THE EFFECTS OF MICROGRAVITY DURING PARABOLIC FLIGHT, SHORT-DURATION AND LONG-DURATION SPACEFLIGHT ON LUNG VOLUME, CAPACITY AND SHAPE: A SYSTEMATIC REVIEW AND META-ANALYSIS

Abstract

Purpose: The advent of consumer spaceflight and space tourism raises the issue of individuals who are not in peak physical health being exposed to periods of microgravity. It is likely lung function will be altered by gravity, so it is important to understand the key anatomical and functional changes currently understood to occur with a change in gravitational load. Also, our knowledge of the long-term effects of space on human health is still in its infancy. The impact on lung anatomy including volume, capacity, and shape parameters have not been systematically reviewed in recent times. There is however microgravity lung data dispersed in multiple publications and by amalgamating the current research on anatomy, we can extrapolate and simulate the effects spaceflight might have on those with pulmonary impairments. Therefore, the aim of this work was to review all available evidence and provide a comprehensive analysis of the effects of microgravity in space on pulmonary anatomy.

Methodology: A systematic review was conducted where thirty studies including parabolic (10-25s), short-duration (<30d) and long-duration (>30d) spaceflight were analysed. Anatomical parameters including lung shape, volumes and capacities reported before flight and in-flight were extracted. A meta-analysis was performed to directly compare differences between 0G and 1G results across multiple studies where possible.

Results: Although no change was seen in lung volume and capacity between 0G and 1G in long-duration spaceflight, the data available is insufficient to deduce a finding. Slight changes, particularly in measurements taken in the supine position, were observed in parabolic and short-duration spaceflight. No consistent effects were observed in lung shape in microgravity compared to 1G for all flight types. While pulmonary anatomy is not improved in spaceflight, there is no evidence to suggest it is impaired.

Conclusions: The review highlights the stability of the lung anatomically and structurally in microgravity and exposure for short or long periods is, overall, not a serious health concern for lung anatomy. The physiological basis of lung volumes and capacity measures are clinically significant and microgravity exposure during spaceflight may impact those with pulmonary health problems like obstructive or restrictive lung diseases. This work provides an evidence-based reference for experts in medicine, healthcare, and human spaceflight programs to understand the human lungs in space, in preparation for spaceflight
tourist activities and long-duration exploration missions beyond the Earth’s gravity including a Lunar habitat and advancing to Mars, and future direction for research to address current gaps.