Space radiobiology needs realistic hypotheses and relevant methodology

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“If humans ever start to live permanently in space” and to verify whether assisted reproductive technology is safe in space, Wakayama et al. (1) maintained freeze-dried mouse spermatozoa in the International Space Station for 9 mo. While these authors are aware of the risks linked to space radiation, both their rationale and methodology approach raise two concerns.

First, protracted exposure to radiation is known to cause radiation-induced cancers and cataracts, at least, and represents one of the major risks for space crews. This is notably a severe limit for a mission to Mars (2). On Earth, the natural radiation background (NRB) varies from 0.5 mSv/y (Japan) to more than 70 mSv/y (e.g., Ramsar, Iran) (3). By omitting the solar particle events (SPE), and by considering the dosimetry data of all missions of the spatial history, the average exposure to radiation in space is ≈0.4 mSv/d, 146 mSv/y (4). Consequently, a 9-mo space mission corresponds to an exposure of 109.5 mSv but also to 1.5 y spent in Ramsar. Hence, when the authors report that the low dose rate in space is 100 times higher than on Earth, they omit the highest NRB where there is no evidence of significant hazard (3). By contrast, the authors admit that a cumulated dose higher than 400 mGy may be hazardous (1). Such a dose corresponds to a 2.7-y space mission and 5.7 y spent in Ramsar. Why did the authors not expose their DNA samples to the highest-NRB areas to verify the measurability of their data before exposing them to space? How do we extrapolate the risks for a 2.7-y mission that may be hazardous from the nonsignificant data obtained for a 9-mo mission?

Second, the authors also examined the impact of space radiation upon fertility. However, there is no evidence that the highest NRB leads to mutations that propagate to the offspring. Furthermore, literature shows that only doses greater than 350 mGy cause reversible human aspermia, and aspermia may be permanent after more than 2,000 mGy (5). An exposure to 109.5 mSv is very far from these doses. Hence, to evaluate the impact of space radiation upon fertility a much longer mission would have been more relevant. Again, equivalent experiments performed in the highest-NRB areas can be useful, notably to better evaluate the impact of SPE.

We are fully aware that biological experiments in space are very difficult to set up. However, while there will always be a fascination of the general public for space, scientists should take particular care to justify their methodology and moderate their conclusions with regard to space radiobiology.

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