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CORE BODY TEMPERATURE AND CIRCADIAN RHYTHM CHANGES UNDER DIFFERENT PHYSICAL AND ENVIRONMENTAL CONDITIONS ON EARTH AND IN SPACE

Abstract

Introduction. Heat exchange between an organism and its environment occurs via conduction, convection, radiation, and evaporation [1]. Under terrestrial conditions, heat exchange for an adult occurs mainly by radiation and convection, and the body core temperature fluctuates by only +/- 0.5C throughout the day, i.e. the "circadian rhythm". In space the heat loss pathways are challenged due to the lack of natural convection which results in the diminished occurrence and/or efficiency of evaporation.

Methods. Three core body temperature investigations will be presented: i) during long-term bed-rest [2, 3] (study A), ii) during rest and exercise in space [4] (study B), and iii) continuously over 36-hrs in astronauts on ISS (ESA//DLR CircRhythms Experiment) (study C).

Results. In (A) 7 males were monitored during long-term bed rest; in (B) 11 astronauts during a regular V O2 ergometer testing on ISS, and in (C) several times continuously over 36-hrs . Study (A) proved that the device correlated well (r¿0.704) with the rectal temperature recordings, (B) revealed that the astronauts had marked and prolonged increases during exercise in core body temperature, sometimes ¿40C, in space on the ISS (p¡0.01). Finally, study (C) (N=13) results revealed that the mesor was markedly increased in space by about 1 C. In addition, the first results indicate that there seems also to be a slight trend for a wider range of fluctuation during spaceflight (increased rhythm amplitude). When core body temperature is measured in humans following a conventional lifestyle, circadian rhythm of core body temperature is characterized by a minimum around 05:00 h in the morning (nadir). Phase shift is an indication that circadian rhythm is altered. While we observed some overall variance (phase shift of core body temperature is rather advanced, i.e. appears earlier), we found in the present study on ISS no substantial pattern between pre- and in-flight recordings of the astronauts.

Conclusions. Changes in body core temperature can be markedly attenuated in space. Further studies on this topic are urgently needed because i) the frequency, length, and intensity of extravehicular activities will increase in future and ii) alteration of the circadian rhythms have to be further investigated because they might aggravate the physical, psychological, and cognitive performance of humans in space.

References. [1] Gunga H.-C. (2015) Human physiology in extreme environments. Elsevier, pp. 201-213. [2] Gunga H.-C. et al (2009) Respir Physiol Neurobiol 169S, S63-S68. [3] Mendt S. et al. (2017) Chronobiol Int 34, 666-676. [4] Stahn A.C. et al (2017) Nature Scientific Reports 7, DOI:10.1038/s41598-017-15560-w

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