# The Effects Of Long-Term Space Travel

# On The Human Body

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## Abstract

The purpose of this paper is to demonstrate through current research that it is possible to alleviate and endure symptoms of long-term space travel. The author first gives general information about space travel in the various aspects of it. He then describes the symptoms that arise from the body being in a weightless environment. The symptoms are divided into two groups and analyzed. The author then goes on to cite current research that shows evidence of being able to combat the more harmful symptoms. The information was from researchers that have studied people who have spent time in space and a first-hand account from someone who had actually spent time in space. The author found much of the available resources from database searches of scientific journals and organized this data according to the source and the value of the information that was presented. The paper concludes that long-term space travel is possible with current technology although it would be extremely inefficient.

# The Background of Long-term Space Travel

Humans have always wanted to travel to distant planets. With the level of technology mankind has achieved, long-term space travel is becoming a greater possibility. The major problem that has affected humans since they have begun expeditions into space is the physiological effects that an environment without gravity has on the human body. The realization that lack of gravity causes physical changes to the human body came when NASA started sending astronauts into orbit for short periods of time. When the astronauts returned to the ground, they would be disoriented and unable to walk. This led to some early studies on what goes on with the human body in space.

As the duration of space flights became longer, scientists began to discover other changes in the human body. One of the first findings was that without the pressure of gravity, the human heart becomes enlarged and the bones within the body began to deteriorate. The muscles of the body also begin to become extremely atrophied due to the lack of use. Scientists were able to study these symptoms even more with the launching of the Mir space station. Astronauts were spending more and more time in an environment without gravity, allowing for more studies as to what kind of problems could arise during long-term space travel. Along with studying the symptoms of space flight, there have also been attempts at negating them with machines designed to exercise the muscle and bone groups most affected by space flight. These machines have usually consisted of elastic straps that were anchored at one end and attached to the astronaut on the other end. The astronaut would stretch it out, thus keeping the muscle and bone from deteriorating as much as it normally would. That is how far our understanding of space

flight and the effect that it has on the human body has come, although many other solutions are being tested for feasibility.

This paper will mainly focus on the effects that long-term space travel has on the human body, and also the solutions that are available to those problems. The first discussion of the paper will be about the various ailments that astronauts experience while in space. The second part of the paper will contain information regarding possible solutions to the symptoms that are experienced in space. Current research as to the feasibility of long-term space travel will also be discussed in the paper. The main claim that is asserted throughout this paper is, with currently available technology, humans can endure long-term space travel.

# Key Terms

**Atrophy-**

**Osteoporosis-**

## Space Travel: General Symptoms

With the advancement of computer and aerospace technologies, the exploration of space is becoming even more of a reality. We are very close to having the technological ability to create vehicles capable of traveling long distances in space. The problem that is continually being encountered is the effects that long-term space travel has on the human body. Researchers have been identifying and studying these problems since 1951 [10].

The human body undergoes numerous changes that are usually harmless while in an environment without gravity. Without gravity there is no longer pressure keeping the fluids of the body on their normal course, and these fluids travel up to the head and chest. This causes your face to puff up, your heart and other organ to become enlarged, and the veins in your neck begin to bulge out because of the extra fluid. This extra fluid causes the body to try and fix the problem by excreting the excess fluids. These fluids contain important contents such as electrolytes, blood plasma, and calcium [6]. The excretion of excess fluids from the body also causes the body to increase the rate at which the kidneys filter blood by twenty percent [10]. The spinal discs also begin to enlarge from the lack of gravity. This can cause a person to grow around two inches. Another problem that occurs is the impairment of the sense of direction. The human body relies on the fluid in the inner ear to determine our direction and balance. Without gravity, this fluid no longer stays at the bottom of the inner ear and causes the body to become mildly disoriented. An environment without gravity also can cause psychological changes that accompany the physical changes. The body can suffer from insomnia and sever depression and irritation with other people [5]. All of these symptoms that the body undergoes usually alleviate and have no lingering effects when the body is reintroduced to gravity.

The other changes that the body undergoes can be potentially harmful. Without gravity, important muscles no longer need to be used. These muscles atrophy at an incredibly high rate. After returning from space flights with a length of more than a month, the muscles usually no longer have the mass to function as they once did. This means that often times, the body is no longer able to walk or do other seemingly simple actions. The rehabilitation time for this can in some cases be longer than two years. The other potentially harmful change that the body undergoes is extreme osteoporosis. In space, the human body loses between one and two percent of its bone mass each month. That amount is on average what a postmenopausal woman loses in a year [3].

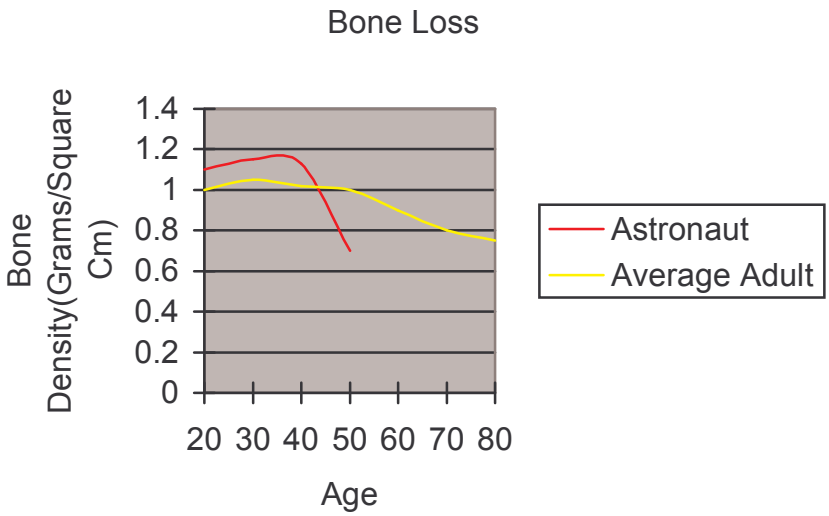


**Figure 1:** Shows difference of bone loss over time by comparing astronauts and normal adults. Source: Long, Michael E. Surviving in Space. National Geographic Magazine, January 2001, 9-29.

This amount of bone loss could cause severe osteoporosis in the human body. The amount of bone lost over a duration of two years for an astronaut would be about equal with the bone loss of an 85 year old adult (see figure 1). The skeletal system would be

incredibly susceptible to breaks and stress fractures both in space and on the ground. This could cause problems once the spacecraft reached its destination and a person had to travel in an environment that has gravity. Some scientists speculate that the body could possibly be so weakened that just walking (if the muscles were not too atrophied) could cause a break or fracture [8]. Scientists are unsure was to whether or not the osteoporosis could be completely reversed, or if it would be impossible to gain back normal bone density.

The last problem that the human body could possibly suffer in outer space is radiation poisoning. The sun gives off a large amount of radiation that can potentially mutate genetic material.

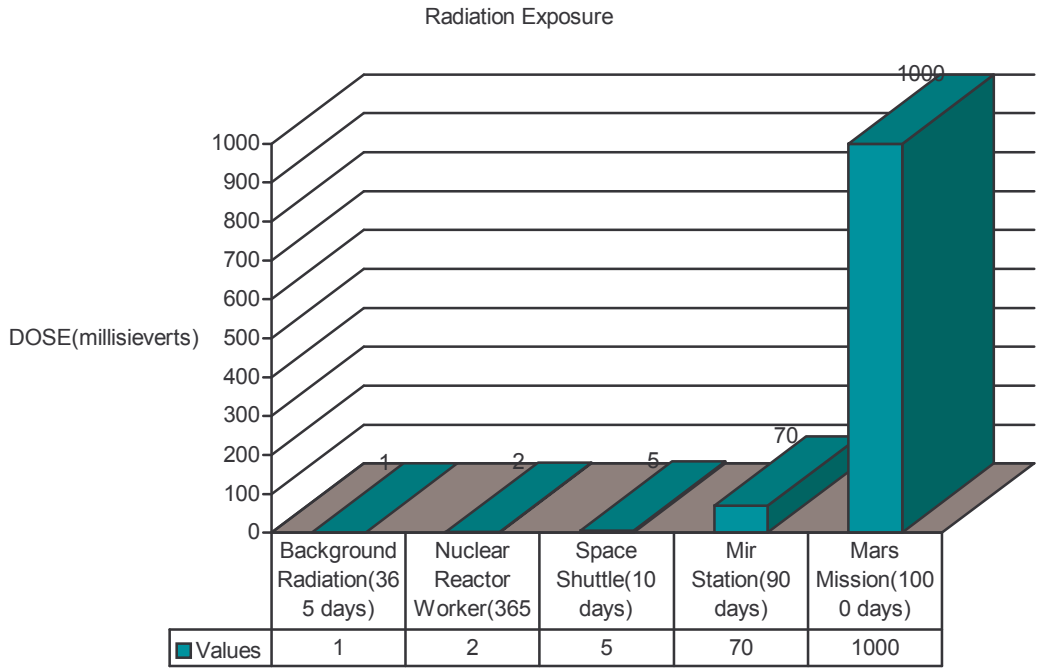


**Figure 2:** Different amounts of radiation exposure vs. different locations. Source: Long, Michael E. Surviving in Space. National Geographic, January 2001, 9-29.

Earth is shielded from this radiation by both its magnetic field and the atmosphere. Space has no such protection, so the amount of radiation could be over 1000 times greater than on Earth (see figure 2). This amount of radiation could potentially cause severe cancer or radiation poisoning. Massive damage to cells can also be caused by exposure to radiation and can lead to severe internal problems [2].

## Space Travel: Current Solutions

All of the harmful effects that space travel has on the human body need to be effectively diminished in order for long-term space travel to be feasible. There are currently numerous treatments and technological advances that have been made for the purpose of combating these problems. These technologies range from specialized drug mixtures to vibrating machines. The most important treatments are those that help reduce or nullify the harmful effects of weightlessness.

There are numerous new treatments that are being utilized to treat the muscle and skeletal problems cause by weightlessness. One of the simplest items being used to help keep muscle and bone healthy is a group of bungee cords. The cords provide elastic resistance while in space that allows the user to work their muscles. The bungee cords are not enough to completely alleviate muscle loss, but with proper use, they can slow down the breakdown of muscles [7]. Another solution to help keep muscles from atrophying is a vacuum treadmill. The treadmill works by placing a vacuum suction around the waist of the person, and this vacuum helps to hold the person to the treadmill. The amount of vacuum being exerted can be increased to compensate for people of different weights. A solution that has been recently discovered to treat the loss of bone density is a moving plate. The plate vibrates at a frequency of between twenty and fifty Hz. Clinton Rubin,

the inventor of the machine, has found evidence that this vibrating contributes to the formation of new bone. After a year of twenty minute sessions per day, the bone mass of a sheep had increased twenty percent as compared to the control group [9].

**Bone Density Before & After**


**Figure 3:** Bone density of control group as compared to the group that tested. Source: Baard Erik. Bone Growth Simulator. Space.com, 2001. Available online at http://www.space.com.

The machine has only been tested on chicken and sheep so far, but scientists are hopeful that it will have the same effect on humans [1]. There are also several new drugs that are currently not certified by the FDA, but are being tested. These drugs could potentially help increase the production of new bone material, or stop the decay of old bone material. All of the solutions for osteoporosis are currently in the experimental stage, but within the next couple of years scientists hope to be actively testing these solutions in an environment without gravity.

One solution that would completely get rid of all the problems caused by an environment without gravity would be to create artificial gravity. This could be done by

using centrifugal force. Artificial gravity could be created by designing a drum that spins in a circle. The momentum of this spinning would create artificial gravity within the drum. There are several problems that prevent this solution. The first problem is the energy requirement. It would take an enormous amount of energy to keep the drum continually spinning. This is too inefficient to be feasible for long-term space travel. There are also several engineering problems that arise with designing the drum. There is a problem regarding wiring through it. If one part of the craft is spinning while the other part is not, there isn't anyway that there could be electrical wires that run through the drum and into the other section.

The last potentially harmful issue is radiation. Shielding the spacecraft with lead can filter out much of the dangerous radiation present in space. Lead is extremely heavy, and the amount needed to lower the radiation levels to normal levels found on earth would require shielding several inches thick around the whole spacecraft [2]. This is extremely inefficient because the amount of thrust needed to leave the atmosphere would increase several times over. Until there is an easier way to achieve orbit, heavy lead shielding remains too cost inefficient to be feasible. This solution could be remedied by designing a new, more efficient way of leaving the atmosphere. Until then, a lighter shielding of lead that blocks out most of the radiation is the most effective way of combating this problem.

## Conclusion

It is evident through research that the technology is available to help the human body adapt to long term space travel. There is a setback though, as some of this technology has not been fully tested on human subjects. In their current state if applied

together, these different solutions could help alleviate most of the problems that the body experiences in a weightless environment. This shows that space travel for a long duration at our technological level is feasible with current technology. The experimental technologies can greatly benefit astronauts by lowering their dependence on exercise and help the overall efficiency of space travel. It would be more beneficial to us to wait until our technology advances even more, but if there was an immediate need for long-term space travel, the resources would be available to help keep those involved healthy.

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