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ASTRONAUT'S BODY BIOLOGY CHANGES DURING SPACE TRAVEL

Relevant for: Science & Technology | Topic: Space Technology & related matters

U.S. astronaut Scott Kelly shortly after landing near the town of Dzhezkazgan (Zhezkazgan), Kazakhstan, March 2, 2016. | Photo Credit: Reuters

The world's first astronaut was Yuri Gagarin of the then Soviet Union. He journeyed into outer space, completing one orbit around the Earth on 12 April 1961. This provoked the US to launch "Project Apollo," to send humans to the moon and bring them back — and they did. After returning from the moon, the astronaut Armstrong made the famous statement: "one small step for man, a giant leap for mankind." And as of today, over 536 people from 37 countries have been astronauts, including our own Rakesh Sharma. And today, there are at least four companies that will, if you have the purse and passion, arrange to make astronauts out of you.

How does going out of the Earth into space affect the human body — its chemistry, physiology, biology and associated medical conditions? For example it takes about 300 days to reach Mars which is 57 million km at its closest from the Earth. How much bodily change can happen during this one-year trip? It was with these issues in mind that the National Aeronautics and Space Administration of the U.S. set up an experiment to test the changes that happen to various biological features in an astronaut, who will be stationed at the International Space Station (ISS) which is 400 km above, and completes multiple orbits around earth every day.

They placed an astronaut named Scott Kelly on the ISS for a year, measured many biological parameters there as he was in flight. For comparison, as "control" they chose his genetically identical twin Mark Kelly, kept him on earth and did the same set of measurements on him. This case–control study was a brilliant strategy, since whatever changes they monitor in Scott vis -à-vis Mark can be attributed to the effects of space-stay.

What are the factors that may go to affect the body biology in space in contrast to these on Earth? One is what is called zero gravity or micro-gravity. Out in space, the individual feels weightlessness, which will affect his body. On the earth, gravity allows us to stay erect. While standing or walking, our body fluids flow downwards (we have body pumps and valves built in, so as to maintain our circulation against the natural downward flow). In space with microgravity, such fluid movements will be affected. As Dr. Lobrich and Dr. Jeggo point out (*Science*, 12 April 2019, pp 127-128), surface gravity has shaped life on earth and most, if not all, physiological process have adapted to it. How will zero- or microgravity affect them?

The second point of concern is exposure to ionising radiation or IR. This arises from cosmic rays, solar flares and such, which will affect the circumnavigating astronaut. On Earth, the atmosphere and the magnetic field of Earth protect us earthlings reasonably efficiently. The terrestrial twin is thus better protected from IR than the space twin.

This twin experiment of comparing many of the chemical, physiological and biochemical features of the space twin with those of his twin on land was done in detail by a group of scientists (Francine Garrett- Bakelman et al., *Science* 364, eaau8650 (2019) DOI: 10.1126/science.aauu.8650). They studied cognition, physiology, biochemical changes, microbiology, and gene expression through a variety of methods, as well as the ends of the chromosomes called telomeres. They did exactly the same with Mark on Earth. In addition, they monitored these on Scott before his flight, during the flight and immediately after he returned, and again six months afterwards. This whole study lasted over 25 months.

What did they find? Some biological functions such as immune response (T cells), the body mass, the microbial content in the gut and a few others were in the “low risk” category. Some others, such as the fluids in the vasculature were of mid-level risk. High risk in space flight had to do with the telomeres at the chromosome ends- they shortened. This appears to suggest that IR had an effect on him in flight. The effect of microgravity was felt in a head-ward shift of fluids, thickening of the carotid wall and hence cardiovascular and cerebro-vascular changes. The blood flow around the retina of the eye and the thickening of the choroid was noticed, making his vision a bit blurred.

Happily enough, as they monitored Scott months after he returned from ISS, they found much of the in- flight changes reverted to pre- flight levels. While we need more such studies, it becomes clear that long time space travel may affect biological and physiological levels and that, the longer the travel the more the effect. And one may need even more recuperation time post-flight in order that the changes disappear, and the space- tourist gets his/her body back to normal.

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