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## **THE ERGONOMIC FACTORS: A STUDY ON ACTIVE WEAR**

<sup>1</sup> Kushanee Jayasinghe, <sup>2</sup> Niromi Seram

<sup>1,2</sup> Department of Textile & Clothing Technology, University of Moratuwa, Sri Lanka

<sup>1</sup> kushaneej@gmail.com, <sup>2</sup> niromis@uom.lk

### **ABSTRACT**

*Ergonomics requisites are of particular importance in designing and developing active wear. Ergonomics in clothing is interpreted as the consideration of comfort and performance factors in the design of clothing made for a specific end user requirements. Although active wear have been introduced in a global context, their functionality within customized circumstances, appropriateness in geographical and climatic contexts has been an insufficiently explored aspect. Thus the focus of this study is to identify the influence of ergonomic factors on active wear in the Sri Lankan context. In order to identify the factors that need to be considered when designing active wear for the Sri Lankan market, this research was conducted on the joggers in the urban population of Sri Lanka. A questionnaire survey was carried out among working professionals aged between 20-40 years to understand the current level of consideration of ergonomic factors among users of active wear, particularly jogging, in the local context. A statistical data analysis process was used to analyze the gathered data. The analysis yielded varying results with certain ergonomic factors such as fit of the garment, weight of the clothing being considered as significant while the functional features of the fabrics used and the items of clothing worn being somewhat inappropriate in the environmental context. Particular attention should be given in the future to develop novel fabrics and innovative constructions that are compatible with the environmental conditions. This will be an essential support for designers and product developers to gain an understanding on special ergonomic factors that need to be considered when designing active wear (jogging clothing) for the Sri Lankan context. Key words- ergonomic factors, clothing, active wear, Sri Lankan context,*



## INTRODUCTION

Ergonomics in clothing can be interpreted as the consideration of comfort and performance factors in the design of clothing which is made for a specific end user requirement, determined by the environment in which the user operates and the activities performed (Gupta, 2011b). It is primarily concerned with the interactions between clothing and humans to optimize comfort, safety, wellbeing and performance (Bishop, et al., 2013). According to many research results, clothing by nature is known to add physiological loads that could contribute to a progressive decline in physical and mental capacity by causing heat stress, reducing task efficiency as well as limiting the range-of-motion of the wearer (Bishop et al., 2013; Gupta, 2011b). Therefore, unlike in fashion clothing, which is essentially a product of the designer's creative instincts, ergonomic criteria play an important role in the design of functional clothing (Gupta, 2011b). While there are many categories of functional clothing based on the end use such as sports, protective, medical etc. active wear is considered to be the most dynamic and the fastest growing segment (Gupta, 2011a).

### 1.1 Active Wear and Ergonomics

With the ongoing global trends focused on health-conscious lifestyles, dramatic lifestyle changes, a rapidly aging population, increasing sports participation and health consciousness has created a huge demand for functional sports apparel (Gupta, 2011a). Accordingly, a range of value-added clothing with multi-functional properties such as temperature regulation, moisture management, stretch, odour reduction, light weight are available in the market for everyday sportswear (Gupta, 2011a). In addition, performance enhancing clothes specially targeted for professional sportsmen to gain a competitive advantage in sports are also marketed which are mostly governed by below principles (Gupta, 2011b).

The application of compression on specific muscles to increase blood flow

The application of principles of aero/ hydro dynamics to reduce wind, air, fluid drag in high speed sports

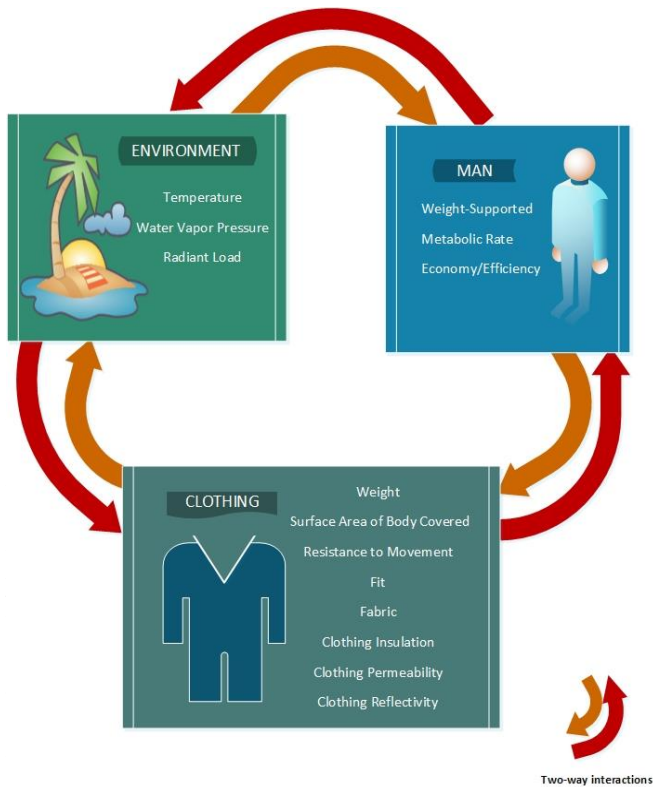
Gupta (2011b) has identified ergonomic considerations as one of the four major user requirements of functional wear (besides the primary requirement of functionality), particularly active wear while the other factors are physiological, biomechanical and physiological considerations. Therefore, the integration of all these considerations and the correlation between various characteristics of clothing and these requirements must be taken into account in the design of functional clothing.

In his publication on ergonomics, Bridger (2003) explains human as one of the three major components in a typical work system; environment and the machine (clothing in this context) being the other two. As per Bridger (2003), there can be six directional interactions between each of these, i.e. Human on Clothing, Human on Environment, Environment on Clothing, Environment on Human, Clothing on Environment and Clothing on Human.

Bishop et al. (2013), in his study on ergonomics of functional clothing, has identified 14 key variables affecting ergonomics of sports clothing which are categorized under three major categories as Activity, Clothing and Environment as shown in Figure 1. Even though these characteristics are categorized as above, they tend to be interrelated and mutually inclusive.

Although active wear have been introduced in a global context, their functionality within customized circumstances, appropriateness in geographical and climatic contexts has been an insufficiently explored. Thus the focus of this study is to identify the influence of ergonomic factors on active wear in the Sri Lankan context.

Figure 1- The interaction of the three components of a work system. The ergonomic variables in functional clothing (Bishop et al., 2013) incorporated into the components of a work system (Bridger, 2003). (Created by Authors)



employees engaged in white collar jobs residing in the Western Province of Sri Lanka.

Questionnaires were given to frequent joggers to find out the comfort levels and the difficulties they face when jogging.

### DATA ANALYSIS

A statistical data analysis process was used in this research study to analyze the collected data. Descriptive statistics tools such as percentages and weighted mean were employed in the process and the analysis was carried out using the Microsoft Excel software.

### 3. Research findings & Discussion

As mentioned before, the study was conducted based on a questionnaire survey and the selected population was the private sector employees engaged in white collar jobs residing in the Western Province of Sri Lanka. The sample population was limited to the above due to the time constraints and the sample size amounted to 130.

#### 3.1 The demographic characteristics (Gender and Age variation of the sample)

Out of the 130 respondents, the majority was males (53%) and the remaining 47% were females. All the respondents were between 20-40 years. With the highest were in the age category of 20- 30 years (54%) while the rest were between 30-40 years.

#### The ambient environmental conditions

##### 3.2.1 The time of exercise during the day

Majority of the respondents (78%) opted to go for jogging during the latter part of the day, while the rest went in late morning. There were no responses for going in the early morning (before 5.00 am) and afternoon (Figure 2). The reasons for this could be twofold; the

sample population being limited to working professionals in urban areas with time restraints due to busy work schedules and the hot and humid environmental conditions during the daytime.

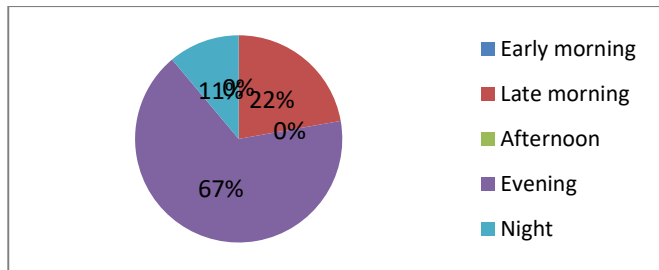


Figure 2. The time of exercising during the day

### 3.2.2. The sensations felt by the wearer at different stages of exercise

It was revealed that, at the beginning of the exercise most of the respondents felt non-sweaty and hot. While exercising and at the end, the extreme majority felt hot and sweaty. A sensation common to all those instances is hotness due to the hot ambient temperature of the Sri Lankan climate.

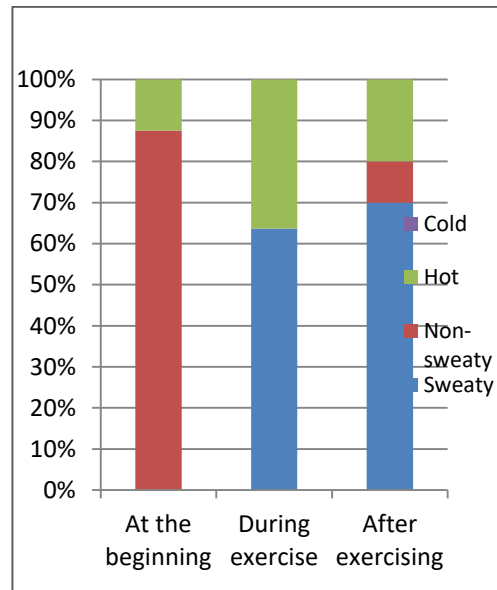


Figure 3. The sensations felt by female

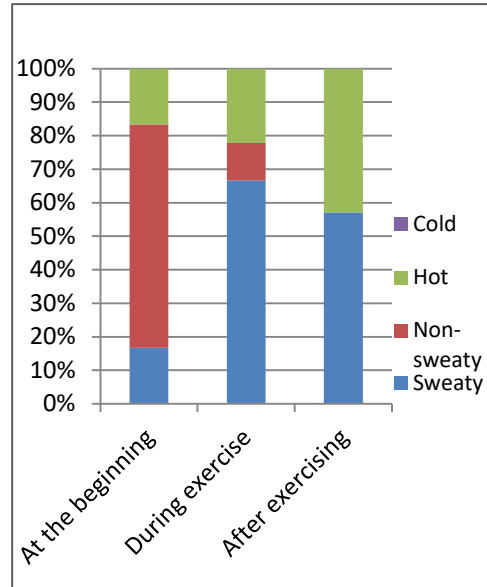


Figure 4. The sensations felt by male

### 3.3 The attributes of the wearer

#### 3.3.1 Calculation of the Body Mass Index (BMI)

The height and weight of the respondents were acquired for which the Body Mass Index (BMI) of an individual could be calculated. Body mass index (BMI) is a measure of body fat based on the weight in relation to the height of an individual, and applies to most adult men and women aged 20 and over (Medical News Today, (n.d), para 1). BMI is independent of variables such as age, gender, ethnicity or muscle mass and is used as

A measurement scale to track weight status in populations and

A screening tool to identify potential weight problems in individuals which may lead to health risks like blood pressure, heart diseases etc. (Medical News Today, (n.d), para 4)



Body Mass Index of an individual = Mass in (kg) / (Height in (m))<sup>2</sup>

Table 1 -The BMI rating of males and females (Adapted from “Calculate Your Body Mass Index”, by Department of Health and Services, USA.)

BMI	Categories
<18.5	Underweight
18.5–24.9	Normal
25–29.9	Overweight
>30	Obesity

The BMI values thus obtained were categorised based on Table 1. Figure 5 depicts the BMI distribution of the male and female respondent population. The majority of females were in the normal weight range with 29% being overweight. On the contrary, most of the male joggers belonged to the overweight category.

No underweight percentage was recorded which could be due to such individuals not having considerable health concerns like the overweight and obese population or the motivation of the normal weight population to stay fit and healthy.

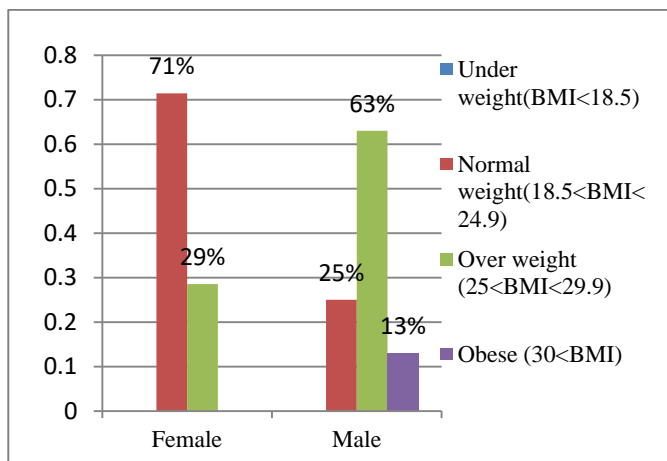


Figure 5. BMI distribution of female and male population

### 3.4 The attributes of clothing

#### 3.4.1. Restrictions in movement due to clothing

Both males and females have responded negatively implying that the joggers were able to move freely in their clothes without unnecessary interruptions when they were questioned whether the clothing worn by the joggers inhibits movement. The sports bras were deemed to be less supportive which restricted the speed of the workout for the female. The males found some shorts to be too loose fitted which made it difficult to jog.

#### 3.4.2The weight of the clothing

The weight of the clothing was recorded as lightweight by most respondents (Figure 6). No responses were recorded for clothing being heavy which could be seen as a positive factor since heavy weight clothing could add to the energy cost of transporting the weight of clothing as well.

#### 3.4.3Fit of the garment

The fit of the garment against the body was claimed to be medium by the majority. In females, the remaining percentage wore tight-fitted garments while in males the numbers were equally divided among loose fitted and tight fitted garments. No loose fitted garments were worn by females while 12.5% males wore loose fitted garments(Figure 7).

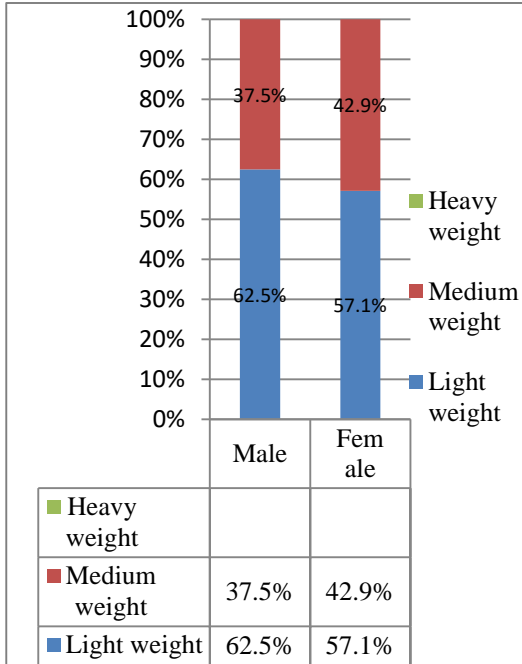


Figure 6. Weight of clothing

#### 3.4.4. Clothing worn by males and females

For ease of understanding, clothing were categorized as shown in the Figures ( 8 & 9)below. For the upper body inner layer, normal brassieres and sports brassieres were worn by a majority of females. This could be seen as a positive aspect since studies recommend sports bras being more comfortable than normal bras for workouts which help reduce breast movement and related breast

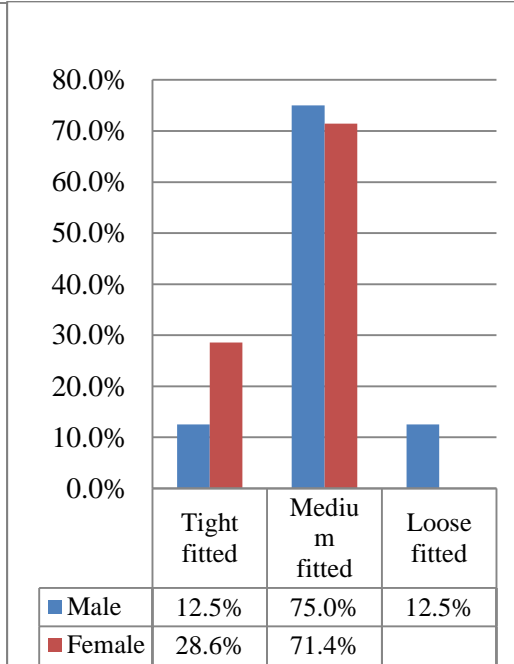


Figure 7. Fit of the garment

pain by providing proper support and compression (Reilly,2009).

For the upper body outer layer, most females wore t-shirts which covers the body more than tanks which were worn by only 29% (Figure 8). Similarly, most of the male population opted to wear body covering clothing such as t- shirts when compared to tanks. For the lower body they wore shorts while compression pants were worn by 38% (Figure 9).

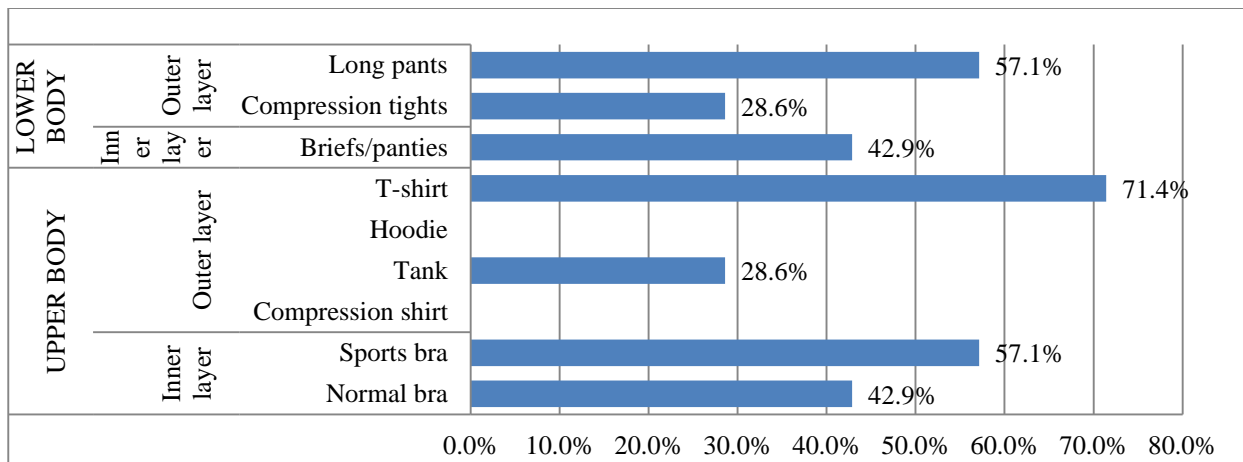


Figure 8. Clothes worn - females

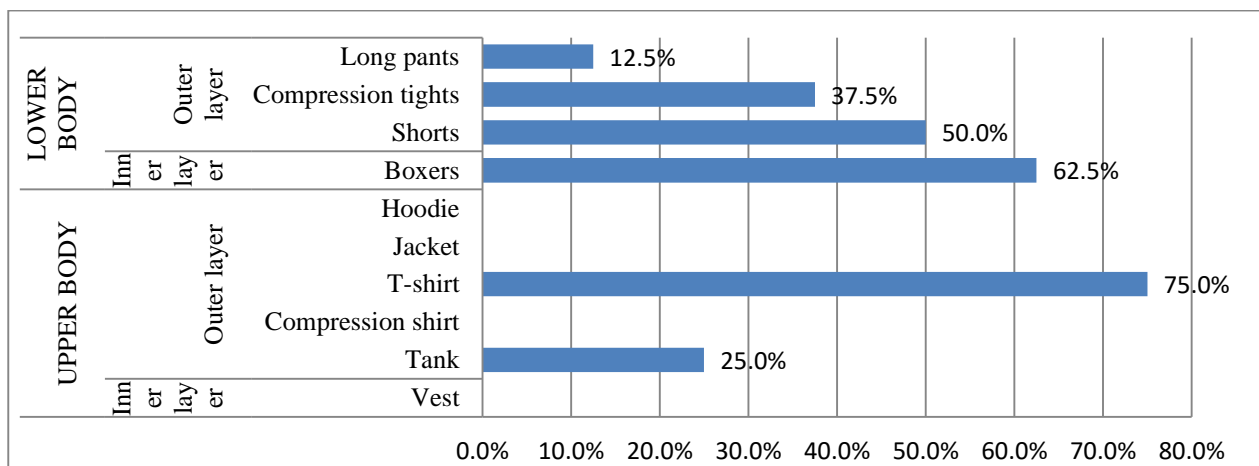


Figure 9. Clothes worn - males

According to literature, encapsulating clothing tends to present more ergonomic issues in warm/hot environments. Thus, wearing body covering clothing may decrease the level of comfort in joggers. Exposure of the skin surface for evaporative cooling is important for high metabolic activities such as jogging (Reilly, 2009).

majority of both genders claimed to be medium stretch. Only 12% of males responded that their clothing was not stretchable (Figure 10).

### 3.5 The properties of the fabric

#### 3.5.1. The stretch of the fabric

The fabric is of particular importance in jogging wear. The results revealed that jogging clothing worn by

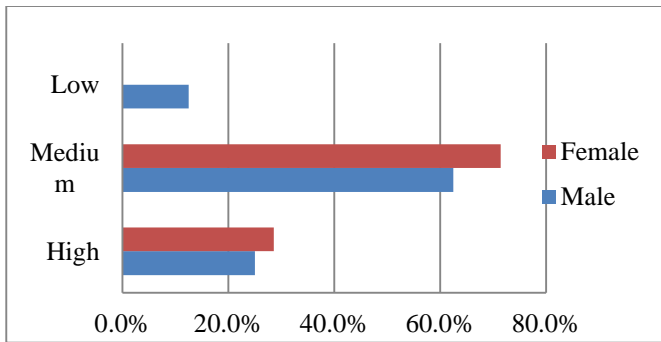


Figure 10. Fabric stretch

### 3.5.2. Sweat wicking ability

Sweat wicking ability of the fabric was recorded as either slightly damp or wet by the majority of both genders (males – 87%, females -85.7%). Only a minority has claimed the fabric to be dry which could be seen as a negative aspect since wearing a wet fabric may cause discomfort to the wearer.

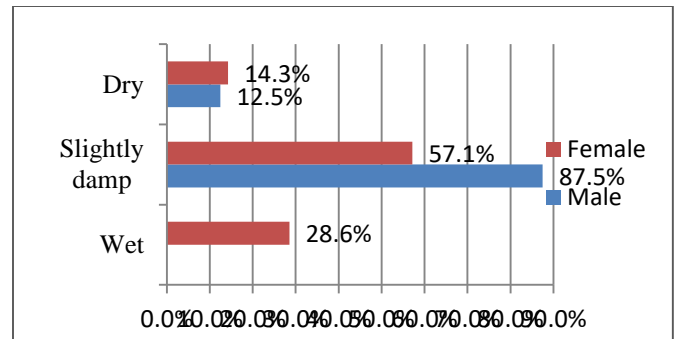


Figure 11. Sweat wicking ability of fabric

### 3.6 The variables considered when purchasing active wear

Since the respondents narrowed down to a sample of working professionals within the age range of 20 to 40 years, the Figures 12 and 13 depict the existing perceptions and awareness of the said sample.

It is clear that the fit of the garment seems to be a critical factor in the buying behaviour of both genders. Both genders have responded in a similar manner in prioritizing the factors they consider with price, appearance, brand and colour in descending order of importance.



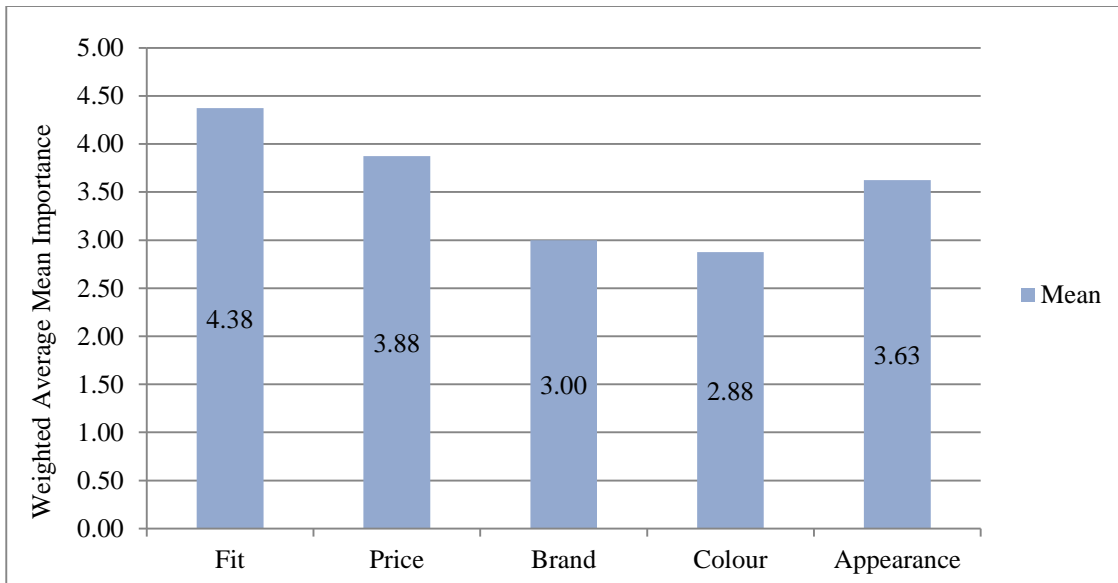


Figure 12. Factors considered in purchasing - females

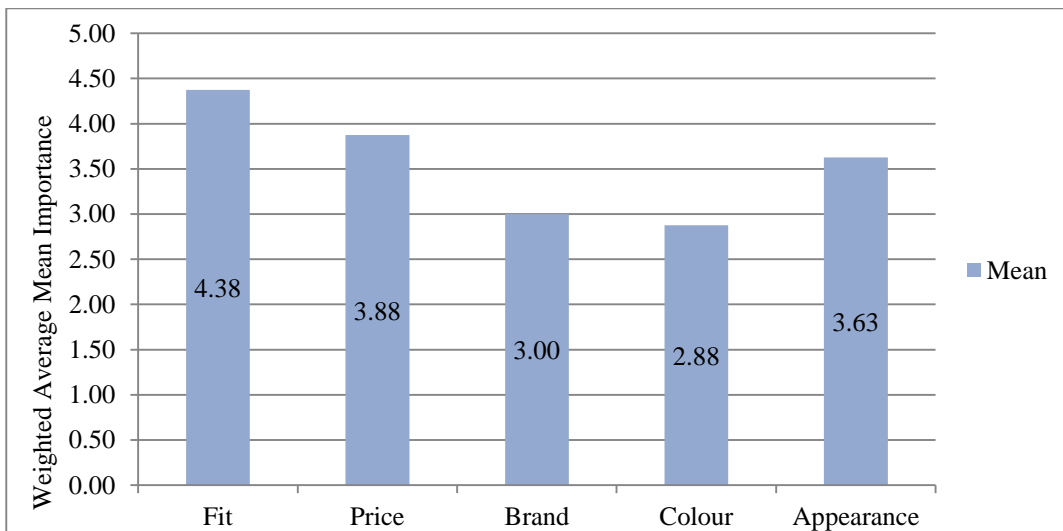


Figure 13. Factors considered in purchasing - males

## CONCLUSION AND RECOMMENDATIONS

As per the facts discussed in research findings, there seem to be a general concern towards considering ergonomic factors in jogging clothing in the Sri Lankan



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context. Since Sri Lanka is an equatorial country, the climate of the country is of hot and humid nature where maintaining the thermal characteristics (evaporative heat loss and dry heat) of the body in optimum levels is a major challenge. Through the survey findings, it is evident that the joggers experience thermal discomfort since the majority reported as feeling hot and sweaty during all times of exercise. This research can be further extended to other provinces in Sri Lanka and other regions not only to verify the findings but also to determine the ergonomic factor variations on other geographical and climatic contexts.

The clothing usually worn by the majority tend to be generally light weight, medium fitted with no restrictions. Based on the previous research findings that claim loose-fitting clothing is ideal for use in hot climates to keep the microclimate next to the skin cool by means of convection and evaporation, it could be suggested that loose fitted garments would be a better option.

Based on the information received on the types of clothing worn, the Sri Lankan population seems to wear body covering clothes where a greater percentage of skin is covered by clothing. With research recommending exposure of the skin surface for evaporative cooling is deemed important for high metabolic activities such as running, less coverage of skin would provide more comfort to the wearer. In this context, developing innovative style and construction of garments with minimum hindrance to body movements and maximum comfort may pave the way for better comfort and performance.

When considering the fabric properties of the jogging wear, medium stretch and medium sweat wicking ability were recorded. Based on the wearers' sensations plus these results, it is clear that fabric properties tend to inadequate to meet up to the comfort requirements of the user. Therefore the need to develop novel fabrics that suit the ambient environmental conditions and develop

new construction methods that incorporate ventilating structures into the garment with regard to specific areas of the body to maximize the clothing permeability and minimize the clothing insulation must be investigated.

When buying active wear, the purchasing decisions of the sample population of Sri Lankan working professionals in 20 to 40 years of age to whom the survey was conducted seem to hover between based ergonomic considerations and economic constraints as depicted clearly by the weighted average values obtained. The type of brand seemed of least importance to the Sri Lankan consumers which is in stark contrast to the western population where brand values garner a lot of consideration.

Finally, it can be concluded that this study will be an essential support for designers and product developers to gain an understanding on special ergonomic factors that need to be considered when designing active wear (jogging clothing) for the Sri Lankan context. Moreover, this will be an starting point to identify the areas for improvement in enhancing performance and comfort when designing active wear for specific consumer groups in the future and suggest suitable adaptations that could be incorporated for future design.

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