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Effect of Abaya Designs and Daily Wear Clothing on Thermal Comfort Measured with a Female Thermal Manikin

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Abstract

Multiple layers of clothing are known to increase thermal resistance and evaporative resistance. This study investigates the effect of wearing abaya, an Islamic outerwear stipulated for women, on thermal resistance performance assessed with a female thermal manikin. Tests were conducted at two climatic conditions. The first set was at 23 °C and 50% RH as the dry condition and the second set was at 35 °C and 40% RH as the wet condition. Thermal resistance and evaporative resistance properties were measured by dressing a female thermal manikin in various ensembles of clothing within different types of abaya. The test results revealed that for all abaya combinations with daily wear, the manikin needed less heat to maintain the average skin temperature than with daily wear clothing alone. This study suggests that the abaya provided additional thermal and vapour resistance. Among the types of abaya evaluated, those worn on the head offered higher thermal resistance than those worn from the shoulder with tight sleeves. Marginal variations were also observed on the basis of the clothing worn under the abaya.

Keywords: Abaya Design; Thermal Resistance; Evaporative Resistance; Thermal Manikin; Clothing Comfort

1 Introduction

Abaya is an outer garment for women particularly in the Islamic faith. It may be worn either from the shoulder or from the top of head over the normal day-to-day clothing (daily wear clothing). Abaya is normally used with a long scarf (Hijab) to wrap and drape over the head such that the neck and hair are completely covered. Considering the extreme climate in Saudi Arabia, with summer daytime temperature occasionally exceeding 45°C, wearing abaya can be very uncomfortable especially over several layers of clothing [1-3].

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Ease of body movement, tactile and thermal comfort are considered as components of clothing comfort. The type of fabric used and garment design are important to obtain good functional design and clothing comfort [4]. Celcar [5] defines clothing comfort as a state of mind influenced by a range of factors such as ambient temperature and relative humidity (RH), wind velocity, metabolism of wearer and most importantly the characteristics of the clothing worn. Therefore, clothing comfort may be considered to be the result of a balanced process of heat exchange between the human body, the clothing system and the environment. It may be quantified by the ability of the clothing to conduct heat and transport or restrict moisture from the surface of the human body to the environment, expressed as thermal resistance (thermal insulation) and water vapour resistance, respectively. It should be noted that factors such as colour, fashion, and the physical and psychological state of the wearer also influence the feeling of comfort. This paper reports thermal comfort only.

The type of clothing worn directly affects the heat loss from the human body to the environment. Clothing blocks conduction heat losses by trapping still air within the fabric structures and between garment layers. It resists convective losses by preventing convection heat current formation next to the body or by providing a barrier against air currents in the environment. Clothing also reduces radiant heat loss since the fibres in each fabric layer provide a thermal radiation barrier. Clothing impedes evaporative heat loss by restricting the evaporative of sweat that may be produced by the body [6].

Measurement of comfort has been commonly done through wearer trials, which are subjective [7, 8]. Recently thermal manikins were used to obtain objective results. With such manikins, the thermal resistance (R_{ct}) and evaporative resistance (R_{et}) of a clothing system can be determined [4, 5, 9]. The research with manikins has been primarily concerned for sportswear, sleeping bags and business attire usually under temperate or cold climatic conditions [10-19].

Al-Ajmi et al. [1] used both male and female thermal manikins to measure the thermal insulation and clothing area factors of a number of Arabian Gulf garments and ensembles for summer and winter seasons. Their study only provided data intended to be added to ISO 9920. To date no research has been carried out to understand the thermal comfort properties of abaya with a female manikin.

The aim of this study is to determine physical values related to the heat transfer properties of abaya ensembles as worn in Saudi Arabia by using a female sweating thermal manikin. The thermal resistance and evaporative resistance of clothing worn within the abaya were measured. The results could contribute to the improvement of abaya design so as to minimize thermal insulation and evaporative resistance in hot environment.

2 Materials and Methods

2.1 Materials

The inner garment (daily wear clothing) used in this study included Underwear (U), long Sleeve Shirt (SH) and Pants (P), and shoes. The outer garment (abaya and scarf combination) included three abaya designs: abaya worn from shoulder either with tight (TS) or Loose Sleeves (LS), and abaya worn from top of the head with tight sleeves (OH). The woven (WA) and knitted (KA) fabrics used for abaya were selected based on their comfort properties reported in previous studies