Prolonged spaceflight could weaken astronauts' immune systems

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NASA hopes to send humans to Mars by 2030 on a round-trip mission that could take up to three years—far longer than any human has ever traveled in space. Such long-term spaceflights could adversely affect

certain cells in the immune systems of astronauts, according to a new study led by University of Arizona researchers.

"What NASA and other space agencies are concerned about is whether or not the immune system is going to be compromised during very prolonged spaceflight missions," said Richard Simpson, senior author and associate professor of nutritional sciences at the UA. "What clinical risks are there to the astronauts during these missions when they're exposed to things like microgravity, radiation and isolation stress? Could it be catastrophic to the level that the astronaut wouldn't be able to complete the mission?"

Simpson and his team of researchers at the UA, the University of Houston, Louisiana State University and NASA-Johnson Space Center, studied the effects of spaceflights of six months or more on natural killer cells, or NK cells, a type of white blood cell that kills cancerous cells in the body and prevents old viruses from reactivating.

"Cancer is a big risk to astronauts during very prolonged spaceflight missions because of the exposure to radiation," Simpson said. "[NK-cells] are also very important to kill off virally infected cells. When you're in the space station, it's a very sterile environment—you're not likely to pick up the flu or a rhinovirus or some community-type infection—but the infections that are a problem are the viruses that are already in your body. These are mostly viruses that cause things like shingles, mononucleosis or cold sores; they stay in your body for the rest of your life, and they do reactivate when you're stressed."

Scientists compared blood samples of eight crewmembers who completed missions to the International Space Station with healthy individuals who remained on Earth. Blood samples were taken before launch, at several points during the mission and after the astronauts' return to Earth.

The results showed that NK-cell function is impaired in astronauts as compared with pre-flight levels and ground-based controls. At flight day 90, NK-cell cytotoxic activity against leukemia cells in vitro was reduced by approximately 50 percent in International Space Station crew members.

"When we look at the function of the astronaut samples during flight compared to their own samples before they flew, it goes down. When we compare them to controls who stayed on Earth, it still goes down," Simpson said. "I don't think there's any doubt that NK-cell function is decreasing in the spaceflight environment when analyzed in a cell culture system."

The effect appears to be more pronounced in first-time astronauts, as opposed to those who have already been in space.

"Serendipitously, we found that half our crew members had flown before, and the other half hadn't," Simpson said. "So we were able to just split them in half to see if there was an effect, and there was. The 'rookies' had greater drops in NK-cell function compared to the veterans."

The differences could be chalked up to age or stress, Simpson said, assuming that rookie astronauts, who are generally younger than their veteran counterparts, would find space travel more stressful than those who had done it before.

Whether the drop in NK-cell function makes astronauts more susceptible to cancer and viral reactivation remains to be seen, Simpson said. He hopes to learn more from future studies.

"The next question would be, how do we mitigate these effects? How do we prevent the immune system from declining during space travel?" he

said. "In order to do that, you have to first figure out what's causing the decline: Is it stress? Is it microgravity? Is it radiation? Is it a plethora of things? When we figure that out, we can try to find ways to directly target those factors and mitigate them."

Simpson and his fellow researchers at NASA-Johnson Space Center, along with European and Russian scientists, are already working on potential countermeasures that could help keep astronauts healthy in space, including nutritional or pharmacological intervention and increased exercise, all of which have been shown to have a positive effect on immune system function.

Studies have shown that spending extended periods of time away from Earth comes with some health risks, such as muscle and bone loss due to the effects of microgravity. But scientists didn't know whether the unique conditions encountered by astronauts had an impact on the immune system until now. The paper, Spaceflight inhibits NK-cell function, was published in the *Journal of Applied Physiology*.

More information: Austin B. Bigley et al, NK-cell function is impaired during long-duration spaceflight, *Journal of Applied Physiology* (2018). DOI: 10.1152/japplphysiol.00761.2018

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