The Effect of Textiles on Perceived Physiological Comfort While Backpacking in the Cold

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Clothing is the primary means that wilderness backpackers have to protect themselves from illnesses and injuries that can occur while hiking in the cold. Currently, backpackers are recommended to dress in clothing layers; however, when hiking in the cold, this system may not meet backpackers' simultaneous, yet conflicting needs for thermal insulation and heat dissipation. Layering clothing items can provide increased thermal insulation; however, it can reduce the breathability and moisture-wicking properties of fabrics, leaving sweat on the skin and chilling the hiker. Additionally, different parts of the body have different clothing needs, depending on the movement of the body and where heat or sweat is generated. This is particularly true among backpackers, where the backpack can cause greater sweat accumulation on the back than on other body areas.

No previous studies have addressed backpackers' needs for both thermal insulation and moisture control in different body areas within a single layer garment. The purpose of this study was to design and evaluate a single-layer garment consisting of different textiles that would improve the physiological comfort of male backpackers hiking in cold winter weather conditions. The objectives of this study were to identify the physiological comfort needs of male backpackers hiking in the cold, to design a prototype backpacking shirt to improve comfort, and to evaluate the comfort and performance of the prototype over time, in comparison to a control. Male employees were recruited from a wilderness therapy program in Bend, Oregon, where subjects' employment duties included regularly backpacking in the cold. Qualitative data were collected by interviewing the subjects about their physiological comfort needs, types of clothing and materials worn while hiking, dissatisfactions and preferences with hiking clothing, and locations on the body that need better attention to thermal and moisture comfort. Information provided by the qualitative interviews was used to develop design criteria.

Based on the design criteria and tests performed on a guarded hot plate and moisture management tester, three fabrics were selected, each serving a different purpose: to provide thermal insulation, to provide moisture management, and to serve as a control. A prototype shirt was designed based on the design criteria and included a combination of strategically placed thermal, moisture, and control fabrics. The control garment was constructed in an identical style using only the control fabric. The prototype and control garments were worn by the subjects while they backpacked on work days in their program field areas near Bend, Oregon in February through April. At the end of each hiking day, the subjects responded to a questionnaire that included both quantitative and qualitative questions about the comfort and durability of the garments, as well as weather and hike conditions. Additionally, as an objective means to compare the thermal insulation of the prototype and control garments, both garments were tested

on a thermal manikin for differences in thermal insulation on the entire upper body as well as in different zones of the upper body.

Major findings from the qualitative interviews were that subjects preferred hiking shirts made with synthetic fibers and style features that helped retain body heat. Overall, subjects preferred to have greater thermal insulation in the chest and the arms, and less thermal insulation in the underarms and upper back area. A polyester fleece pile-knit was selected for the thermal insulation fabric and located in the arms and chest of the prototype. The moisture management fabric selected was a polyester fiber mesh-knit fabric and was located in the upper back, underarms, and side seams of the garment. The fabric locations were consistent with subject preferences and with previous studies about heat and sweat production in different body areas. The control fabric was a brushed polyester double knit fabric and was located in all other areas of the prototype and in the entire control garment.

The wear test data indicated that both the control and prototype garments were perceived to be comfortable. The prototype had slightly better overall comfort than the control, and there were significant differences found between the prototype and the control in the areas of overall comfort, combined thermal comfort, and combined moisture comfort. The prototype did not consistently have better comfort performance than the control in each trial and for each subject. It was found that the prototype and control shirts could be worn without additional clothing layers when the temperatures were above 35 °F and 40 °F, respectively. Thermal manikin testing results confirmed that the overall thermal insulation of both test shirts was equal, but that the prototype had greater or less thermal insulation than the control in specific body areas, depending on the placement of the thermal insulation or moisture management fabrics.

In summary, the prototype shirt designed in this study has accomplished the goal of meeting backpackers' physiological comfort needs identified in the qualitative interviews. The design prototype, when worn alone, was able to keep backpackers comfortable when hiking in cold conditions, particularly in temperatures above 35˚F. Although not intended to be worn as part of a layer system, the prototype also kept subjects comfortable when they wore multiple clothing layers. Although both the prototype and the control shirts were found to have good thermal, moisture, and overall comfort, the prototype had slightly higher overall comfort ratings than the control. In addition, both the prototype and the control were perceived to be better than the subjects' own base layer shirts, and all subjects were willing to recommend the shirts to other hikers. Thus, the use of different fabrics in different body areas satisfied the backpackers' needs of both retaining and dissipating body heat experienced due to changes in physical activity. Additionally, the ability of the prototype to wick moisture in the areas of greatest sweat accumulation helped to prevent post-physical activity chill that can occur when the skin or the inside of clothing remains wet after hiking. Overall, the prototype was found to keep backpackers comfortable in cold conditions, contributing to their enjoyment of the outdoors and preventing cold-related illnesses and injuries that can occur while hiking.