Journal of Fiber Bioengineering and Informatics 13:4 (2020) 169–179

Cite as: Y. Horiba et al.
doi:10.3993/jfbim00363

Relationship between Stretchability of Garment Lining and Ease of Body Movement ⋆

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Abstract

In this study, the effect of the stretchability of garment linings on the ease of body movement was examined experimentally. For this purpose, three types of women's jackets with different linings were used: 1) a jacket with stretchable linings along the back and side panels, 2) a jacket with stretchable linings along the sides, and 3) a jacket with standard linings of a stretch-resistant material. During the experiment, subjects wearing these jackets were instructed to abduct both arms at 90° and then adduct them 90° along a horizontal plane. To clarify the ease of body movements during this motion, a sensory evaluation was performed. Additionally, the extension of the jacket samples during these movements was measured using displacement sensors, and the tension generated in these samples was estimated based on the tensile properties of the material. Further, the effect on clothing pressure, which is known to be closely related to ease of body movement, was also examined. The experimental results confirmed that subjects experienced greater ease of body movement when donning jackets with linings that stretched more easily, which helped minimize the tension generated in the material and the clothing pressure. In addition, compared with the sample employing stretchable linings along the sides, the sample with stretchable linings both along the back and the sides afforded greater ease of body movement and less tension and clothing pressure. As samples with stretchable materials require less force for deformation during motion, wearers stated that they experienced greater ease of movement. Based on these observations, it was concluded that employing stretchable material throughout the jacket lining is an effective approach for producing garments offering greater ease of body movement.

Keywords: Stretchability of lining; Ease of body movement; Sensory evaluation; Displacement measurement; Clothing Pressure measurement

1 Introduction

Garments such as jackets feature a secondary material known as the "lining". This term refers to the fabric that lines the insides of the outer shell of garments. Generally, linings are employed to

⋆Project partially supported by JSPS KAKENHI (No. 15H01789, 17H0195501, 19K02332)

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Dec. 2020

ensure that the insides of garments are smooth, making it easier to don these garments. These linings create a layer of air between the lining and the shell, thereby inducing a thermal effect; linings also help prevent deformation of the shape of the garment at portions such as the elbows or knees, protect the shell from friction-induced damage, and avoid sweat stains or other similar blemishes [1]. However, while previous research has primarily focused on the physical properties [2-5] and thermal and tactile comfort of linings [6-9], research on the relationship between linings and ease of body movement has been limited to skirts [10] and therefore has remained unaddressed.

In this regard, this study focuses on the stretchability of garment linings. The primary aim of this study was to analyze and clarify variations in the freedom of movement when wearing jackets with respect to the stretchability of the lining material. The experimental procedure employed in this study is as follows: women's jackets with different lining arrangements were created, and a sensitivity evaluation was conducted to clarify the relationship between the freedom of movement and the stretchability of the lining. If the jacket necessitates a significant amount of force to undergo deformation, wearers are expected to experience resistance to their movements, resulting in a reduced freedom of movement. Considering this, in addition to the sensitivity evaluation, displacement measurements of the jackets were also conducted during the movements of the wearers. The tension generated in the jacket during these movements was estimated based on the tensile properties of the jacket material. Most previous research on ease of body movement in garments [11-12] has shown that clothing pressure is closely related to ease of body movement and the higher the clothing pressure during movement, the more the wearer feels that their movement is restricted. Therefore, the effect of a stretchable lining on clothing pressure during movement was also investigated.

2 Methodology

This section discusses the samples used for the experiment as well as the methods employed for the sensory evaluation of the ease of body movement and for measuring the displacement and clothing pressure in the samples during movement.

2.1 Experiment Samples

To verify the impact of the area of the stretchable fabric and the locations where this fabric is applied on the ease of body movement, three jacket samples were fabricated: two women's jackets with highly stretchable fabrics (hereinafter referred to as stretchable lining) positioned at different locations (i.e., Sample 1 and Sample 2) and one woman's jacket fabricated solely from a general fabric with low stretchability (hereinafter referred to as standard lining), which was termed as Sample 3. The patterns for each sample are presented in Fig. 1; with regard to this figure, the stretchable lining was applied at the portions indicated in red, whereas the standard lining was applied at the portions indicated in other colors. Sample 1 employed stretchable linings along the back and the sides, whereas Sample 2 employed stretchable lining only along the sides. Furthermore, these sample jackets were fabricated using the same sewing method, with identical materials, shapes, and weights, except for the position of the lining material. Figs. 2(a)-(c) depict the results of the tension tests along the weft, bias, and warp directions of the shell, stretchable lining, and standard lining, respectively, for the samples used in this study. As the shell and the lining overlap when these jackets are worn, tension tests were conducted considering