Five things that happen to your body in space

By Naomi Brooks, The Conversation on 12.01.17
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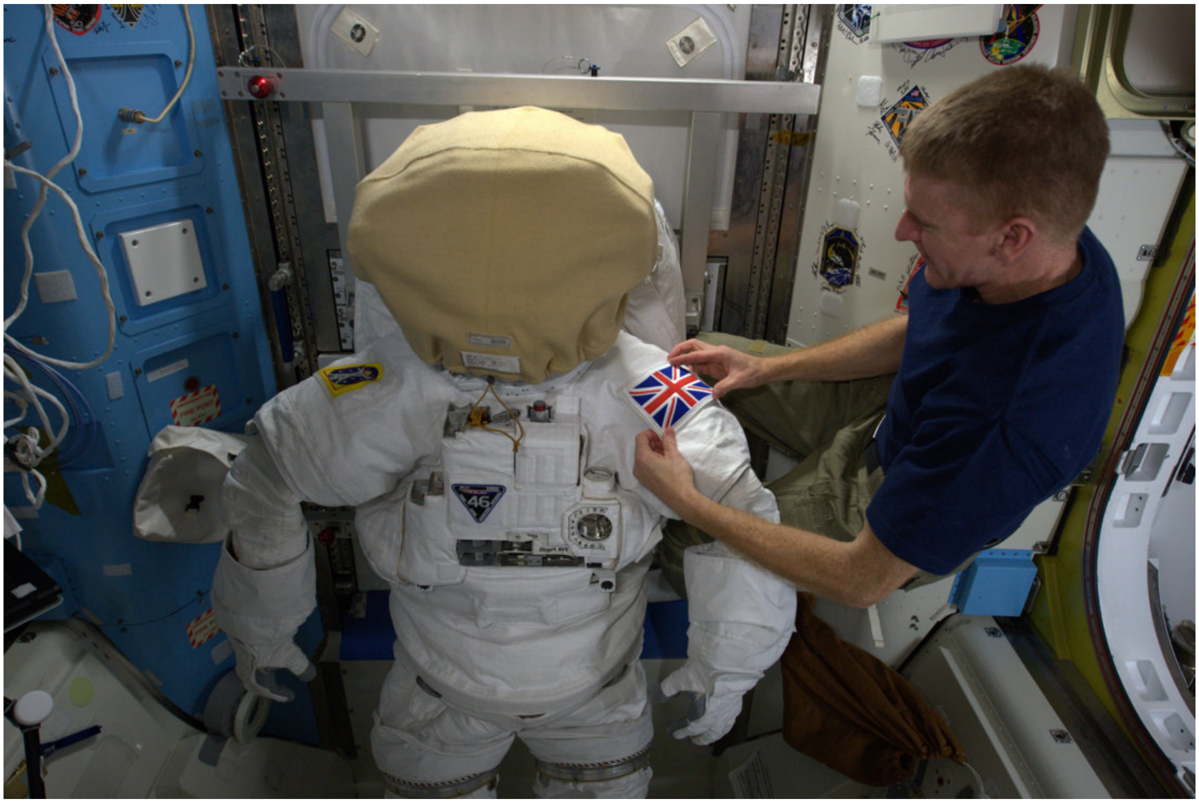
NASA astronaut Tim Kopra is seen floating during a spacewalk in 2015. Photo by: Scott Kelly/NASA. Photo by: Scott Kelly/NASA.

Tim Peake was the first official British astronaut to walk in space. The former Army Air Corps officer had spent a month in space, after blasting off on a Russian Soyuz rocket to the International Space Station on December 15, 2015, but the spacewalk was doubtless his most grueling test.



But what exactly did he go through, during his remarkable spell aboard the space station? Space travel leads to many changes in the human body, many of which have been investigated since Yuri Gargarin made the first manned spaceflight in 1961 – and an extensive team provides guidance and preparation for astronauts before, during and after any spaceflight. But if you're planning an out-of-this-world trip, here are some of the things to expect.

1. You Get Weaker

The skeletal muscle system is the largest organ system of the human body. Hundreds of muscles are used for maintaining posture – sitting, standing – and performing a wide range of movements, with different loading conditions imposed by the forces of gravity on Earth.

Skeletal muscles have the ability to adapt to different purposes and the different loads placed on them, a quality known as plasticity. But like inactivity, space flight leads to loss of both skeletal muscle mass (atrophy) and strength.

During long spaceflights on the ISS, research found that 37 crew members experienced a decrease in mean isokinetic strength of between 8 percent and 17 percent. Men and women were similarly affected. In fact, this degradation occurs even when astronauts follow a strict exercise regime, meaning that it has profound implications for humans embarking on even longer journeys, such as to Mars. Data suggests that around 30 percent of muscle strength is lost after spending 110 to 237 days in microgravity.

2. So Does Your Heart

Many parts of the cardiovascular system (including the heart) are influenced by gravity. On Earth, for example, the veins in our legs work against gravity to get blood back to the heart. Without gravity, however, the heart and blood vessels change – and the longer the flight, the more severe the changes.

The size and shape of the heart, for example, changes with microgravity and the right and left ventricles decrease in mass. This may be because of a decrease in fluid volume (blood) and changes in myocardial mass. A human heart rate (number of beats per minute) is lower in space than on Earth, too. In fact, it has been found that the heart rate of individuals standing upright on the ISS is similar to their rate while lying down pre-flight on Earth. Blood pressure is also lower in space than on Earth.

The cardiac output of the heart – the amount of blood pumped out of the heart each minute – decreases in space, too. Without gravity, there is also a redistribution of the blood – more blood stays in the legs and less blood is returned to the heart, which leads to less blood being pumped out of the heart. Muscle atrophy also contributes to reduced blood flow to the lower limbs.

This reduced blood flow to the muscles, combined with the loss of muscle mass, impacts aerobic capacity (below).

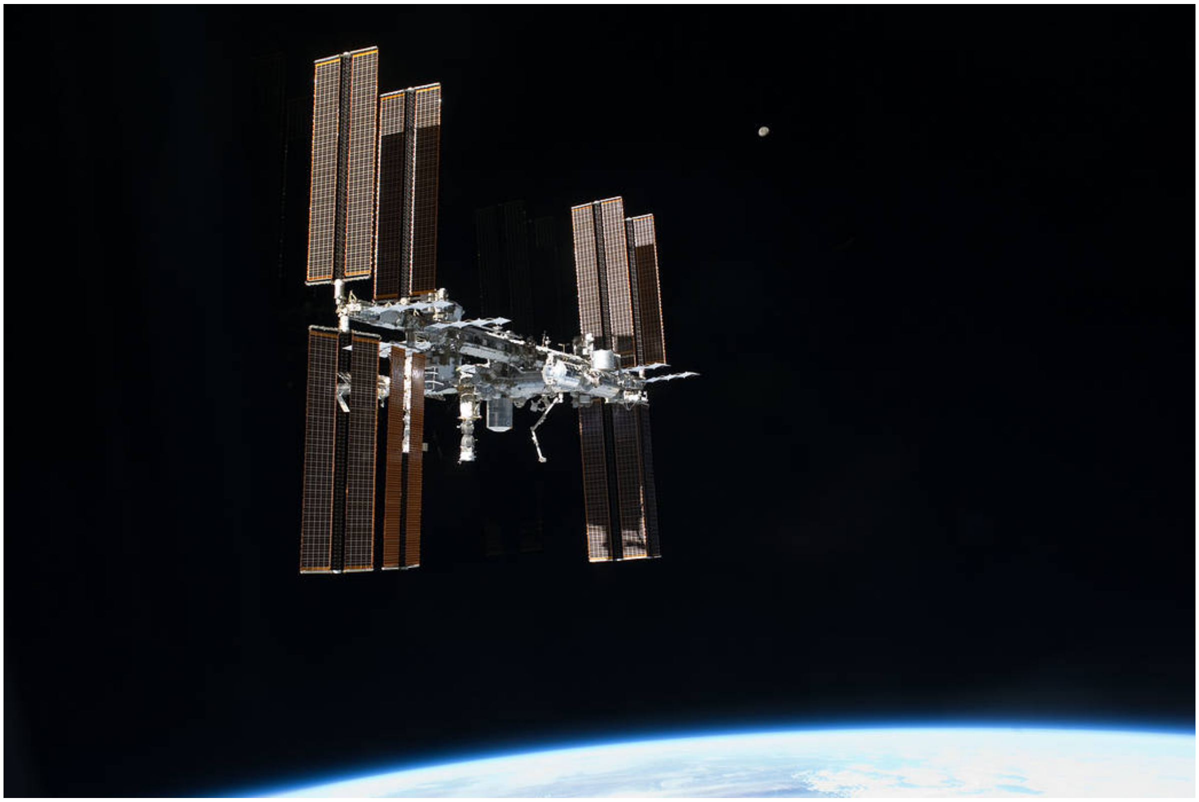
3. Fitness Suffers

Aerobic capacity is a measure of aerobic fitness – the maximum amount of oxygen that the body can use during exercise. This can be measured by VO2max and VO2peak tests. Changes to both the muscles and cardiovascular system caused by spaceflight contribute to reduced aerobic fitness.

After 9 to 14 days of spaceflight, for example, research shows that aerobic capacity (VO2peak) is reduced by 20 to 25 percent. But the trends are interesting. During longer spells in space – say, five to six months – after the initial reduction in aerobic capacity, the body appears to compensate and the numbers begin improving – although they never return to pre-trip levels.

4. You Lose Bone

On Earth, the effects of gravity and mechanical loading are needed to maintain our bones. In space, this doesn't happen. Bone normally undergoes continual remodeling and two types of cells are involved: osteoblasts (these make and regulate the bone matrix) and osteoclasts (these absorb bone matrix). During spaceflight, however, the balance of these two processes is altered which leads to reduced bone mineral density. Research shows that a 3.5 percent loss of bone occurs after 16 to 28 weeks of spaceflight, 97 percent of which is in weight-bearing bones, such as the pelvis and legs.



5. Your Immune System Suffers

The immune system, which protects the body against disease, is also affected. There are a number of variables which contribute to this, including radiation, microgravity, stress, isolation and alterations in the circadian rhythm, the 24-hour cycle of sleep and wakefulness that we follow on Earth. Also, while in space, astronauts will interact with microbes from themselves, other crew members, their food, their environment and these can alter their immune response, which may lead to challenging situations and increase the potential for infections among the crew as well as contamination of extraterrestrial sites.

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Quiz

1 Read the following paragraph from the section "2. So Does Your Heart."

> *The size and shape of the heart, for example, changes with microgravity and the right and left ventricles decrease in mass. This may be because of a decrease in fluid volume (blood) and changes in myocardial mass. A human heart rate (number of beats per minute) is lower in space than on Earth, too. In fact, it has been found that the heart rate of individuals standing upright on the ISS is similar to their rate while lying down pre-flight on Earth. Blood pressure is also lower in space than on Earth.*

Which of the following conclusions can be drawn from the above paragraph?

(A) A decrease in blood pressure makes the human heart healthier in space than on Earth.

(B) The size and shape of the heart are likely to remain changed even upon return to Earth.

(C) Structural changes in the heart may be related to a decrease in blood flow and capacity.

(D) Astronauts must prepare their hearts for space flight by spending time lying down.

2 The list of sentences below supports the argument that the processes that maintain the human body are weakened by time in space.

1. *But like inactivity, space flight leads to loss of both skeletal muscle mass (atrophy) and strength.*
2. *Without gravity, however, the heart and blood vessels change – and the longer the flight, the more severe the changes.*
3. *After 9 to 14 days of spaceflight, for example, research shows that aerobic capacity (VO2peak) is reduced by 20 to 25 percent.*
4. *There are a number of variables which contribute to this, including radiation, microgravity, stress, isolation and alterations in the circadian rhythm, the 24-hour cycle of sleep and wakefulness that we follow on Earth.*

Which additional piece of evidence from the article creates the MOST COMPLETE argument that the processes that maintain the human body are weakened by time in space?

(A) Skeletal muscles have the ability to adapt to different purposes and the different loads placed on them, a quality known as plasticity.

(B) Aerobic capacity is a measure of aerobic fitness – the maximum amount of oxygen that the body can use during exercise.

(C) But the trends are interesting. During longer spells in space – say, five to six months – after the initial reduction in aerobic capacity, the body appears to compensate and the numbers begin improving – although they never return to pre-trip levels.

(D) During spaceflight, however, the balance of these two processes is altered which leads to reduced bone mineral density. Research shows that a 3.5 percent loss of bone occurs after 16 to 28 weeks of spaceflight, 97 percent of which is in weight-bearing bones, such as the pelvis and legs.

3 Which of the following provides the BEST analysis of the article's introduction [paragraphs 1 and 2]?

(A) The introduction effectively engages the reader by contrasting the experiences of two astronauts in space, and exploring how research has changed astronauts' planning and preparation for space travel over time.

(B) The introduction effectively engages the reader by describing a recent accomplishment in space travel, and noting that changes to the human body have been documented since the earliest accomplishments in space.

(C) The introduction does not effectively develop the author's key ideas because it presents problems with spaceflight and questions about the human body that are left unanswered by the remainder of the article.

(D) The introduction does not effectively develop the author's main premise because it suggests that astronauts face many problems while in space that are not solved or further explored in the remainder of the article.

4 HOW is this article organized? What is the MOST LIKELY reason the author chose this organizational structure?

(A) by cause and effect; to demonstrate that loss of muscle is responsible for all other changes astronauts experience in space

(B) by cause and effect; to illustrate the impact of space flight on different and related functions of the human body

(C) by compare and contrast; to demonstrate how the impact of space flight on the human body has changed over time

(D) by compare and contrast; to illustrate the parts of the human body that are weakened and strengthened by time in space