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An Investigation on the Effect of Rolling Up Women's Shirt Sleeves on Clothing Thermal Distribution

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Abstract – In garment design clothing dimensions, garment fit, and the thermal comfort of the clothing were defined among the important features. Most of these features are not changeable after production except for some clothing dimensions. At this stage, functional clothing can help the consumers to improve the clothing comfort according to individual demands. The aim of the research is to make ergonomic changes in the sleeves of the women's shirts to improve the thermal comfort of the clothes on the existing shirt models. In this regard, the arm part was preferred as the region. Discomforts (sweating, odor, etc.) can be easily observed in the lower part of the arm because of the changes in the thermal balance between the body-clothing-environment. The easiest way to minimize the discomfort feelings is making a form change in the arm part (sleeve rolling, arm folding, etc.). Basic types of rolling up shirt sleeves were selected to compare with the non-rolled up form. Their effects on clothing thermal distribution were investigated in wear trials on subject during activity protocol (sitting up/down, walking, and putting up/down weights (books) through to shelf) managed to imitate the movements regularly done in office conditions. Temperature distributions on different body parts were investigated in thermal camera software (Flir İgnite Software). The experimental results show that ergonomically changes on women's shirt sleeves influence the clothing surface temperatures. In the garment industry, functional and ergonomic designs on shirt sleeves should be defined for better clothing comfort in office conditions.

Keywords – Women's Shirt, Clothing Comfort, Thermal Distribution, Ergonomic Design, Sleeve Design.

I. INTRODUCTION

Today's consumers prefer functional clothing with comfort performance that can make themselves feel better psychologically and physiologically. Clothing dimensions, garment fit and the thermal comfort of the clothing play important roles in clothing comfort performance. Clothes; In addition to being well designed to allow free movement to the body, should also help the body maintain its balance in terms of thermal comfort. The fit of the garment to the body and thermal comfort are not only important for sportswear, but also play an important role in increasing the quality of life in the clothes used in our daily lives. It has been observed by survey studies on clothing comfort that a large proportion of today's consumers are of the same opinion [1-3].

When the literature was searched, it was observed that it was mostly carried out on men's shirt models regarding the comfort of clothing. The fact that this study will proceed through the women's shirt model will also make a different contribution to the literature.

Joshi et al. (2021), studied different clothing combinations (t-shirt-trousers, shirt-trousers) in his study, and used 100% cotton shirts as loose and tight fit among these clothing combinations. He investigated the heat transfer between the layers of clothing by mathematical modeling by measuring

the change of the air layer between the shirts and the body while in motion on the thermal mannequin, using the three-dimensional scanning method. However, no form changes or model changes were made on the shirts, only loose and narrow cuts were compared [4].

Some researchers investigated the relation between body measurements and men's shirt patterns [5-6-7]. They researched better ways to create the optimum pattern dimensions according to body measurements.

The aim of the research is to make pre-research to purpose ergonomic changes in the sleeves of the women's shirts to improve the thermal comfort of the clothes on the existing shirt models. In this regard, the arm part was preferred as the region. Discomforts (sweating, odor, etc.) can be easily observed in the lower part of the arm because of the changes in the thermal balance between the body-clothing-environment. The easiest way to minimize the discomfort feelings is making a form change in the arm part (sleeve rolling, arm folding, etc.). Basic types of rolling up shirt sleeves were selected to compare with the non-rolled up form. Their effects on clothing thermal distribution were investigated in wear trials on subject during activity protocol (sitting up/down, walking, and putting up/down weights (books) through to shelf) managed to imitate the movements regularly done in office conditions.

II. Materials and Method

A. *Materials*

The basic women's shirts were provided from garment producer. They were produced with white coloured and plain-woven fabric made of 50% PES and 50% Cotton. All the shirts had the same size (39-size).

B. *Method*

The women participant tried on the shirts in wear trials. She was provided with a participant information sheet, informing the procedures of the activity. The wear trials were managed in a room at a temperature of 20± 2˚C, relative humidity of 50± 5%. Before the trials, the shirts were hanged on for 24h and subject rested for 10 min to adapt to the room conditions. Only one test was done for each day.

Subject was asked to stand still on and keep both arms straight. The imaging distance of thermal camera and body posture were kept constant during the measurements (Fig.1).

Fig. 1 Body posture and Infrared thermal camera capture.

The thermal imaging measurements consisted of two steps, first subject was asked to wear the shirts (wear trial-1:non-rolled up sleeves and wear trials-2-3: basic rolled-up sleeves) and body postures were photographed then subject made the activity in a defined protocol for ten times by wearing shirt and body postures were photographed again. Figure 2 shows two basic types of rolling up shirt sleeves.

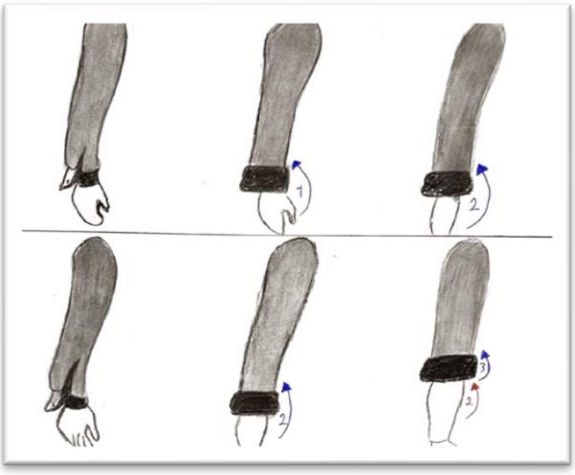

Fig. 2 Basic types of rolling up shirt sleeves.

In first type, the cuff of shirt sleeve was folded up in two times. In another type, the cuff of shirt sleeve was folded up in three times. Figure 3 shows the non-rolled up type and basic types of rolling up

shirt sleeves applied on women's shirts in wear trials.

Fig. 2 Non-rolled up sleeve, two times folded up sleeves and three time folded up sleeve in wear trials.

The average clothing surface temperatures of four defined points (Sp1-2-3-4) on shirt sleeves were then analysed by thermal imaging software (Flir Ignite Software). The activity protocol starts with sitting on a chair and then standing up, walking to the shelf, putting up/down weights (books) through to shelf, and repeating it in opposite way. The subject made the activity for ten times in a row.

III. Results

A. Clothing Thermal Distributions on Body Sections

The thermal imaging of frontal body sections was analysed by Flir Ignite Software (Figure 3). Four body points (Sp1-2-3-4) were selected on right arm.

Fig 3. The thermal capture of subject and measuring points.

The subject participated in three wear trials. She worn the shirt having non-rolled up sleeves and the shirts having respectively two times and three times folded cuff. Figure 4 shows the thermal imaging of subject before and after activity in wear trials respectively (wear trial 1-2-3).

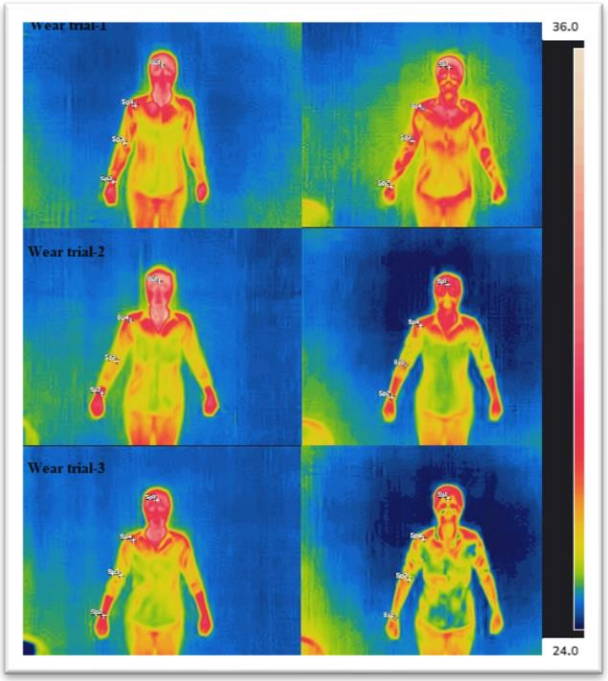

Fig.4 The thermal imaging of subject before and after activity in wear trials respectively (1-2-3).

The average surface temperatures of four body sections of the shirt sleeve (wear trial-1: non-rolled up sleeves and wear trial-2-3: basic rolled-up sleeves) are shown in Figure 4. It shows that the average temperatures when first worn (Sp1, Sp2, Sp3 and Sp4) and after activity (Sp1A, Sp2A, Sp3A and Sp4A).

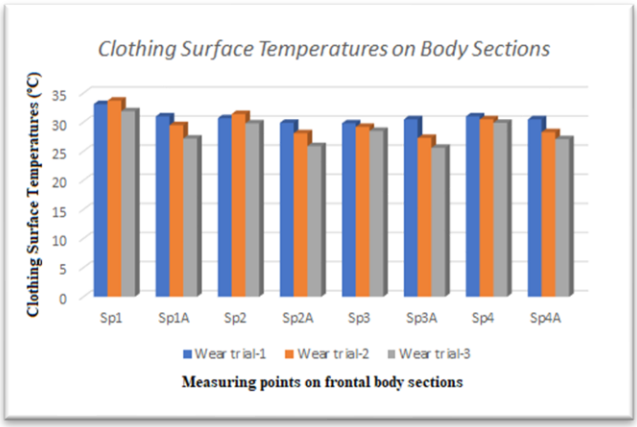

Fig 4. The average surface temperatures of measuring points on frontal body sections

IV. DISCUSSION

The forehead temperatures (Sp1) decreased after the activity in all wear trials. The temperature drop rate of 6.3% percent was seen in the shirt with non-folded sleeve (wear trial-1). The temperature drop rates in shirts with folded sleeves (wear trial-2-3) are much higher (12,4% and 14,7% respectively). The reason for this may be that the shirts with folded sleeve trap the air layer in the arm part and causes sweating. Along with sweating, body temperatures tend to decrease.

The overall body temperature after activity in wear trial-1 is the highest and the one after activity in wear trial-3 is lowest as seen in thermal imaging shown in Fig. 4.

The temperature drop rates in measuring point Sp4 over shoulder is the lowest rate (1,6%, 7,2% and 9,3% respectively) in all wear trials. This is because of isolation caused by trapped air layer between body and cloth.

V. CONCLUSION

In this study, we investigated the effect of rolling up women's shirt sleeves on clothing thermal distribution The experimental results show that changing the forms of sleeves influence the heat distributions and clothing surface temperatures. Clothing thermal distribution are effective on overall clothing comfort. So ergonomically changes in women's shirt sleeve can help to balance the body temperature and increase the clothing comfort. In the garment industry, functional and ergonomic designs on shirt sleeves should be investigated for better clothing comfort in office conditions.

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