'Pillownauts' help future manned missions to Mars

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Dr. Natalie Shur and first 3 day bed rest volunteer, Dorsan, at the University of Nottingham. Credit: @University of Nottingham

The 3-day bed rest study is being carried out in Nottingham in parallel to a 60-day bed rest study by the European Space Agency at the MEDES facility in Toulouse, France. Bed rest is a tried and tested way to measure the effects of weightlessness on the human body which include

bone and muscle mass loss, cardiovascular decline and impaired carbohydrate metabolism which could be a risk for type 2 diabetes.

Many astronauts come back to Earth from space showing signs of pre-diabetes because weightlessness can lead to insulin resistance whereby the muscles and liver can't absorb glucose to help regulate blood sugar levels. The Nottingham study is specifically aiming to find out how quickly we develop insulin resistance from prolonged bed rest, and what are the mechanisms driving this harmful effect.

Ten healthy male volunteers have been recruited to take part in the study in the Medical School at the Queen's Medical Centre in Nottingham from February 2018. After baseline tests for weight, muscle mass, liver and pancreatic function including MRI scans and muscle biopsies, the participants will spend three days lying flat in bed in a slight head-down incline to mimic weightlessness in zero-gravity.

Professor of Metabolic Physiology, Ian Macdonald, said: "There is a big push at the moment for a manned mission to Mars - a journey that would take as long as 9 months with huge implications for the fitness of the astronauts. Multiple scientific groups across NASA, the UK Space Agency and ESA, are working on many aspects of this physical deterioration in zero gravity and we hope our contribution to this will be significant and possibly lead to further studies about insulin resistance over a longer time period."

Co-leading the study, Professor of Muscle Metabolism, Paul Greenhaff, said: "Non-weight-bearing has a major negative impact on health, including reduced muscle mass and sensitivity to nutrition. Pre-diabetes is a very marked negative side effect and it is this aspect that we want to investigate as part of the wider ESA studies. This research has important implications for space flight, but will also provide important insight into the negative effects of inactivity on metabolic health in the general

population. Indeed, many of the effects currently attributable to ageing across our life course are most likely caused by decreasing physical activity levels that accompany ageing."

Dr Natalie Shur, PhD researcher on the project, added: "Over the period of bed rest, we will use the gold standard method to measure insulin resistance in our ten participants. This is called an 'insulin clamp' and it shows us exactly how much glucose is being taken up by the muscles. We also use stable isotope tracers, administered both orally and intravenously, to show how glucose uptake by muscles changes over time as the bed rest progresses. We expect to find an accelerated onset of insulin resistance in the first 3 days of bed rest and we hope to answer significant questions about the rate and magnitude of that resistance and associated muscle wasting."

The current space exercise protocol dictates that to prevent gross muscle atrophy, astronauts have to do around 2 hours of intense physical exercise a day in space and take on a set number of calories to give them the best chance of maintaining physical fitness. The Nottingham research team aims to work out when the most detrimental changes take place, possibly in the first week in space, then they may be able to offset these changes by a programme of early rehabilitation exercises.

At MEDES in France, the participants in the longer bed rest study are also having an antioxidant cocktail versus placebo to see if this can prevent insulin resistance and some of the detrimental changes. This could mean that astronauts end up having an antioxidant supplement in their diet to mitigate some of these detrimental effects.

Provided by University of Nottingham