Bq/m3 vs. 56 Bq/m3, respectively). The frequency of MNc in the study group was significantly higher than in the reference group (2.93‰ vs. 2.58‰ respectively; $p=0.002$). The OR for formation of MNc in the hydrothermal area was 1.5 (95% CI 1.07–2.02). A moderate and positive correlation was found between the frequency of MNc and 222Rn ($rs = 0.459$, $p<0.001$).
To our knowledge this is the first study that clearly associates the exposure of volcanogenic indoor radon in inhabitants of hydrothermal areas and the DNA damage in human oral epithelial cells, evidencing that volcanic air pollution is a risk factor of carcinogenesis. Although the present findings require confirmation in larger studies, bio-monitoring for DNA damage is recommended for inhabitants of localities with active volcanism and mitigation measures such as restriction of building in certain areas should be taken into consideration in these volcanically active areas.