

## HUMAN PHYSIOLOGY DURING EXPOSURE TO CAVE ENVIRONMENT: A SYSTEMATIC REVIEW AND POTENTIAL FUTURE IMPLICATIONS FOR AEROSPACE MEDICINE

*LA PHYSIOLOGIE HUMAINE LORS DE L'EXPOSITION À L'ENVIRONNEMENT DES GROTTES: UNE ÉTUDE SYSTÉMATIQUE ET DES IMPLICATIONS FUTURES POSSIBLES POUR LA MÉDECINE AÉROSPATIALE*

**L Zuccarelli**, L Bessone , EB Coffey , G Strapazzon  
CNR- National Research Council, Segrate, , Italy  
[lucrezia.zuccarelli@ibfm.cnr.it](mailto:lucrezia.zuccarelli@ibfm.cnr.it)

**Introduction:** Cave environment has become one of the last frontiers of exploration on earth. Caves, in fact, are characterised by absence of light and day/night cycles, specific environmental conditions, confinement and three-dimensional human movement. Since 1938, studies in caves have been conducted on human behaviour, physiology and neuroscience. In the 70's, Siffre's and Montalbini's isolation studies attracted space agencies' interest. The European Space Agency (ESA) established a course in 2011 for Cooperative Adventure for Valuing and Exercising human behaviour and performance Skills (CAVES) in caves. However, little is known about human physiological responses during a stay/exploration in a cave. The aim of our review was to conduct a systematic bibliographic research review of human studies associated with permanence in caves, with a view to extend the results to implications for human planetary exploration missions.

**Methods:** A systematic search was conducted following the structured guideline PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) of electronic databases (Google Scholar, MEDLINE, NASA Technical Reports Server, OPAC, WorldCat) and manually searching reference lists of the articles investigating human body responses during a stay/exploration in a cave.

**Results:** The systematic search retrieved 2097 articles. There were 156 articles selected for further revision. Articles were classified into seven categories: atmospheric science (24), emergency medicine (61), human factors (0), human physiology (23), neuroscience (29), psychological aspects (4) and radiation (15). An analysis of the methods of each study revealed wide discrepancies with respect to the selection and number of participants, the nature of the experimental protocols, and degree of scientific rigor.

**Discussion:** Our study provides the first comprehensive overview of physiological human studies related to the underground environment. The review will facilitate comparison with knowledge in related disciplines, stimulate research and offer an opportunity for implementation of human space analogue research in underground environments.