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ON THE ROLE OF PHYSIOLOGICAL COMPUTER MODELS FOR PREDICTING RISKS IN MOON AND MARS EXPLORATION MISSIONS.

Abstract

The objective of this work is to analyse and simulate long-term effects to the cardiovascular system, and gender differences when individuals are exposed to long-term microgravity. Risk probability of a health impairement which may put in jeopardy a long-term mission is also evaluated. Computer simulations are becoming a promising research line of work, as physiological models become more and more sophisticated and reliable.

Technological advances in state-of-the-art hardware technology and software allow nowadays for better and more accurate simulations of complex phenomena, such as the response of the human cardiovascular system to long-term exposure to microgravity. Experimental data for long-term missions are difficult to obtain and reproduce, therefore the predictions of computer simulations are of a major importance in this field. Our approach is based on a model developed and implemented in our laboratory (NELME: Numercial Evaluation of Long-term Microgravity Effects). The software simulates the behaviour of the cardiovascular system and different human organs, has a modular architecture, and allows to introduce perturbations such as physical exercise or countermeasures. The implementation is based on a complex electrical-like model of this control system, using inexpensive development frameworks, and has been tested and validated with the available experimental data. Gender differences have been implemented for this specific work, as an adjustment of a number of parameters that are included in the model. Women versus men physiological differences have been therefore taken into account, based upon estimations from the physiology bibliography. The simulation allows us to make step-by-step changes of gravity from Earth-based to zero. The system allows us to include responses to patterns of physical aerobic exercise and thermal stress simulating an extra-vehicular activity.

Results show that significant differences appear between men and women physiological response after long-term exposure (more than three months) to microgravity. Risk evaluation for every gender, and specific risk thresholds are provided. Different scenarios of Moon and Mars exploration missions are considered, and their associated risks are quantified.

We conclude that computer-based models such us NELME are a promising line of work to predict health risks in long-term missions. More experimental work is needed to adjust some parameters of the model. This work may contribute to a better understanding of the underlying processes involved for both women in man adaptation to long-term microgravity.