CAREGIVERS: THE INVISIBLE WORKFORCE PAGE 82

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TOXIC OFFICE? **HOW TO COPE**
PAGE 12

WHEN TO CALL 911
PAGE 63

HUMAN HEALTH IN **OUTER SPACE**
PAGE 14

10 WAYS TO **CURB YOUR ANXIETY**
PAGE 16

MAKE A **GREAT CHILI TONIGHT**
PAGE 58

SHARON STONE

STEPS BACK INTO THE SPOTLIGHT
PAGE 40

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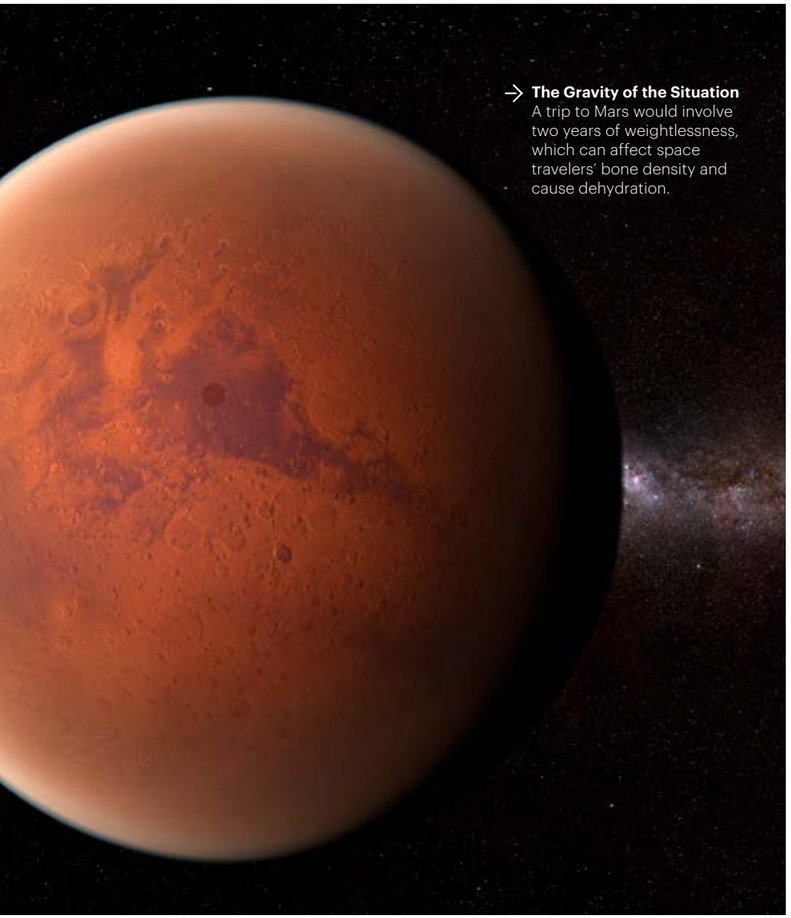
CUTTING EDGE

Safe Space

Can we really send humans to Mars and back in the near future? Very likely, experts say. But how would such a journey impact the health of long-term space travelers?



The Gravity of the Situation A trip to Mars would involve two years of weightlessness, which can affect space travelers' bone density and cause dehydration.

GETTY IMAGES

FOR MOST OF US, THE NOTION OF SPACE TRAVEL TO MARS IS LIMITED TO A Saturday night viewing of *The Martian*, starring Matt Damon. But for NASA and a team of researchers planning for such a mission, not only is it possible, it's probable. And perhaps relatively soon.

Still, even if NASA can tackle the technological challenges of landing a shuttle on the "red planet" some 40 million miles away from Earth and then safely returning its crew home, important questions must be answered about potential health effects on astronauts before blastoff can happen.

Enter Carl A. Olsson of Advanced Urology Centers of New York and Michael Leapman, MD, assistant professor in the Department of Urology at the Yale School of Medicine. Their studies incorporate ongoing research collected from the International Space Station and focus on gender differences in osteoporosis and fertility, as well as issues of the genitourinary tract (which includes the reproductive organs and the urinary system) during prolonged missions in space.

GRAVITY MATTERS

Humans have already survived prolonged space flights. Record holder Russian cosmonaut Valeri Polyakov logged an uninterrupted 483 days in space back in 1995, and American astronaut Scott Kelly claimed the second-longest stay at 340 days in 2016.

According to Olsson, a mission to Mars would likely take, "at minimum, two years," including time spent for data collection on the planet's surface as well as the round-trip flight. That's twice the length of time any human being has thus far lived in microgravity, or weightlessness, which NASA defines not as zero gravity but as very weak gravity.

The mission's duration matters because the human body reacts differently to microgravity—which negatively impacts both skeletal and renal health—than it does to Earth's stronger gravitational pull.

"During the earliest space missions of the 1960s scientists observed prompt changes in bone density and leakage of calcium into the urine. So skeletal health is a big concern," Leapman explains.

Olsson elaborates: "Earth's gravity pulls bodily fluid"—meaning blood, plasma, and urine—"down into the direction of our feet, or, when we're lying down, toward the back. In microgravity more fluid goes to the brain and upper torso."

The result, he says, is that bodies in space immediately react to protect the heart, brain, and eyesight from too much fluid, working to readjust total blood volume mass through urine loss, as well as through calcium leakage from the bones into the urine.

"Astronauts become significantly dehydrated with losses of 2% to 3% of the entire body's water," says Olsson. Such fluid loss may trigger a range of renal problems, including kidney stones.

OVERRIDING MICROGRAVITY

Left untreated, kidney stones can be painful and life-threatening. "That's why urologists are involved," Leapman says. "We can walk [an astronaut] through an emergency situation in space when kidneys are blocked. NASA is developing "contingency plans so astronauts can perform ultrasounds, downlink to medical personnel on Earth, and theoretically perform an emergency procedure on themselves," he adds.

Bone density loss also contributes to osteoporosis, a condition where the bones become brittle and fragile, which can lead to bone breaks. To maintain bone health as well as strong cardiovascular systems, NASA crew members exercise on average two hours each day. Olsson says astronauts use AREDs or advanced resistance exercise devices aboard NASA flights—the equivalent of lifting weights in space.

As for dehydration, NASA has developed a specially formulated electrolyte concentrate called "The Right Stuff," a daily staple of astronauts' space diets. (Space fans here on Earth can order the hydrating drink online.)

IS THERE A GENDER DIVIDE?

"To boldly go where no man has gone before" goes the famous *Star Trek* refrain. Memo to Captain Kirk: NASA's latest class of astronauts is 50% female.

When it comes to gender difference, "There don't seem to be that many," Olsson says. Bone density changes occur in both men and women at the same rates. "Women may have different baselines, but no worsening in space than men do."

"For decades there was a sexist attitude: Can women tolerate the stresses of space? We have female astronauts approaching their seventh decades, still flying and doing well, and women in space who then had children, or who've gone to space after having children," says Olsson.

Similar to Polyakov and Kelly, women astronauts show no long-term health or fertility effects once they've returned to Earth. Leapman says research shows that once the known physiological challenges of the microgravity state are controlled for, both genders can thrive among the stars.

But will a Mars mission really happen in our lifetime?

"It's a lofty goal," admits Leapman. "I think it's going to happen by the 2030s," predicts Olsson, citing the Space X program of entrepreneur Elon Musk, who "has done an amazing job catching up to, and exceeding, the capacity of NASA in very few years. It's doable with people like Musk on board, along with the entire NASA effort."

Final Frontier Facts

GETTY IMAGES

DO ASTRONAUTS HAVE SPECIAL NUTRITIONAL NEEDS?
In space, astronauts' blood volume contracts, resulting in excess iron, which can cause bone loss, according to NASA. So iron levels are carefully monitored.

IS VITAMIN D DEFICIENCY AN ISSUE?
Astronauts in space can't absorb this essential nutrient from sunlight. NASA studies humans working in Antarctica who absorb zero sunlight over long periods of time to predict how much supplemental vitamin D astronauts require in space.

DO CIRCADIAN RHYTHMS GO HAYWIRE IN SPACE?
The answer is still pending. Currently, NASA is investigating the body's biological clock, the roughly 24-hour cycle affecting sleeping and feeding patterns, and how it changes during long-duration missions.

HOW ABOUT INTERPLANETARY PROCREATION?
"For truly prolonged missions there is talk of colonization. Could we fertilize an egg?" muses Michael Leapman, MD. "It has yet to be demonstrated if that's viable. There are concerns about cosmic radiation."

BY THE NUMBERS

9.4% more spherical
A recent study on 12 astronauts showed the heart becomes more spherical with less muscle mass after prolonged exposure to microgravity, which could cause cardiac problems during a lengthy Mars mission.

2/3 the limit
Some researchers speculate a single journey to Mars and back could expose a space traveler to two-thirds of his or her safe lifetime limit for radiation exposure, thus increasing cancer and DNA damage risk.

665 days
On April 24, 2017, astronaut Peggy Whitson broke the record for most cumulative (as opposed to consecutive) days spent in space by any NASA astronaut, male or female.