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A ground-based evaluation of the impact of neutron dose rate on health effects during space travel

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The lack of information on how biological systems respond to low-dose and low dose-rate radiation makes it difficult to accurately assess the corresponding health risks. This is of critical importance to space radiation, which remains a serious concern for long-term manned space exploration. Therefore, a growing number of particle accelerator facilities implement ground-based analogues to study the biological effects of simulated space radiation. In this presentation, we will introduce first results of a project on the "Optimization and validation of a unique ground-based in vitro model to study space health effects" (INVEST) at iThemba LABS, which aims to implement a first ground-based set-up to study space health effects in Africa. The focus of this work is on neutron irradiation, which is considered to be an important secondary component in space radiation fields. In a first set of experiments, the effect of neutron dose rate on immune system alterations and DNA double-strand break (DSB) induction and repair was investigated. Blood samples of adult volunteers were exposed to p(66)/Be(40) neutron irradiation (fluence-weighted average energy: 29.8 MeV) at a lower dose rate (LDR) of 0.015 Gy/min or a higher dose rate (HDR) of 0.400 Gy/min. DNA DSB formation was 40% higher at HDR exposure compared to LDR exposure. The DNA DSB levels decreased gradually to 1.65 ± 0.64 foci/cell (LDR) and 1.29 ± 0.45 (HDR) at 24 h post-irradiation, remaining significantly higher than background levels. The impact of neutron dose and dose rate on immune alterations was studied using the in vitro cytokine release assay. Recall antigens and mitogens were used to activate lymphocytes post-irradiation and dose rate effects on the cytokine production capacity of the cells were observed under specific conditions. The results give a first indication that the dose rate should be taken into account for health risk estimations related to neutron irradiation.

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