SPACE
{Editorial Insights}

The Physiology of Recreational Space Travel

Michael B. Reid*, Ph.D.

***Correspondence: michael.reid@ufl.edu, College of Health and Human Performance, University of Florida**

Abstract: Recreational space travel is an emerging industry that is serving a growing number of travelers. These customers enjoy a unique experience that provides unsurpassed views of the planet Earth and a thrilling introduction to weightlessness. However, space also has effects on the human body that can be uncomfortable and may pose health risks. The current wave of recreational travelers has a broader age range, lower fitness levels, less-defined health status, and far less training than professional astronauts. Commercial firms are conducting a grand experiment in human physiology. Recreational travelers will broaden our understanding of human physiology in space and may identify new limits. We are indebted to recreational travelers for advancing the commercial space industry and expanding the body of knowledge on space physiology.

Keywords: Space Tourism, Space Travel, Countermeasures, Space Physiology, Space Medicine, Space Industry.

This inaugural issue of SPACE is the ideal venue in which to consider recreational space travel. Both this journal and space travel as recreation are new enterprises. Both are risky yet have the potential to revolutionize their respective fields. And both are led by visionary entrepreneurs who embrace innovation in space science. It is an honor to help launch SPACE by considering the intrepid souls who recreate in space.

Recreational space travel, sometimes called space tourism, allows civilians to experience space without the extensive medical evaluations, intensive training, and years of preparation required of professional astronauts. This is not a new concept. In the second century BC, Lucian of Samosata satirized the experience of visitors to the Moon who were untrained and unprepared in his book *True History* (Lucian of Samosata, circa 150 BC). This account included fantastical changes that occurred in the bodies of humans who were lunar inhabitants. His predictions missed the mark a bit (we have yet to see pregnant men in space!) but the general concept has held up. As Lucian suggested, long-term exposure to the space environment causes changes that are complex, time-dependent, and can be debilitating. We don't fully understand the mechanisms of these changes. Nor can we prevent them. Accordingly, professional astronauts and cosmonauts have traditionally undergone years of testing and training to prepare for space flight. Now, however, space travel is opening up to the general public, allowing amateurs of all ages to blast into space with minimal preparation. Ready or not, here they come!

State of the Industry

Nineteen centuries after Lucian, space travel is becoming accessible to well-heeled civilians. A small number of paying passengers have been transported to low earth orbit by government agencies, first the

Russian space agency ROSCOSMOS and later NASA. These fee-for-service arrangements generated revenue for cash-strapped programs but were not casual sightseeing trips. The first private individual to pay for space travel was American business executive Dennis Tito. In 2001, Tito purchased a six-day trip to the International Space Station (ISS) for $20M. He rejected the moniker ‘space tourist’, citing the lengthy training that NASA required before his trip.

In contrast, a growing number of commercial firms are working to democratize space travel, accommodating more customers at more affordable prices. SpaceX (2024), Blue Origin (2024), and their competitors are developing orbital and sub-orbital experiences for would-be travelers. To facilitate access, Stellar Frontiers is functioning as a rideshare company to help customers book space travel experiences across the various providers. These advances are being facilitated by NASA (2024) which has a strategic goal to, “develop a human spaceflight economy enabled by a commercial market.”

In the near term, brief excursions to the edge of space are most accessible. For example, Blue Origin is using traditional rocket technology to propel a crew capsule holding up to six passengers. The capsule follows a parabolic trajectory. As it reaches an altitude of roughly 62 miles – the Karman line -- travelers traverse the edge of space. They get a panoramic view of the planet and experience several minutes of weightlessness before the capsule falls back to Earth for a parachute landing in West Texas. Blastoff to touchdown, it’s an 11-minute trip. To date, Blue Origin has achieved eight manned flights. A similar edge-of-space travel experience is being developed by Virgin Galactic using a reusable spaceplane. It is designed to travel beyond the Karman line for a brief period in space before flying back for a controlled landing. The previous version of this spaceplane carried two pilots and four passengers to the near-space altitude of 54 miles and returned safely, after which it was retired from use. Virgin Galactic reports that commercial operations are currently on hold as a larger spaceplane is being developed. In a very different approach, Zero 2 Infinity is developing a stratospheric balloon with pressurized crew cabin that is meant to carry four passengers. Travelers won’t reach space – the maximum altitude is 20 miles -- or experience microgravity. Still, the view should be nice.

Travel to low earth orbit is more exclusive. SpaceX routinely shuttles crew members to the ISS for NASA and is leading the way on commercial travel to low earth orbit. The first private charter flight of a SpaceX Dragon capsule was in 2021 when Jared Isaacman funded three days in orbit for himself and two associates. A year later, three businessmen paid $55M each for a 10-day trip to ISS. Another milestone was reached in 2024 when Isaacman and three other commercial travelers spent five days orbiting the Earth in a SpaceX capsule. The flight achieved higher altitudes than any flight since the Apollo program, exposing capsule occupants to radiation levels hundreds of times higher than on Earth. The mission also included the first-ever extravehicular activity (EVA) on a private mission, the first operational test of the new SpaceX space suit, and several research projects.

Other companies are partnering with NASA to develop private space stations with an emphasis on hospitality and the guest experience. Classified by NASA as ‘commercially-owned and -operated low earth orbit destinations’ (CLDs), three space stations are scheduled to launch in the next few years to replace the aging ISS. Each CLD will be a multipurpose platform designed with hospitality and tourism in mind. The Starlab CLD will have living quarters and hospitality suites designed by Hilton in partnership with Voyager Space. Blue Horizon is developing the Orbital Reef CLD as an orbital business park that emphasizes the human experience and accommodates tourists. And finally, plans for the Axiom CLD include a space hotel with designer décor and five-star amenities.

The Years Ahead

NASA will return humans to the Moon over the next few years, an initiative that involves commercial partners and sets the stage for lunar tourism. The first step was taken in early 2024 when a spacecraft built by Texas-based Intuitive Machines landed successfully on the Moon. This provided proof-of-concept for lunar missions by commercial firms in cooperation with NASA. Public-private partnerships underpin NASA's Artemis program for returning humans to the Moon. Boeing is lead contractor on the new heavy lift rocket while Lockheed Martin is overseeing manufacture of the next-generation crew capsule. The new capsule will ferry people on roundtrip journeys from Earth to a space station in lunar orbit. From there, commercial landers from SpaceX and Blue Origin will shuttle travelers back and forth to the Moon's surface. NASA expects to return humans to the moon in 2025, reprising the successful lunar orbits of the 1970s, and to land a crew on the moon a year later. The long-term goal is for NASA and their commercial partners to establish permanent lunar facilities that support exploration, research, and commercial activities including recreational travel. Tourism on the Moon will differ from low Earth orbit, creating unique considerations for the hospitality industry and posing additional challenges for the traveler.

Even more ambitious is travel to Mars. After a series of uncrewed flights, SpaceX expects to deliver crew members to the Red Planet by 2030. The trip will take six months each way, requiring at least a year of travel in microgravity. The crew experience would be extended by spending time in Mars orbit or by landing on the planet's surface. NASA has a longer timeline for trips to MARS by the Artemis program. Sometime in the 2030s, crew members would leave the Earth's surface for up to three years depending on the route that is taken and the 'loiter' time spent in Mars orbit. Initial trips to the Moon and to Mars will be crewed by professionals. Plans are in the works for establishing habitations on the Mars surface that could lead to permanent human colonies over the next few decades. The timeline for recreational travel to Mars has not been established.

The Travelers

Space travelers now represent a broad cross-section of humanity. Men and women of diverse racial and ethnic composition have made the journey to space. It is a burgeoning international community comprising over 600 souls from almost fifty nations across the globe. Most of these travelers have been professional crew members who were selected, trained, and supported by NASA, ROSCOSMOS, the European Space Agency (ESA), or other government-funded space agencies. Fewer than ten percent of have been recreational travelers. These two populations have key differences from a physiologic perspective.

The best public information on professional astronauts is available from NASA (2024). Aspiring astronauts apply to the program at the ages of 26-46 yrs and are accepted on stringent criteria that include education, medical status, physical fitness, temperament, social skills, and life experience. Once selected for the astronaut corps, these individuals undergo years of training and conditioning before experiencing the rigors of space travel. This training includes a program of physical fitness, preparing astronauts for the physiological stresses of microgravity. Detailed medical workups identify potential health risks before spaceflight. And psychological evaluations ensure these individuals can coexist with colleagues in the close confines of a spacecraft. As a result, NASA astronauts earn their reputations as elite professionals. None reaches space unprepared.

Space tourists? Not so much. Application pages on commercial websites request little more than contact information and an affirmation that the applicant is at least 18 years of age, a requirement of the Federal Aviation Administration. Commercial firms surely have other criteria for their customers, most obviously deep pockets, but these criteria are not well advertised and do not match NASA standards. A prominent example of this mismatch is age. Across all companies and all flight modalities, space tourists who have flown since Dennis Tito range in age from 18 to 90 yrs age. This encompasses two full generations, illustrating the accessibility of commercial space tourism across most of the human lifespan. Clearly age poses little hindrance.

Commercial space passengers also receive less training than NASA crew members. SpaceX training can last for several months. Prospective passengers may be tested for g-force tolerance and experience weightlessness in parabolic flight. They learn emergency procedures and may be trained in aspects of spacecraft operations. The curriculum for a given passenger depends on the nature of the mission and the individual's background. Blue Origin needs only two days to prepare passengers for parabolic flight. On-site training covers the flight profile, zero-gravity protocols, mission simulations, and emergency procedures that comply with FAA safety regulations.

Six decades of space exploration have shown that risks to human health are mitigated by physical fitness and preflight medical screening. It is not clear how commercial firms approach these issues. Any requirements for physical ability or medical pre-approval of paying customers are not publicized. Nor is objective information available on the fitness or health status of prior commercial travelers. Accordingly, none of the physiologic responses or known health risks of space travel can be ruled out. Caveat emptor.

Physiology of Space

Our understanding of space physiology is based on decades of data from professional crew members who are highly trained, physically fit, and under close medical supervision. In contrast, recreational space travelers are less trained, less fit, and likely to be more susceptible to space maladies. The physiologic responses of recreational space travelers have not been reported publicly. Still, we can make reasonable predictions based on existing knowledge. In the following sections, we focus on physiological experiences that humans may expect in the near-term. These occur during suborbital flights or flights in low earth orbit with space exposure times ranging from 3-4 minutes to a couple of weeks.

<u>Gravitational effects on the human body</u>. On Earth, we are exposed to a 1-Gz gravitational field that keeps us planted firmly on the ground and affects shape of the human body (Pollock et al., 2021). In the upright posture, gravity compresses the skeleton, pulls internal organs downward, and causes skin to sag. Internal fluids such as blood, lymph, and interstitial fluid are especially affected, flowing downward when we stand and accumulating in the lower extremities. A horizontal posture minimizes gravitational effects, allowing internal fluids to redistribute more uniformly throughout the body. In fact, lying with a slight head-down tilt is a standard model of microgravity used in human research on Earth.

The human body is adapted for a 1-Gz environment. We blithely tolerate postural changes to gravitational loading that continually occur during our activities of daily living. This reflects the body's elegant responses to gravity, most of which occur at the subconscious level. In brief, our body continually monitors the direction and magnitude of gravitational loading using an array of senses. Orientation of our body in the Earth's gravitational field is sensed by the inner ear and eyes. This information is complemented by mechanoreceptors in skin, muscle, and bone that sense the position of our body. Integrating these complex sensory inputs, the brain responds to gravitational changes in real time. Neural and endocrine control mechanisms adjust the neuromuscular, cardiovascular, and renal systems to counteract changes in gravitational loading and maintain normal body function.

The microgravity of space minimizes gravitational forces on the body. We become weightless. Recreational travelers experience this for several minutes during parabolic flights and as a continual element of flights in low earth orbit and beyond. Microgravity can be entertaining, enabling free-floating aerobatics that are a hallmark of spaceflight. Other effects of microgravity are less publicized and can be less pleasant.

<u>Cardiovascular changes</u> in space have been extensively studied in crewmembers (Charles & Bungo, 1991). An obvious effect of microgravity is the headward shift of blood and tissue fluids from the lower body, causing the facial puffiness and 'chicken legs' that are commonly seen in flight. The physiologic response to this fluid shift is a reflex reduction in plasma volume that can be detected within 20 minutes of arriving

on orbit. This reflex is mediated by release of antidiuretic hormone triggered by the central shift in blood volume. The decrement in plasma volume is accompanied by changes in blood pressure, vascular tone, heart rate, and cardiac size as the cardiovascular system adjusts to gravitational unloading. These adaptations can challenge orthostasis when returning to a 1-Gz environment, affecting postural control and mobility. Countermeasures to stabilize cardiovascular function include pharmacologic interventions and fluid supplementation prior to the return flight. We can assume that recreational space travelers will have similar cardiovascular responses to microgravity and will have access to standard countermeasures. Arrythmias and other cardiovascular risks have not been common in professional crewmembers. However, recreational travelers will be older and less fit and will have medical histories that are less well documented. Accordingly, cardiovascular risk is less predictable for recreational travelers than crewmembers and will bear monitoring as recreational space travel becomes more common.

<u>Space motion sickness</u> afflicts roughly 70% of astronauts (Heer & Paloski, 2006). Initial symptoms include dizziness, nausea, vomiting, cold sweats, loss of appetite, and fatigue. These appear within minutes-to-hours of microgravity exposure and may persist for days, promoting dehydration and electrolyte imbalance. The functional impact of space motion sickness varies from mild discomfort to incapacitation depending on the intensity and duration of symptoms. Space motion sickness is thought to be caused by conflicts among sensory information from the inner ear, eyes, and pressure receptors that humans use for spatial orientation. A range of pharmacologic and nonpharmacologic countermeasures can lessen the symptoms of space motion sickness but efficacy is variable and there is no single best treatment.

<u>Headaches</u> are common during space flight. Over 90% of professional astronauts experience tension-type headaches or migraines during long-haul flight (van Oosterhout et al., 2024). These occur repeatedly in most individuals with headaches being more frequent, more severe, and more likely to be migraines at earlier stages of the flight. Headaches during the first 72 hours in microgravity are often accompanied by space motion sickness and are thought to be caused by the same mechanism (see below). After a week or so in space, headaches persist but are less frequent and less severe. These are largely attributed to the elevated intracranial pressure caused by the redistribution of body fluids. Countermeasures for space headaches mimic those on Earth, i.e., sleep, exercise, rehydration, coffee, and NSAIDs.

<u>Visual acuity</u> can degrade in spaceflight. In a study of short-duration flights, over one quarter of shuttle crewmembers reported degradation in distant and near visual acuity that reversed on return to Earth (Mader et al., 2011). Such flights were similar in length to the commercial flights in low earth orbit by recreational travelers. Assuming travelers respond like astronauts, roughly one-in-four will experience visual degradation during spaceflight. The number may even be higher. Visual changes in space are more evident with age and recreational travelers can be older than NASA professionals. This age difference makes travelers more susceptible to visual degradation than astronauts. Decades from now, recreational travel to Mars will likely involve spaceflights lasting 6-9 months. These long-duration flights will carry the risk of ‘spaceflight associated neuro-ocular syndrome’ or SANS. This complex, multifactorial pathology alters neuro-ocular anatomy and physiology, degrades vision in flight, and can persist after returning to Earth (Ong et al., 2023).

<u>Postural instability</u> is expected after recreational travel to low earth orbit. This is well documented in astronauts and cosmonauts returning from short-duration space flights. Crewmembers can be unstable when initially standing upright or walking in the 1-Gz environment. These motor deficits reflect adaptive changes in the neuromotor control system where loss of gravitational input alters sensorimotor/vestibular function (NASA, 2022). A functional reorganization of proprioceptive processing alters behavioral motor control. Visual changes can alter spatial perception, compromising fine motor tasks and performance of ballistic movements. Vestibular function is also disrupted due in part to otolith asymmetry. Inflight countermeasures are used by NASA crewmembers to preserve postural control. These include pharmacologic

countermeasures, mechanical and electrical devices, and various training methods. Presumably, commercial firms provide inflight countermeasures to preserve motor control in recreational travelers. However, the nature and effectiveness of commercial countermeasures are not clear.

<u>Muscle weakness and fatigue</u> are inherent in the space travel experience, as detailed by Dr. Elizabeth Barton in this issue of SPACE (Barton, 2024). In brief, antigravity muscles of the legs and torso are most affected. Loss of gravitational loading lessens the use of these muscle groups and limits the forces required for task performance. Muscles adapt to this chronic unloading, a process that begins within days-to-weeks of arriving in space and continues to progress over months (Fitts et al., 2001). Aerobically adapted, slow twitch motor units are preferentially impacted. Constituent muscle fibers undergo reductions in cross-sectional area, mitochondrial content, myoglobin expression, and oxidative capacity. Compounding these structural losses, the remaining muscle fibers become dysfunctional, generated abnormally low force for a given cross-sectional area. In aggregate, these changes weaken astronauts during spaceflight and predispose them to fatigue. Reductions in muscle function can be slowed or prevented by an aggressive program of resistance exercise in flight. While effective, this countermeasure requires specialized equipment that can be unwieldy in the close confines of a spacecraft. Exercise also consumes valuable time, taking astronauts away from operational tasks that are critical for the mission.

Muscle deconditioning in microgravity can limit work capacity and endurance, compromising operational readiness. An example is task performance during spacewalks, termed extravehicular activity or EVA. Astronauts perform EVAs in space suits that are bulky and awkward. Limb movements require the astronaut to deform the pressurized suit, working against the elastic load imposed by the suit to change its shape. This can be exhausting during prolonged EVA missions which can last for hours. Muscles of the hands and forearms are especially susceptible to fatigue as astronauts must deform the pressurized glove to grab tools, instruments, and handrails (Roy & O'Hara, 1997). The relevance for recreational space travelers was demonstrated earlier this year when private citizens on a SpaceX mission performed the first-ever civilian EVA. SpaceX space suits differ from traditional NASA and ROSCOSMOS suits. Innovations in design, construction, and materials of the SpaceX suit are designed to look spiffy while increasing comfort and facilitating movement of the wearer. Beyond space suit design, other countermeasures for handgrip fatigue include specialized exercises that can be performed before and during space flight. Pharmacologic interventions to delay fatigue and prolong task performance during EVA have been explored (Matuszczak et al., 2005) but are not currently operational.

<u>Decompression sickness</u> is another potential risk for recreational space travelers (NASA, 2023). This illness is caused by sudden exposure to a low atmospheric pressure. Nitrogen bubbles form in the body, obstructing blood flow and oxygen delivery to the tissues. This is a painful experience that can permanently damage the brain, heart, and other vital organs. On Earth, decompression sickness occurs when individuals rapidly surface from a deep sea dive, emerge from a construction caisson, or fly in an unpressurized aircraft. Astronauts face two potential causes of decompression sickness: 1) EVA transitions from the pressurized spacecraft (typically 14.5 psi) to a lower-pressure space suit (4.5-5.6 psi) and 2) operational depressurization of the spacecraft prior to EVA. Civilian travelers on a commercial SpaceX flight recently experienced both types of pressure transitions. They donned the new SpaceX space suit and fully depressurized the space capsule before conducting a spacewalk. To our knowledge, these commercial travelers did not develop decompression sickness, suggesting SpaceX countermeasures were effective. Current countermeasures include depressurizing the spacecraft prior to EVA prebreathing 100% oxygen, or a combination of both strategies. While effective, these countermeasures are time consuming and interfere with crew operations so space agencies are continuing to refine them for greater efficiency.

<u>Et cetera</u>. Other space-related challenges fall outside the scope of this editorial. For example, radiation exposure is a prominent cancer risk of deep space travel. This risk is largely mitigated in suborbital flight

and low earth orbit, the current loci of recreational travel. Another example is bone demineralization which is promoted by microgravity. This reduces bone density and promotes fractures. However, these changes are most problematic after months in space, an experience not available on the recreational market at present. And finally, the psychological impacts of space can cause anxiety, stress, or emotional concerns but these topics are outside the purview of us physiologists.

The Takeaway

Space travel is not a trivial undertaking. Currently, the financial cost is staggering and access to flights is nearly unobtainable. This makes recreational space travel beyond the reach of most people, the supply-and-demand principle at work. However, economic and logistical barriers will recede over the next decade as commercial options expand. This will broaden the market and increase the number of recreational space travelers.

In contrast, the physiological challenges of space are ineluctable. Sixty years of experience with space travel has honed the criteria for astronaut selection, refined the training and education of professional crew members, and created in-flight protocols that ensure safe operations. A portfolio of countermeasures is available to blunt the effects of microgravity, enabling professionals to tolerate the many physiologic side effects and work safely in space for weeks-to-months.

Recreational travelers to space are certain to have an experience unlike any other. Panoramic views of the Earth and the cosmos will be spectacular and the introduction to weightlessness is sure to be exhilarating. However, potential side effects of microgravity can be profoundly uncomfortable, coloring the experience of space flight and posing potential health risks. On balance, the overall experience of space travel is likely to vary among individuals and is not predictable.

Commercial firms are conducting a grand experiment in human physiology. The first wave of recreational travelers is a unique population with a broader age range, lower fitness levels, less-defined health status, and far less training than prior travelers to space. This diversity will help define the range of physiologic responses to space travel and may identify new physiological limits. We are indebted to recreational travelers for advancing the commercial space industry and expanding the body of knowledge on space physiology. Fingers crossed for their safety.

References

Barton, E. (2024). What's Load Got to Do with It? Challenges of Space Travel for Skeletal Muscle Function. *SPACE, 1(1), 3-5.*

Blue Origin. (2024). *Book Your Flight on New Shepard*. Blue Origin. https://www.blueorigin.com/new-shepard/fly

Charles, J. B., & Bungo, M. W. (1991). Cardiovascular physiology in space flight. *Exp Gerontol*, *26*(2-3), 163-168. https://doi.org/10.1016/0531-5565(91)90008-a

Fitts, R. H., Riley, D. R., & Widrick, J. J. (2001). Functional and structural adaptations of skeletal muscle to microgravity. *J Exp Biol*, *204*(Pt 18), 3201-3208. https://doi.org/10.1242/jeb.204.18.3201

Heer, M., & Paloski, W. H. (2006). Space motion sickness: incidence, etiology, and countermeasures. *Auton Neurosci*, *129*(1-2), 77-79. https://doi.org/10.1016/j.autneu.2006.07.014

Lucian of Samosata. (circa 150 BC). *Lucian's True History* https://archive.org/details/lucians_2203_librivox/lucianstruehistory_01_lucian_128kb.mp3

Mader, T. H., Gibson, C. R., Pass, A. F., Kramer, L. A., Lee, A. G., Fogarty, J., Tarver, W. J., Dervay, J. P., Hamilton, D. R., Sargsyan, A., Phillips, J. L., Tran, D., Lipsky, W., Choi, J., Stern, C., Kuyumjian, R., & Polk, J. D. (2011). Optic disc edema, globe flattening, choroidal folds, and hyperopic shifts

observed in astronauts after long-duration space flight. *Ophthalmology*, *118*(10), 2058-2069. https://doi.org/10.1016/j.ophtha.2011.06.021
Matuszczak, Y., Farid, M., Jones, J., Lansdowne, S., Smith, M. A., Taylor, A. A., & Reid, M. B. (2005). Effects of N-acetylcysteine on glutathione oxidation and fatigue during handgrip exercise. *Muscle Nerve*, *32*(5), 633-638. https://doi.org/10.1002/mus.20385
NASA. (2022). *Risk of Altered Sensorimotor/Vestibular Function Impacting Critical Mission Tasks*.
NASA. (2023). *Decompression Risk DAG Narrative*. https://www.nasa.gov/wp-content/uploads/2023/09/decompression-sickness-rev-c-dag-narrative.pdf
NASA. (2024). *Commercial Space*. https://www.nasa.gov/humans-in-space/commercial-space/
Ong, J., Mader, T. H., Gibson, C. R., Mason, S. S., & Lee, A. G. (2023). Spaceflight associated neuro-ocular syndrome (SANS): an update on potential microgravity-based pathophysiology and mitigation development. *Eye (Lond)*, *37*(12), 2409-2415. https://doi.org/10.1038/s41433-023-02522-y
Pollock, R. D., Hodkinson, P. D., & Smith, T. G. (2021). Oh G: The x, y and z of human physiological responses to acceleration. *Exp Physiol*, *106*(12), 2367-2384. https://doi.org/10.1113/EP089712
Roy, S. H., & O'Hara, J. M. (1997). Evaluation of forearm fatigue during EVA pressure glove work. *Work*, *8*(2), 157-169. https://doi.org/10.3233/WOR-1997-8206
SpaceX. (2024). *Human Spaceflight*. https://www.spacex.com/humanspaceflight/
van Oosterhout, W. P. J., Perenboom, M. J. L., Terwindt, G. M., Ferrari, M. D., & Vein, A. A. (2024). Frequency and Clinical Features of Space Headache Experienced by Astronauts During Long-Haul Space Flights. In *Neurology* (20240313 ed., Vol. 102, pp. e209224). https://doi.org/10.1212/WNL.0000000000209224

Michael B. Reid, PhD is Dean of the College of Health and Human Performance, Professor of Applied Physiology and Kinesiology, and founding member of the Astraeus Space Institute at the University of Florida. Dr. Reid is best recognized for his research on the redox biology of skeletal muscle. He was a founding member of NASA's National Space Biomedical Research Institute. As principal investigator, he led a translational research program to evaluate countermeasures for muscle weakness and fatigue during spaceflight. In parallel, Dr. Reid and his colleagues at Johnson Space Center confirmed that untrained volunteers are highly susceptible to space motion sickness (SMS). The research team showed that SMS could be induced by sequential exposure to brief bouts of microgravity and that SMS was refractory to contemporary pharmacologic countermeasures. That project directly informed the current editorial and established that Dr. Reid does not aspire to space travel.