Editorial

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NASA’s Twins Study: Scope and Implications for Biomedical Research

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Manned space exploration is an inherently risky endeavour. Astronauts experience a range of cellular and physiological changes on spaceflights due to hostile environmental conditions such as gravitational transitions, ionizing radiation, acoustic noise, and thermal extremes [1-3]. Several short- and long- term risks including bone loss, decline in cardiovascular and kidney function, behavioural or cognitive issues, and visual impairment have been associated with these spaceflight experiments [1,4-7]. However, the genetic pathways underlying these physiological changes are not yet fully determined.

NASA’s Human Research Program (HRP) is dedicated to researching such hazards and stresses of prolonged missions by utilizing cutting-edge space biology research tools and expertise from multidisciplinary research teams. The purpose of this editorial is to examine the various potential biomedical research opportunities and benefits from The Twins Study undertaken by the HRP. To study the effects of spaceflight, astronaut Scott Kelly was aboard the International Space Station on a year-long mission between 2015 and 2016 while his identical twin brother, astronaut Mark Kelly, remained on the ground as a control subject [8]. Samples collected from these homozygous twins are invaluable since they allow a means of investigating the effects of environmental factors on individuals with identical genetic makeup. For instance, although there is evidence for extensive research using both culture-based [9,10] and culture-independent [11] microbiological methods for studying the microbial composition of space shuttle surfaces, water, and astronauts, little is known about the role of human genetics in shaping gut microbiome. Hence, a deeper understanding of the human microbiome would be one of the many plausible achievements of The Kelly Study.

Not long ago, astronaut John Glenn (the first American to orbit the Earth, and the oldest man in space) was used as a research subject for geriatric studies in 1998 at the age of 77 [12]. He was aboard Discovery space shuttle on a nine-day mission where the effect of microgravity on his body was studied and compared to that of the younger crew on flight. However, the scope of this study was limited due to the short duration of the flight and lack of adequate controls. In contrast, The Twin Study is aimed at several novel study investigations and hence is expected to be much more insightful with statistically significant trends owing to the long duration of the mission as well as availability of a great biological control on Earth.

Preliminary findings [13,14] show promise for a multitude of biomedical applications both for space and Earth. Comprehensive analysis of the molecular profile, oxidative and metabolic markers, immune functions and microbiome changes might shed new light on predicting the development of several diseases in astronauts. Hence, assessing the influence of environmental stressors on preexisting conditions may help prevent the onset of cancer, premature aging, cardiovascular disease, vision problems and atherosclerosis in future. Moreover, as exposure to radiation is unavoidable during interplanetary expeditions, research can be focused on developing super foods that not only boost immune responses to combat inflight infectious agents, but also protect from galactic cosmic rays. These research results are very relevant and correlatable to the conditions encountered by human body here on Earth as well. Achieving mechanistic insights down to molecular level in altered conditions can lead to the formulation of enhanced therapeutic strategies for treatment and prevention of many challenging diseases. In conclusion, The Twin Study has laid an excellent groundwork for improving health and welfare of astronauts on future voyages to Mars and beyond. It has also opened new avenues for exploration that are aimed at advancing our understanding of the link between lifestyle and human disease, thereby facilitating scientific breakthroughs on Earth.

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