Mission to Mars

It would be the ultimate ultra-long-range flight. But the nature of the human body might put the Red Planet off limits, writes Cheryl Jones.

EVER SINCE John F. Kennedy talked of putting a man on the moon – not because it was easy, but because it was hard – people have dreamt of stretching the human frontier even further, perhaps to Mars.

But while NASA might soon have the technology to put a person on the Red Planet, the limits of the human body could make the mission just too hard.

Leading United States-based space medicine and human performance expert, Dwight Holland, says astronauts exposed to microgravity during the long mission could lose bone rapidly.

Bone demineralisation – the loss of calcium and other minerals from the skeleton – mimics osteoporosis, making bones fragile and increasing the risk of fracture. Its effects could be disastrous on a Mars mission. Crew would be lumbering over the planet and coming home with skeletons prematurely aged.

"Bone demineralisation and fracture might be the great physical threat to long-duration space flight," Holland told the last International Congress of Aviation and Space Medicine. "That's assuming we can control radiation issues," he said, referring to another big danger – prolonged exposure to cosmic rays and solar flares.

Psychosocial factors related to confinement and isolation during the mission could emerge as a "very serious wildcard in the equation".

NASA is considering putting astronauts on Mars, partly to search for answers to big questions about the possibility of life on other worlds. Such questions have been left hanging despite years of unmanned missions.

And a manned mission, which would take up to two-and-a-half years, would carry great prestige, even though the imperative to be first has diminished with the end of the Cold War. Many see it as the obvious next step in space exploration.

Bone demineralisation related to space flight is caused when calcium metabolism changes in response to microgravity, said David Newman, director of the aviation medicine unit at Melbourne's Monash University.

"In normal conditions on Earth, calcium metabolism ensures that our bones are strong enough to support our bodies," he said.

"In space, where the body weighs effectively nothing, the bones no longer have to support its weight. The requirement for strength disappears, and the body's calcium balance changes to reflect the new situation.

"Calcium leaves the bones, and since it is now considered by the body to be surplus to requirements, it is excreted via the kidneys."

At its closest point, when it is in opposition, or on the same side of the sun as the Earth, Mars is 56 million kilometres away, writes former Lockheed Martin engineer, Robert Zubrin, a vocal campaigner for a manned mission.

When Earth and Mars are in conjunction, or on opposite sides of the sun, they are at their maximum distance apart – 400 million kilometres. The conjunction class trajectory, with the greatest distance to cover, would use the minimum energy, Holland said. But orbital mechanics would dictate a blast-off by 2018 – very soon, given the problems yet to be solved.

Holland and colleagues assessed the impact of bone demineralisation using results from the longest space missions flown so far and big studies on Earth-bound populations relating osteoporosis to age and bone fracture rates.

The population data show that our bone mineral density normally peaks at age 30 to 35. By age 40, losses are occurring at a rate between 0.3 and 0.5 per cent a year.

The best flight data compiled so far suggest that astronauts in micro or partial gravity would suffer bone losses of up to four per cent per month. In its calculations, the team conservatively assumed a rate of between one and two per cent a month.

Assuming bone demineralisation of one per cent per month, the prevalence of lumbar spine fractures for astronauts 12 months into the mission would reach 20 per cent. The rate would rise to 40 per cent after 24 months. Crew would have the hipbones of a 90-year-old by the time they returned from a Mars mission.

Holland stressed that the results were preliminary and that the figures could improve by the time a craft left for the Red Planet. By then, more precise data would be in and scientists would probably have worked out ways to mitigate the problem.

A big question is the extent of recovery on return to Earth gravity. "We think it will be partial," he said.

A five-year follow-up study of Skylab astronauts revealed only a modest recovery in bone mineralisation after a significant loss. More recent data from astronauts on missions to Mir and the International Space Station, showed better recovery rates.

And the degree of bone recovery varies between individuals.

Another big question is the rate of bone demineralisation in partial gravity, which on Mars is almost 40 per cent that of Earth. "Everything depends on how much you lose while you're on Mars," Holland said, adding that the answer to this question could dictate the mission trajectory chosen.

NASA would have to put in place measures to counter the effect of bone demineralisation. The main one would be the creation of artificial gravity by spinning the astronauts' compartment on the spacecraft, creating a centrifugal force.

Others could include drugs, a finely-tuned exercise program and spacesuits designed to protect against fractures.