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ISOLATION AND CONFINEMENT IN SPACE AND UNDERWATER MISSIONS

Abstract

Isolation and Confinement (I-C) are among the major hazards of space missions. Studies conducted using terrestrial analogues, such as Antarctica research stations and NEEMO, have demonstrated that prolonged periods of exposure to I-C can induce psychological and physiological alterations ranging from cognitive impairments, fatigue, anxiety, altered circadian rhythm, and worse sleep quality to changes in circadian heart rate, neuroendocrine stress response, headache, gastrointestinal problems, compromised immune function, and impaired neuromuscular performance. The consequences of I-C will become increasingly important in the future exploration class interplanetary missions. Psychological, cognitive, and physiological alterations may strongly affect the crew's performance and could have devastating effects during long-term spaceflight. Therefore, our knowledge of the effects deriving from I-C needs to be increased. Terrestrial analogs enabling in-depth exploration of long-term effects induced by I-C are extremely helpful. Underwater habitats are considered an excellent facility for space analog research. In particular, submarines involved in operative missions are probably the best analogue of a space vehicle/station. Excluding microgravity and radiation, the crew of a submarine mission is exposed to the same stress factors experienced by space mission crews, such as I-C, artificial light, slightly hypoxic environment, challenging and focused activities, work shifts that change the sleep-wake alternation, etc. Therefore, studies conducted with submarine crews, which are more numerous than those of space missions, can be of great importance to increase our understanding of the long-term effects of I-C. The EXPOSOME SIGNATURE and NUT projects study the neuroendocrine, metabolic, redox, immune and inflammatory profiles, as well as the microbiome and virome composition/activation in astronauts before, during, and after short and long-duration space mission. The aim is to shed light on the concurrent effects of spaceflight and possible implications in the onset of acute and chronic diseases. Parallel studies are conducted on submariners of the Italian Navy involved in underwater missions of similar duration. The comparison between astronauts and submariners makes it possible to distinguish the effects due to space-related stressors (microgravity and cosmic rays) from those mostly due to I-C and psychophysical stress, which are common to life on the ISS and aboard a submarine. Data from submarine missions and the AXIOM-3 mission will be presented. The authors thank ESA (AO-2019-ISS-PP and AO-2019-ISS-SDM and MAP-WHISPER Project C.N. 4000130928/20/NL/PG/pt) and ASI (C.N. 2021-14-U.0_NEPTUNESDM and C.N.2021 – 15 – U.0_NEPTUNE – PP) for their support.