

THE EFFECTS OF MICROGRAVITY ON SEATED HEIGHT (SPINAL ELONGATION)

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ABSTRACT

Many physiological factors, such as spinal elongation, fluid shifts, bone atrophy, and muscle loss, occur during an exposure to a microgravity environment. Spinal elongation is just one of the factors that can also affect the safety and performance of a crewmember while in space. Spinal elongation occurs due to the lack of gravity/compression on the spinal column. This allows for the straightening of the natural spinal curve. There is a possible fluid shift in the inter-vertebral disks that may also result in changes in height. This study aims at collecting the overall change in seated height for crewmembers exposed to a microgravity environment.

During previous Programs, Apollo-Soyuz Test Project (ASTP) and Skylab, spinal elongation data was collected from a small number of subjects in a standing posture but were limited in scope. Data from these studies indicated a quick increase in stature during the first few days of weightlessness, after which stature growth reached a plateau resulting in up to a 3% increase of the original measurement [1-5]. However, this data was collected only for crewmembers in standing posture and not in a seated posture. Seated height may have a different effect than standing height due to a change in posture as well as due to a compounded effect of wearing restraints and a potential compression of the gluteal area.

Seated height was deemed as a critical measurement in the design of the Constellation Program's (CxP) Crew Exploration Vehicle (CEV), called Orion which is now the point-of-departure vehicle for the Multi-Purpose Crew Vehicle (MPCV) Program; therefore a better understanding of the effects of microgravity on seated height is necessary. Potential changes in seated height that may not have impacted crew accommodation in previous Programs will have significant effects on crew accommodation due to the layout of seats in the Orion. The current and existing configuration is such that the four crewmembers are stacked two by two with the commander and pilot seats on the top and the two remaining seats underneath, thereby limiting the amount of clearance for the crewmembers seated in the bottom seat. The inner mold line of these types of vehicles are fixed due to other design constraints; therefore, it is essential that all seats incorporate additional clearance to account for adequate spinal growth thereby ensuring that the crew can safely ingress the seat and be strapped in prior to its return to earth. If there is not enough clearance to account for spinal growth deltas between seats then there is the potential that crewmembers will not be able to comfortably and safely fit into their seats. The crewmember in the bottom stacked seat may even have negative clearance with the seat above him or her which could lead to potential ingress/egress issues or potentially injury of the crewmember during landing. These impacts are specific to these types of vehicles with stacked seat configuration. Without proper knowledge of the amount of spinal elongation, or growth, which occurs due to microgravity and space flight, the design of future vehicle(s) or suits may cause injury, discomfort, and limit crew accommodation and crew complements.

The experiment primarily aimed to collect seated height data for subjects exposed to microgravity environments, and feed new information regarding the effect of elongation of the spine forward into the design of the Orion. The data collected during the experiment included, two seated height measurement and two digital pictures of seated height pre-, in-, and post-flight. In addition to seated height, crewmembers had an optional task of collecting stature, standing height. Seated height data was obtained from 29 crewmembers that included 8 ISS increment crew (2 females and 6 males) and 21 Shuttle crew (1 female, 20 males), and whose mean age was 48 years (± 4 years). This study utilized the last six Shuttle flights, STS-128 to STS-134.

The results show that participating crewmembers experienced growth up to 6% in seated height and up to 3% in stature. Based on the worst case statistical analysis of the subject data, the recommended seated height growth of 6% will be provided to the designers as the necessary seated height adjustment.

REFERENCES

- [1] Anthropometric Source Book Vol. I: Anthropometry for Designers., (NASA 1024). [2] Brown, J. (1975). ASTP002: Skylab 4 and ASTP Crew Height, [3] Brown, J. (1977). *The Apollo-Soyuz Test Project Medical Report* (pp. 119-121), [4] Thornton, W., Hoffler, G., and Rummel, J. (1977). *Biomedical Results from Skylab* (pp. 330-338).

[5] Thornton, W. and Moore, T. (1987). In: *Results of the life sciences DSOs conducted aboard the space shuttle 1981-1986* (pp. 55-57).