Even with regular exercise, astronaut's heart left smaller after a year in space

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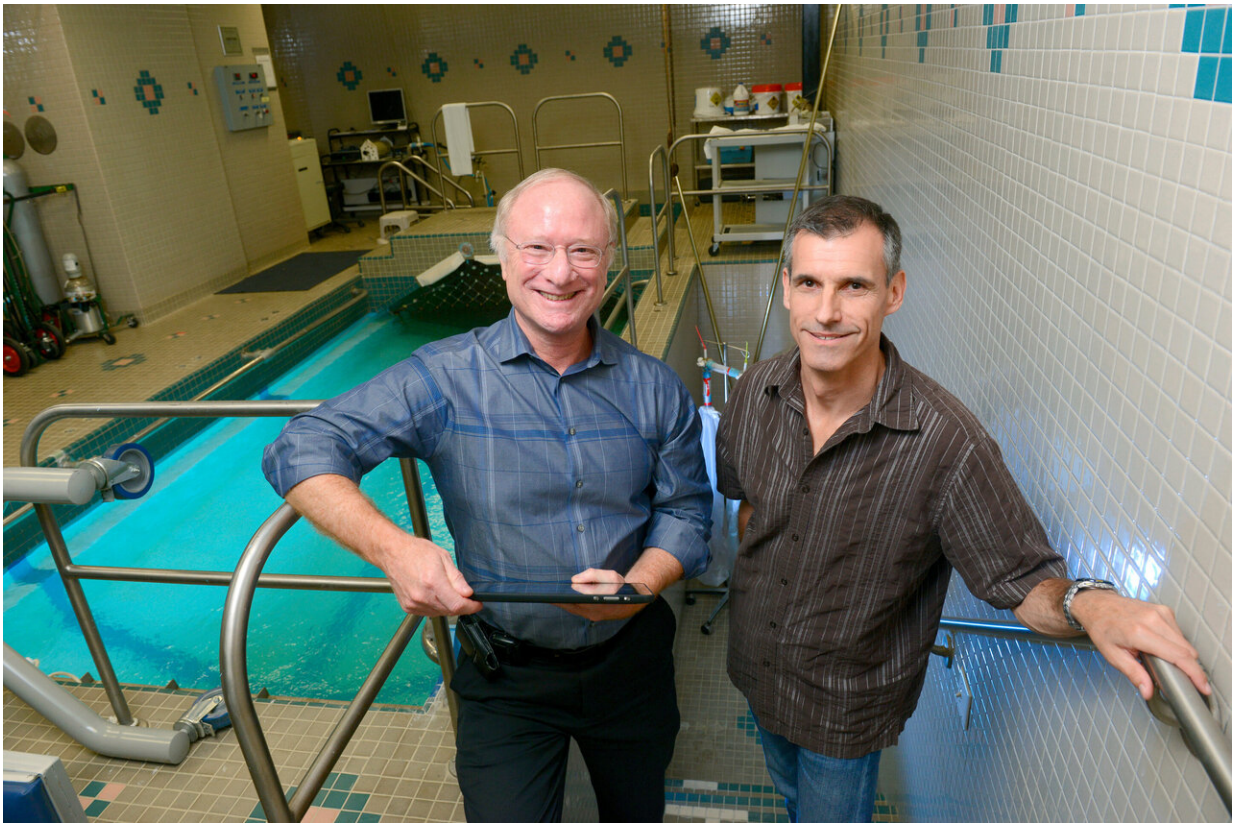

Benjamin Levine, M.D. (left) with long-distance swimmer, Benoit Lecomte. Credit: UT Southwestern Medical Center

With NASA preparing to send humans to Mars in the 2030s, researchers are studying the physical effects of spending long periods in space. Now

a new study by scientists at UT Southwestern shows that the heart of an astronaut who spent nearly a year aboard the International Space Station shrank, even with regular exercise, although it continued to function well.

The results were comparable with what the researchers found in a long-distance swimmer who spent nearly half a year trying to cross the Pacific Ocean.

The study, published today in *Circulation*, reports that astronaut Scott Kelly, now retired, lost an average of 0.74 grams—about three-tenths of an ounce—per week in the mass of his heart's left ventricle during the 340 days he spent in space, from March 27, 2015, to March 1, 2016. This occurred despite a weekly exercise regimen of six days of cycling, treadmill, or resistance work.

Despite the shrinkage, which was accompanied by an initial drop in the left ventricle's diameter when relaxed to fill with blood (diastolic diameter), the astronaut's heart adapted relatively well, according to senior author Benjamin Levine, M.D., professor of internal medicine at UT Southwestern, and founder and director of the Institute for Exercise and Environmental Medicine (IEEM) at Texas Health Presbyterian Hospital Dallas, a partnership between UT Southwestern and Texas Health Resources

"It did shrink a little bit. It did atrophy and it did get a little smaller, but the function remained good," Levine says. "I think this is encouraging for long-duration space flight. It shows that even after a year in space, the heart adapts relatively well."

Such reductions in size are also seen in patients undergoing strict bed rest and stabilize over time, he says. Levine recently completed a different project that looked at heart structure and function in 13

astronauts who spent six months on the space station. That research found cardiac adaptation to space varied from astronaut to astronaut, with the most-fit astronauts losing heart muscle mass during their stay in space (though not as much as with strict bed rest), while some of the least fit actually gained muscle mass. "It all depended on how much work the astronaut's heart did in space relative to how much it regularly did on the ground," Levine says.

Levine has been involved in research on the effects of space travel since the late 1980s, when he implanted the first catheter to monitor the heart pressure of an astronaut in space.

Since then, Levine has worked with NASA on various projects and advises its flight surgeons on cardiovascular medical issues. NASA recently awarded him $3.8 million in direct and indirect funding over 13 years to study the effects of space travel on the heart, funding that will allow him to continue his research as more long-duration space flights are conducted.

Another of Levine's interests has been the effects of exercise—especially extreme exercise—here on Earth. He serves as a consultant to the NCAA, the NFL, and the U.S. Olympic Committee and Paralympic Committee.

In this study, the researchers compared the impact on Kelly's heart with the effects seen in an endurance swimmer who set out to cross the Pacific Ocean in 2018. The swimmer, Benoit Lecomte, made it about a third of the way across the Pacific before stopping due to bad weather and damage to a sailboat accompanying him. He swam more than 1,750 miles over 159 days, according to the study.

Endurance swimming mimics some of the effects created by the weightlessness of space, as water pressure counters the effects of gravity,

Levine explains. During space flight—and endurance swimming—the heart does not have to work as hard to pump blood uphill from the feet.

During Lecomte's swim, he also lost mass in his left ventricle, averaging a slightly lower 0.72 grams per week.

Levine says he was more surprised by the swimmer's loss of heart mass than the astronaut's, given that Lecomte swam an average of six hours per swimming day while Kelly spent one to two hours exercising. Endurance swimming is not a high-intensity exercise, Levine says, so the benefit from the exercise was apparently outweighed by the heart not having to work as hard to pump blood uphill.

More information: James P. MacNamara et al. Cardiac Effects of Repeated Weightlessness During Extreme Duration Swimming Compared With Spaceflight, *Circulation* (2021). DOI: 10.1161/CIRCULATIONAHA.120.050418

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