Pre-Flight Advanced Clothing Study

All human space missions require significant logistical mass and volume that will become an excessive burden for long duration missions beyond low Earth orbit. The current International Space Station (ISS) crew wardrobe has already evolved not only to reduce some of the logistical burden but also to address crew preference. The present study was undertaken to find ways further to reduce this logistical burden while examining human response to different types of clothes.

The primary objective of the study is to measure how long people can wear the same exercise garment, depending on the type of fabric and the presence of antimicrobial treatment. The secondary objective is to assess the reasons for length of wear from perceptions of clothing characteristics, including nine ordinal scales. Cardiovascular exercise was chosen as the activity in this experiment for its profuse sweating effect and because it is considered a more severe treatment applied to the clothes than every-day usage. Study garments were exercise T-shirts and shorts purchased from various vendors. Fabric construction, fabric composition, and finishing treatment were defined as the key variables. A web-based questionnaire was used for self-reported data collection.

The study was divided in three balanced experiments: a cotton-polyester-wool (CPW) T-shirts study with 61 participants, a polyester-modacrylic-polyester/cocona (PMC) T-shirts study with 40 participants, and a shorts study with 70 participants. In the CPW study, the T-shirts were made of 100% cotton, or of 100% polyester or of 100% wool, and categorized into open and tight knit constructions. In the PMC study, the T-shirts were made of 100% polyester, or of 82% modacrylic, or of 95% polyester with 5% cocona fiber, without construction distinction. The shorts were made either of 100% cotton or of 100% polyester, and were knitted or woven. Some garments were treated with Bio-Protect 500 antimicrobial finish according the experimental design. The data collected from the questionnaire included garment identification, level of exertion, duration of exercise session, number of exercise sessions, an ordinal preference scale for nine sensory elements, and reason for retiring a used garment.

From the analysis of the combined CPW and PMC shirt studies, there are statistically significant differences among the mean lifetimes of various types of shirts. The exercise shirts with the longest mean lifetimes are untreated wool (600 minutes), treated cotton (526 minutes), and untreated modacrylic (515 minutes). From the combined CPW and PMC shirt studies, the most preferred material was untreated open-knit wool, which is one of the two materials that jointly were worn the longest, untreated wool, both open-knit and tight-knit.

For the CP shorts study, there were no statistically significant differences in mean lifetimes of the exercise shorts at the 5% significance level due to the treatment combinations. There was therefore no justification to examine differences among levels of main effects or interactions. The preference for shorts was in this order: untreated woven polyester, untreated knitted polyester, untreated woven cotton, and treated knitted cotton.

The nine preference scales were tabulated to determine the preference responses at the end of those exercise periods which were prior to the period when a garment was retired and a new garment was started. The assumption is that an unfavorable assessment of a garment leads to its retirement. The scent scale response was predominantly unfavorable at the end of the exercise period immediately prior to the exercise period when a new garment was started.

Additional work on wool clothing is needed to assess if this material can be part of a crew wardrobe for long duration missions. The results of this study informed the choice of fabrics for an upcoming ISS intra-vehicular clothing study.