CDRA (Cancer Development Risk in Astronauts)

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Background

- As space exploration expands exponentially, it is necessary to focus on the effects of spaceflight on human health. Radiation, in long-term encounters, is known to damage cellular structure mechanisms, leading to mutations and later to cancer. In space, astronauts face an increase level of ionizing radiation due to not having a protective barrier which may trigger a carcinogenic effect.

- The Low Earth Orbit (LEO) is protected by Earth's atmosphere and the magnetosphere, but it can still be affected by increased solar radiation during solar particle events. The LEO is estimated to be 0.33-0.44 mGy per day, while a human on Earth absorbs about 1 mGy compared to outer space dosimeter readings that showed a 1-1.8 mGy per day.

Methodology

The National Cancer Institute made a model called Radiation Risk Assessment Tool (RadRAT) to calculate the lifetime cancer risk from ionizing radiation, which calculates with a 90% uncertainty the probability of getting induced cancer by high-energy radiation. The dose can be acute or chronic, simulating a long-term exposure or a particular event.

$$\mathrm{LAR}\ (D,e,s) = \int_{e+L}^{a_{\max}} M\,(D,e,a,\ s)\,\frac{S_{aj}\,(a,g)}{S_{aj}\,(e,g)}\mathrm{d}a,$$

Results

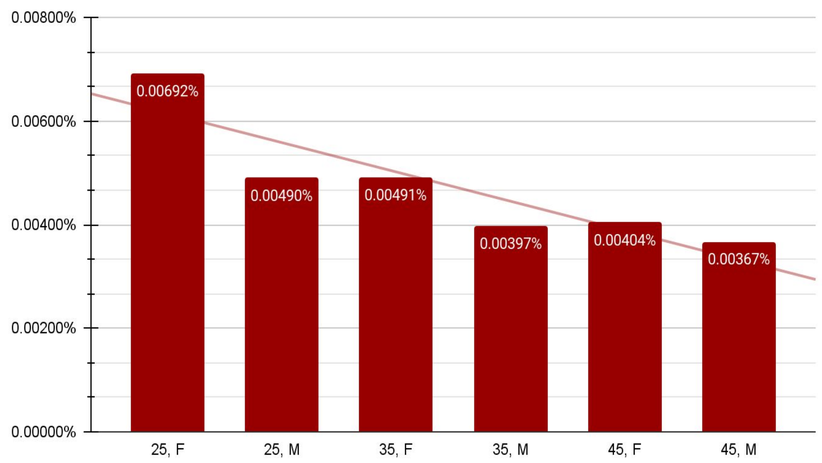

Figure 1 shows the relationship of age and gender and the possibility of getting induced cancer after being exposed to radiation in one event at the ranges of 0.33-0.44 mGy in LEO.

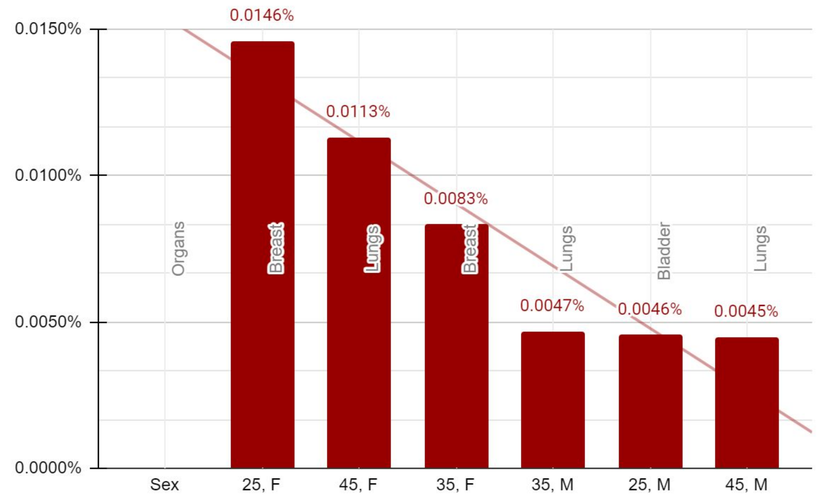

Figure 2 shows the relationship of age and gender and the possibility of getting induced cancer after being exposed to radiation in one event at the ranges of 0.33-0.44 mGy in LEO in the most compromised organ.

Conclusion

- Women in their 25s are more likely to get a higher induced cancer probability, and the principal organ compromised would be the breast, with 0.00692% lifetime risk after being exposed to Low Earth Orbit dosis.

- Since bladder and Breast are the organs with a higher lifetime risk, it is necessary to isolate and study these tissues individually to come up with new ways to protect them from future diseases. Furthermore, as the lungs are one of the most essential organs in our body we need to deepen the study of this tissue after the exposure to ionizing radiation.

- Hydrogen-rich materials such as aerogel act as radiation isolators. Currently, the ISS uses this material, where the crew spends more time, to protect them from high exposure. Also, implementing liquid hydrogen in spacesuits does not compromise the spacecraft's mass.

- Shielding of the spacecraft can be passive or active. Active shielding creates a magnetic or electrostatic field to keep high-energy particles from penetrating the spacecraft. Passive shielding involves utilizing light materials with high-mass nuclei to increase the number of protons inside the spacecraft.

Referencess

1) C. M. Milder, NASA Space Cancer Risk Model: 2020 Operational Implementation. 2021.

2) F. Rukundo, *Assessment of Lifetime Attributable Risk for Public Health Sustainability from the Fukushima Accident*

3) National Institute of Cancer, ***Radiation Risk Assessment Tool - Lifetime Cancer Risk from Ionizing Radiation***

4) R. D. Ferrante, ***Extraterrestrial Gynecology: Could Spaceflight Increase the Risk of Developing Cancer in Female Astronauts***