Response to comments on "Is telomere shortening reversible? A clue from NASA's twins mission"

Rahul Vishvkarma
Division of Endocrinology
CSIR-Central Drug Research Institute, Lucknow UP India 226031
E-mail: rvishvkarma613@gmail.com

Rahul Vishvkarma is an early stage researcher in the Division of Endocrinology, CSIR-Central Drug Research Institute, Lucknow. His research interests include thermal regulation of spermatogenesis and micro RNAs in genomic imprinting.

Citation: Vishvkarma R. Response to comments on " Is telomere shortening reversible? A clue from NASA's twins mission. Polymorphism 2019;3:4-6.

Opinion article "Is telomere shortening is reversible? A clue from NASA's twins study" was published under the good faith with the extrapolation of the original findings (Vishvkarma, 2019). Bevelacqua and Mortazavi (2019) commented on our opinion article and we are happy to note that their discussion has given new dimensions to our thoughts. I am thankful to the authors for reading my article.

I already mentioned that space environmental studies point out several factors that can be harsh on the human body; for example, the confinement, isolation, and environmental stressors such as microgravity, radiation, and noise (https://www.nasa.gov/sites/default/files/files/NP-2015-03-015-JSC_Space_Environment-ISS-Mini-Book-2015-508.pdf). These factors may play a crucial role in the telomere length alteration. While the length could be affected by stressors, it indicates the biological possibility of an increase in the telomere length.

Figure 1 of my article may have been misinterpreted by Bevelacqua and Mortazavi 2019. It simply shows the dynamics of telomere length of Scott's telomeres. In space, the leukocytes collectively show an increased length of telomeres, which shorten after return on Earth. It is clearly mentioned in the article's abstract lines "For a few measures, persistent changes were observed even after 6 months on Earth, including some genes' expression levels, increased DNA damage from chromosomal inversions, increased numbers of short telomeres, and attenuated cognitive function" (Garrett-Bakelman et al., 2019). It was discussed that even after six months short telomeres were observed so this period might be justified for return to its average length.

Figure 1 follows the original study line "Notably, telomere length shortened rapidly upon TW's return to Earth, within ~48 hours [FD340 ambient return to R+0 (R+ days post return); fig. S6B] and stabilized to near preflight averages within months". So there is no serious contrast between the original study and my opinion.

NASA's press release quoted "The telomeres in Scott's white blood cells, which are biomarkers of aging at the end of chromosomes, were unexpectedly longer in space, then shorter after his return to Earth with average telomere length returning to normal six months later. In contrast, his brother's telomeres remained stable throughout the entire period". (https://www.nasa.gov/press-release/nasa-s-landmark-twins-study-reveals-resilience-of-human-body-in-space)

NIH director's blog on twins study also quoted that "Scott also had some measurable changes in telomeres—complexes of specialized DNA sequences, RNA, and protein that protect the tips of our chromosomes. These generally shorten a bit each time the cells divide. But during the time in space, the telomeres in Scott's white blood cells measured out at somewhat greater length. Potentially, this is because some of his stem cells, which are younger and haven't gone through as many cell divisions, were being released into the blood. Back on Earth, his telomere lengths returned to an average length within six months of his return. Over the course of the study, the earthbound telomeres of his twin brother Mark remained stable" (https://directorsblog.nih.gov/2019/04/23/nasa-twins-study-reveals-health-effects-of-space-flight/).

Bevelacqua and Mortazavi suggested adaptive response in space mission (Mortazavi et al. 2003, Bevelacqua and Mortazavi 2017, Bevelacqua et al. 2018), but evidence on the telomere length alteration are found contrasting (Sgura et al., 2006; Das et al., 2009; Ramachandran et al., 2018). Therefore, it may be too early to establish telomere elongation as an adaptive response due to the radiation in the space.

Consecutive space travel may increase astronaut's susceptibility to cancer, but there is no such evident on astronaut's completing more than six months in space, more research is needed to validate covert cancer risk for a specific age group.

Apart from the above, the current study is just the beginning and a lot more is to be revealed regarding the impact of space travel on human body. Studies in the future would reveal the impact of age and various other confounding factors that could affect the impact and their health consequences. While most of these changes may be temporary response to space environment, which may simply reflect the effect of stressors, but they would unravel new biological possibilities, which are not easily envisaged by scientists without such clues. We hope our comment and the following discussions have brought many hidden aspects along with discussing numerous plausibilities in living systems.

REFERENCES

Bevelacqua J & Mortazavi SMJ Comments on Telomere shortening is reversible? A clue from NASA's twins mission. Polymorphism 2019; 2: 134-136

Bevelacqua, J. J. and S. M. J. Mortazavi. 2017. Commentary: Human Pathophysiological Adaptations to the Space Environment. Front Physiol 8:1116.

Bevelacqua, J. J., J. Welsh, and S. M. J. Mortazavi. 2018. Comments on 'An overview of space medicine'. Br J Anaesth 120:874-876.

Das B, Saini D, Seshadri M. Telomere length in human adults and high level natural background radiation. PLoS One. 2009;4:e8440.

Garrett-Bakelman, F. E., M. Darshi, S. J. Green, R. C. Gur, L. Lin, B. R. Macias, M. J. McKenna,.... et al., 2019. The NASA Twins Study: A multidimensional analysis of a year-long human spaceflight. Science 364.

https://directorsblog.nih.gov/2019/04/23/nasa-twins-study-reveals-health-effects-of-space-flight/

https://www.nasa.gov/press-release/nasa-s-landmark-twins-study-reveals-resilience-of-human-body-in-space

https://www.nasa.gov/sites/default/files/files/NP-2015-03-015-JSC_Space_Environment-ISS-Mini-Book-2015-508.pdf

Mortazavi, S. M., J. R. Cameron, and A. Niroomand-rad. 2003. Adaptive response studies may help choose astronauts for long-term space travel. Adv Space Res 31:1543-1551.

Ramachandran EN, Karuppasamy CV, Kumar VA, Soren DC, Kumar PR, Koya PK, et al. Radio-adaptive response in peripheral blood lymphocytes of individuals residing in high-level natural radiation areas of Kerala in the southwest coast of India. Mutagenesis. 2017;32:267-73.

Sgura A, Antoccia A, Berardinelli F, Cherubini R, Gerardi S, Zilio C, et al. Telomere length in mammalian cells exposed to low- and high-LET radiations. Radiat Prot Dosimetry. 2006;122:176-9.

Vishvkarma R. Is telomere shortening reversible? A clue from NASA's twins mission. Polymorphism 2019;2:118-121.