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Consumer expectations and perception of clothing comfort in sports and exercise garments

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**Consumer expectations and perception of clothing comfort
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1 **TITLE**

2 Consumer expectations and perception of clothing comfort in sports and exercise garments

ABSTRACT

Purpose

Sports garments play an important role in the well-being of an athlete by protecting the wearer from changing environmental conditions and providing a comfortable feel. Clothing requirements have changed in recent years and demand for apparel with a higher comfort performance have been rising. Hence, the purpose of this study was to explore consumers' expectations and perception of comfort, and to examine how different textiles are perceived by consumers to provide useful knowledge that allows to engineer comfort into fabrics and sports garments.

Design/methodology/approach

This online survey comprised 292 respondents, classified by sex, age, nationality, and physical activity. The respondents were asked a total of 18 questions through the Bristol Online Survey (BOS) tool to explore expectation, perception and preference of clothing comfort, specifically of sportswear.

Findings

Fit and comfort are closely linked together, both forming part of the clothing comfort concept. When purchasing garments online, the haptics of fabrics was identified as a crucial missing parameter. However, priorities of attributes within the concept varied according to the person's sex and nationality. Females put more emphasis on garment fit and showed higher need for tactile input, whereas males prioritised physiological comfort descriptors, i.e., properties which facilitate thermoregulation. Furthermore, there is an increased importance of physiological comfort parameters for people exercising for 10 or more hours per week. Finally, it was possible to identify common associations and preferences for textile materials (cotton, polyester, cotton/polyester blend and wool). However, consideration should be taken concerning sex and nationality.

28 ***Originality/value***

29 Sex and nationality are parameters modulating the clothing comfort concept and the
30 conceptualized feel of materials. Therefore, sex and nationality of the end-consumer should be
31 considered during the development phase of sports garments, and particular attention should be
32 given to the targeted market in which these will be sold.

33 **KEY WORDS** Clothing comfort, Sports garments, Purchase behaviour, Material perception,
34 Fibre preferences, Haptics

35 **PAPER TYPE** Research paper

INTRODUCTION

The apparel industry faces challenges in satisfying consumers' need due to the change of priorities in the previous decades. During the 80s and 90s, consumers tended to buy fashionable clothing, whereas today, consumers are generally more value-orientated (Freire Castelo and de Oliveira Cabral, 2018). Understanding consumers' perceptions of apparel's quality is essential for providing satisfaction, which could lead to a potential competitive advantage, larger market share and higher revenue for apparel companies. In this regard, one clothing aspect that has to be studied and quantified is comfort. Human's perception of clothing comfort is made when sensory information is received, processed and then compared to past sensory experiences, ultimately representing people's expectations (Rahman, 2011; Freire Castelo and de Oliveira Cabral, 2018). These perceptions lead to the formulation of different clothing attributes, which have different importance for the consumers, and affect purchase decisions. Therefore, having a good understanding of these attributes can help in the product development phase and marketing strategies (Zhang *et al.*, 2002).

Literature review

Past studies have focused on the evaluation of determinant attributes in the perception of apparel products. In a study by Zhang *et al.* (2002), it was found that fit, comfort, colour and workmanship were the most important attributes during the purchase decision of casual wear, and that perceptions were affected by geographic and demographic factors. The geographic location was found to impact attributes such as style, colour and brand; for instance, consumers in northern cities of China were relatively less concerned with colour, whereas consumers in Shanghai paid more attention to colour as well as brand name. Differences are difficult to pinpoint, however these can be traced back to tradition and culture. Furthermore, regarding sex, females place more emphasis on fit, comfort, style, colour, and easy care.

61 Workman and Cho (2013) also indicated that individual preferences are affected by the culture
62 in which a person is exposed to growing up, as well as individual differences such as sex.
63 Additionally, females showed greater preferences for in-store shopping channels than men.
64 Many studies categorised attributes determining consumers' quality perceptions into two
65 general types: extrinsic and intrinsic cues (Hatch and Roberts, 1985). Intrinsic cues are inherent
66 to the physical composition and cannot be modified without changing the overall product: fibre
67 content, fabric structure, garment construction, quality, style, comfort, and fit. Extrinsic
68 attributes are product related, however, are not part of the physical product. Examples for
69 extrinsic cues are price, brand label, store, and country of origin (Hatch and Roberts, 1985;
70 Swinker and Hines, 2006; Rahman, 2011; Freire Castelo and de Oliveira Cabral, 2018). In the
71 perception of quality across a wide range of products intrinsic cues are considered to be more
72 important than extrinsic ones (Fiore and Damhorst, 1992). This is consistent with findings by
73 Rahman (2011), where intrinsic factors regarding denim products were found to play a more
74 significant role than extrinsic factors.

75 Comfort in general is of multifactorial nature; in sports garments in particular it influences the
76 overall performance and utility of the garment. A subdivision of three related major groups can
77 be performed: psychological/ergonomic, physical (sensorial/tactile) and physiological comfort
78 (Kamalha *et al.*, 2013). The psychological/ergonomic comfort includes personal aspects such
79 as personality and cultural background, as well as style, aesthetics, fashion, design, colour, fit,
80 and freedom of movement (Bartels, 2005). The physical (sensorial/tactile) comfort refers to the
81 skin-clothing interaction, which triggers various sensory receptors leading to a rise in
82 psychophysical perception. Sensations felt can be tactile (smoothness, roughness, softness,
83 stiffness, scratchiness), thermal (warmth, coolness, breathability), moisture (wetness,
84 stickiness) and pressure sensations (lightweight, heaviness) (Bartels, 2005; Bishop, 1996; Das
85 and Alagirusamy, 2010). Lastly, the physiological comfort refers to body thermoregulation (Li,

2005). Rahman's (2011) interpretation of comfort in apparel products involves thermal effects of a garment (warmth, breathability), sensory characteristics (tactile feeling), and mobility (ease of movement). In a more recent study (McCann, 2015), comfort is defined as a combination of appropriate shape and fit, including freedom of movement, thermal regulation via moisture wicking and quick drying properties, as well as lightweight, protection and durability. These factors contributed to the overall 'feel good' factor for the wearer.

When purchasing a sports garment in a shop, direct involvement such as touching, feeling or trying-on the garment is a natural tendency before making a final purchase decision (Rahman, 2011). In-store shopping is still leading over online, however, online purchases have been catching up (Mintel, 2018) especially during the COVID-19 lockdown periods (March/April, October 2020, January 2021). Nike expects a permanent shift to online sales. The US company recorded a digital sales increase of 82 % during the June to August quarter in 2020 (BBC, 2020). Similar to Nike, Adidas' online sales surge by 93 % in the second quarter and 51 % in the third (Meyers, 2020). Apparel companies have had to adapt to changing consumer behaviour during the pandemic by focussing on investments in online direct-to-consumer sales. It is therefore important to investigate people's purchase behaviour to be able to prioritise resources across different channels (e-commerce, physical stores). Regarding e-commerce, a big limiting factor could be represented by the difficulty to feel the garment by hand, especially if haptic response plays a major role in the purchase decision. In a study by Hines & O'Neal (1995) consumers evaluated quality using attributes that they associated with social, psychological, economic, physiological, and aesthetic characteristics. When evaluating garment quality, fabric material was the only attribute identified by most of the participants. According to the study, if fabric does not meet the requirements and expectations, all other factors like aesthetic, economic/performance, physiological and social/psychological may become unimportant since fabric is an integral part of clothing. Fabric was perceived to have a noticeable effect on the

overall appearance and performance of the garment. This is in accordance with Fiore & Damhorst (1992) who also stated that fabric is the best predictor of perceived quality of apparel. Product information labels of sports garments are usually stating fibre content and finish, which is helpful in the way of identifying the product composition; however, the consumer must be knowledgeable about which properties are associated with each product component (Hatch and Roberts, 1985). How are materials perceived in consumers' minds? Wool for instance traps air and forms an insulating microclimate between the layer of clothing and the body, which creates an association of wool being a warm fibre. With a soft and natural touch it is comfortable to wear, according to Tomar (2010). However, for sports applications wool is normally not the first choice. A combination of natural and synthetic fibres in knitted and woven materials are commonly used in sports garments. A cotton/polyester blend enhances durability, resilience, and dimensional stability (Horrocks and Anand, 2000). Synthetic materials are generally considered to be a good choice for sportswear as they are able to provide a valuable combination of moisture management, softness, lightweight, and quick drying properties (Uttam, 2013). Polyester e.g. is durable, yet light in weight, easy to care and a dimensionally stable material that absorbs very little moisture and has a high resistance to stretching (Tomar, 2010; Uttam, 2013). Cotton on the other hand provides a good combination of softness and comfort, however has a tendency to absorb and retain moisture (Uttam, 2013). When purchasing online, it is important that the consumer has an understanding of what a material is like to inform their choices. Therefore, understanding the knowledge of materials that user have is important to aid the definition of the garment properties.

132

133 *Research questions*

134 Understanding consumers' perceptions of apparel's comfort is essential for providing (post
135 purchase) satisfaction. The purpose of the study is to identify factors influencing in-store

purchases and establish those factors lacking in the emerging online environment irrespective of sporting activity. Furthermore, the importance of comfort in sports garments and the prioritisation of garment type in relation to comfort was investigated, as well as the consumer attitudes towards specific textile materials in relation to sex and nationality. People from diverse countries have different cultural norms that influence their perception and behaviour. Studies comparing concept of comfort and textile fibre preferences in apparel products have not been undertaken. Increased knowledge of preferences will contribute on garment designs to satisfy the requirements of sports garment users. Based on the existing literature and reflecting current comfort advances in garments as well as changing consumer behaviour, the following research questions were developed.

RQ₁: What are factors influencing the choice of online and in-store shopping?

RQ₂: Is comfort an important attribute in the purchase of sports garments?

RQ₃: Identification of the main attributes contributing to comfort and is there an influence of sex and nationality?

RQ₄: For which garment type is wear comfort most important?

RQ₅: Does the amount of physical activity affect the comfort priorities of sport clothing?

RQ₆: Is there a preconceived opinion regarding the feel of different textile materials?

METHODS

Data collection

A structured questionnaire was designed to explore clothing comfort in sports garments. Data were collected through the Bristol Online Survey (BOS) tool (<http://www.onlinesurveys.ac.uk>). Pilot-tests were carried out with academics as well as laypersons. The conceptual model for the evaluation of the perception of comfort in sports garments derived from the evaluated literature.

160 All procedures have been approved by the Loughborough University Ethics Approvals Sub-
161 Committee (Project-ID: 1257).

162 The survey comprised eight pages with a total of 18 questions. It started off with questions
163 regarding fitness level and type of physical activity typically undertaken. After that, the
164 individual purchase behaviour (online/in-store) was questioned, and respondents were asked to
165 report the three most important attributes when purchasing sports garments. If respondents
166 ticked 'comfort' as one of the three answers, the question "How would you describe comfort in
167 sports garments for you?" was included to gather additional individual information.
168 Furthermore, the conceptualised hand-feel of sports t-shirts and consumer attitudes regarding
169 specific fibre types such as cotton, polyester, cotton/polyester blends and wool was
170 investigated. Additional questions regarding attributes contributing to comfort in sports
171 garments and which types of garments ought to be most comfortable were asked.

172 Participants were recruited online using Facebook, LinkedIn, the Loughborough University
173 blackboard, and mailing lists within the Loughborough University. The survey was carried out
174 between the 20th of April 2020 and 15th of May 2020.

175 *Data analysis*

176 Respondents who did not wear sports garments¹ were excluded from the study. A missing data
177 analysis was completed and resolved, and data evaluation was performed using descriptive
178 statistics. Frequency distributions and multiple response frequency analyses as well as
179 crosstabulations were run to investigate various interdependencies using SPSS version 26. For
180 the analysis of the research questions regarding the comparison of sex and nationality
181 (categorical data) a Chi-square (χ^2) test of independence (Pearson) was performed. Independent
182 variables were gender (male/female) and nationality. A probability level of $p < 0.05$ was defined

¹ For reporting purposes in this study, sports and exercise garments are referred to as sports garments

as the threshold for significance. For the analysis of the open answer question, a qualitative data analysis was performed using NVivo version 12 (12.6.0). A word frequency query was used to identify themes and word trends.

RESULTS AND DISCUSSION

The final sample comprised 292 respondents, classified by sex, age, amount and kind of physical activity undertaken, and nationality. A greater response sample of German and British respondents was elicited; this was primarily due to the two research groups being based in these countries. The representative sample is shown in Table I.

Table I here

The most popular sports activities among the participants are running, gym and outdoor sports. It is most likely that factors such as changes in lifestyles and demographics, as well as physical and mental benefits helped boosting outdoor sports activities. Running in particular provides the opportunity to participate as an individual or a group at any time of the day or week without the need of special equipment. Furthermore, environmental and educational trends support getting active outdoors, especially with an increase in outdoor sporting events such as running or cycling (Outdoor Industries Association and Sport England, 2015; Technavio, 2016; Iliades, 2018).

RQ₁: What are factors influencing the choice of online and in-store shopping?

In-store purchases

Factors responsible for in-store purchase are sizing/fit (91.4%), feel (68.6%) and look/appearance of the garment (54.3%). When looking at the purchase behaviour in relation to sex it is notable that there is a trend for females to purchase sports garments in a store because

they are able to feel the garment (72.7% females, 62.7% males). Females have a higher need for tactile input when purchasing sports garments in a store. This is in line with a study of Citrin *et al.* (2003) who found that more females, in comparison to males, require tactile input in making product evaluations, and that individuals do not purchase clothing products online due to a lack of accessibility to touch. However, the only significant difference between males and females is look/appearance (60.1% females, 46.1% males, $\chi^2(1) = 4.5$, $p = 0.034$) and the category 'other' ($\chi^2(1) = 4.3$, $p = 0.038$), which mostly contained answers of purchasing garments second hand. Regardless of sex, men and women differ on how they think, feel, and act vis-à-vis their bodies. Females hold more negative body-image attitudes than males do and place more cognitive and behavioural emphasis on managing their appearance (Cash and Brown, 1989).

Online purchases

The biggest influencing factor for an online purchase is a cheaper price (63.2%), followed by convenience (58.0%), less time consuming (53.3%) and a greater range of designs (45.8%). Looking once more at a sex separation, it can be concluded that significantly more males buy sports garments online due to a cheaper price (73.5% males, 54.4% females, $\chi^2(1) = 7.6$, $p = 0.006$) and significantly more females due to advertisements in social media (21.9% females, 8.2% males, $\chi^2(1) = 7.8$, $p = 0.005$).

Sporting goods gained from the COVID-19 e-commerce boom of 2020. While consumers shopped online before the pandemic, they were pushed to rely on digital retailers even more during the COVID-19 lockdown periods, as many physical stores were closed (Palmer, 2021). Furthermore, e-commerce is experiencing constant growth with globalisation being in motion and social media as a big influencer. Facebook, Instagram, etc. are used to promote, market, and sell products through the apps (Kulach, 2017; Mintel, 2018). Internet retailing increased its share of sportswear sales in Western Europe as consumers have increasingly selected it for its

easy price comparisons and convenience (Euromonitor, 2019). To push e-commerce further sports companies could focus not only on stating information regarding the material composition of the garment, but possibly on how the materials feel on the skin since this is a missing crucial parameter when shopping online and a major factor when purchasing sports garments in a store.

RQ₂: Is comfort an important attribute in the purchase of sports garments?

When evaluating the question “What are the three most important attributes you look for when purchasing sports garments” ‘comfort’ resulted in the second most frequent selected attribute (61.6%), just after fit (tight/loose) (63.7%). The third and fourth most important attribute when purchasing sports garments is price (45.5%) followed by functionality (43.5%). In the study of Rahman (2011) investigating in the comfort of denim jeans, fit was also reported as the most important and frequently mentioned attribute, followed by style, quality and comfort. Also Zhang *et al.* (2002) found that fit, comfort, style, colour and workmanship were the most important attributes in the purchase decisions of casual wear, however, geographic and demographic factors had impacts on the perceptions. It is questionable, however, whether fit is not already an integral part of the clothing comfort concept. Consumer demand for comfort is nothing new nowadays, however, in the UK it became more prominent in 2019 (Euromonitor, 2020). Not only is it affecting the well-being, but also the performance and efficiency of athletes and consumers, which ultimately influences their success (Bartels, 2011).

RQ₃: Identification of the main attributes contributing to comfort and is there an influence of sex and nationality?

Respondents selected three to four answers on average to answer the question “what is comfort in sports garments for you”. Considering the overall responses, the three most important

descriptors are freedom of movement (73.3%), fit on the body (60.3%) and a nice feel when wearing the garment (58.6%). If comfort had been selected in the previous question as one of the three most important attributes, respondents were asked to describe comfort in sports garments in their own words. The qualitative evaluation of the written words showed good agreements with the fixed answer possibilities. The word cloud (Figure 1) is a visual representation of the text data descriptions of comfort by the participants. The importance and frequency of the keywords is shown with font size: Bigger terms have greater weight.

Figure 1 here

Feel and fit are the most prominent words, which moreover had obtained a high ranking in the fixed answer question. Words were grouped together in stems for a clearer overall picture of the total of 155 answer phrases. The least prominent words in the word cloud appear only once in the overall answer phrases and were mostly combined with more prominent words. For instance, “loose/baggy” with “fit” or “smooth/soft” with “feel”. “Tight” was predominantly used in a negative context; it was typically stated that garments should not be (too) tight. The written phrases of the participants showed that fit is indeed integral part of the clothing comfort concept.

The perception of comfort is further investigated by taking sex and nationality into account. The sex division (Figure 2) shows that significantly more males prioritised physiological comfort descriptors such as protection from environmental conditions (52.7% males, 39.9% females, $\chi^2(1) = 4.8$, $p = 0.029$) and heat and moisture removal properties (49.6% males, 36.2% females, $\chi^2(1) = 5.3$, $p = 0.021$).

Figure 2 here

The comparison according to nationality shows a significantly different response rate for fit ($\chi^2(1) = 18.2$, $p = 0.000$) and feel ($\chi^2(1) = 4.6$, $p = 0.031$) (Figure 3).

Figure 3 here

Significantly more British respondents selected fit on the body compared to Germans (79.2% and 50.5%, respectively, $\chi^2(1) = 18.2$, $p = 0.000$) and more Germans chose a nice feel when wearing the garment compared to the British (68.8% and 54.2%, respectively, $\chi^2(1) = 4.6$, $p = 0.031$). This was further investigated by looking at the interrelationship between German and British females, and German and British males. In the category “when you do not even recognize that you are wearing anything”, a significant difference was found between the German and British males (60.4% and 35.1%, respectively, $\chi^2(1) = 5.6$, $p = 0.018$). Within the category “nice feel when wearing it” only males showed a significant difference (73.6% German males, 48.6% British males, $\chi^2(1) = 5.8$, $p = 0.016$). Fit had a significant impact on both German and British females ($\chi^2(1) = 11.6$, $p = 0.001$) and German and British males ($\chi^2(1) = 5.9$, $p = 0.015$). It is reasonable to suggest that different cultural groups may show varying responses due to interpersonal influences. In a study in six cities within China, respondents were asked to rank 15 different attributes on a 5-point-scale. The most important attributes were fit, comfort, style, colour and workmanship. More importantly, the geographic location was found to have an impact on the relevance of style, colour and brand (Zhang *et al.*, 2002). People from different countries have different cultural setups that motivate their (purchase) behaviour. Even though the world is becoming more and more globally oriented, one has to stay culture sensitive. There are cross-cultural differences and cross-cultural awareness is essential (Kulach, 2017).

RQ4: For which garment type is wear comfort most important?

Respondents were asked to select up to two garment types which ought to be the most comfortable (Figure 4). Males selected t-shirt (79.1%, $\chi^2(1) = 93.8$, $p = 0.000$), pants (69.8%, $\chi^2(1) = 50.0$, $p = 0.000$) and socks (27.9%, $\chi^2(1) = 25.7$, $p = 0.000$), whereas females selected sports bras (83.4%, $\chi^2(1) = 201.5$, $p = 0.000$), leggings (56.4%, $\chi^2(1) = 77.8$, $p = 0.000$) and

pants (28.2%). Furthermore, significantly more males chose jacket ($\chi^2(1) = 5.4$, $p = 0.020$). It should be kept in mind that fewer males wear leggings and only females wear sports bras.

Figure 4 here

The outcome that female respondents consider that sports bras should be the most comfortable sports garment is not surprising. Breast asymmetries as well as the variety of individual breast shapes make it difficult to find well-fitted sports bras and general garment types for the upper body of an individual female. Losken *et al.* (2005) also found that natural breast asymmetry exists, and more precisely that differences in size and shape between the left and right breast with the left breast being on average larger than the right.

Male participants stated that t-shirts and pants should be the most comfortable pieces of clothing. T-shirts are of great relevance, since this type of garment, similar to sports bras for females, is in direct contact with the skin. This is especially relevant when talking about moisture management properties of textiles. The fabric close to the body, can take up sweat from the skin and spread it to a larger area on the fabric, as well as transport it from the inner to outer surface where heat loss due to evaporation takes place (Wang *et al.*, 2013). Surprisingly, socks also gained a higher percentage amongst male respondents. Socks are regarded as an important component within the foot-shoe system and particularly of interest for runners. Exercising without a sock enhance a perception of foot wetness, stickiness and thermal discomfort. Socks have a positive impact on the reduction of tactile and mechanical inputs generated between the foot and the shoe and is therefore relevant for the overall improvements in foot-wear comfort (West *et al.*, 2021). Furthermore, Barkley *et al.* (2011) investigated the role of socks within the shoe-foot system and determined how the perception of comfort was influenced during a treadmill run with different socks. The study found that even though foot temperature did not differ statistically, participant perceptions of foot temperature did not coincide with physiological foot temperature and are strongly influenced by sock

characteristics. The outcome of these studies as well as the relatively high survey response rate for socks amongst the male population indicates that socks are indeed relevant for the overall improvements in comfort.

RQ₅: Does the amount of physical activity affect the comfort priorities of sport clothing?

The overall evaluation of comfort priorities regarding the frequency of practising sports showed that people spending more time exercising (10+ hours) set priorities in garments differently; more precisely, they make higher demands on sports garments than respondents spending less time practising sports (1-10 hours). The importance of the physiological comfort parameters in comparison to the psychological and physical ones is increased. This is plausible since efficient thermoregulation of the human body has critical influence not only on wear comfort but also on the sport performance. Fabric is not only a passive cover for the skin, it also modifies the heat regulating functions of the body (Zhang *et al.*, 2002). In a clothing system with poor breathability, the heart rate and the rectal temperature of the person will increase much more rapidly than with breathable apparel (Umbach, 2001). Consequently, it is unlikely to withstand high levels of performance for a longer period of time in a non-optimal garment.

RQ₆: Is there a preconceived opinion regarding the feel of different textile materials?

Throughout the survey participants relied on information about their previous experiences with the fabrics. A consumer attitude regarding cotton, polyester, cotton/polyester blend and wool was investigated and analysed (Figure 5). The characteristics for wool were warm-feeling (73.6%), scratchy (54.5%), natural (51.7%) and heavy-weight (46.6%). Cotton is considered as a natural (65.4%), soft (53.8%) and smooth (50%) material with a warm feeling (46.2%). 26.7% of respondents selected heavy-weight and 19.5% light-weight. Polyester is judged as synthetic (75%), light-weight (62.7%), and with a cold feeling (41.1%). When analysing the results of

the attitude towards the cotton/polyester blend, it is notable that the characteristics of cotton and polyester, when considered separately, are present in a combined manner. Surprisingly, the blend is mostly judged as synthetic (32.9%, 8.2% natural) with a similar number of respondents selecting a warm- or cold-feeling. Possibly, it was difficult for respondents to distinguish between a cold- and a warm-feeling without being able to touch appropriate textiles. The number of respondents selecting 'not applicable' (8.9%) indicates that some people were overstrained with characterising the feel of the cotton/polyester blend.

Figure 5 here

To further investigate the feel of the selected fibre types a separation was performed between sex and nationality. There was a statistically significant difference in the way in which males see cotton as heavy (34.1% males, 20.9% females, $\chi^2(1) = 6.5$, $p = 0.011$) and warm (55% males, 39.3% females, $\chi^2(1) = 17.1$, $p = 0.000$). Both, heavy-weight and warm-feeling in regard to sports clothing are attributes with negative associations.

Looking at German and British responses separately, there is no agreement in the characterisation of cotton for its thermoregulating properties. Significantly more Germans associate cotton with a warm-feeling ($\chi^2(1) = 17.1$, $p = 0.000$), significantly more British with a cold-feeling ($\chi^2(1) = 15.3$, $p = 0.000$). This could possibly stem from cultural peculiarities where the presentation of materials in familiar surroundings could be different. The surface texture of cotton for instance can generally be smooth or brushed (e.g., in bed sheets). This could have an influence on humans' thermal perception of textiles.

The attitude regarding polyester was significantly different amongst sex in the attributes of cold-feeling (35.0% females, 48.8% males, $\chi^2(1) = 5.7$, $p = 0.017$) and stiff (4.9% females, 0.8% males, $\chi^2(1) = 4.1$, $p = 0.042$). The comparison between Germans and British shows a significant difference in the cold-feel (55.0% Germans, 27.1% British, $\chi^2(1) = 16.4$, $p = 0.000$) and scratchiness (5.5% Germans, 14.6% British, $\chi^2(1) = 4.8$, $p = 0.029$).

The comparison of the cotton/polyester blend broken down by sex shows that significantly more males perceive the material as silky (17.8% males, 9.8% females, $\chi^2(1) = 4.0$, $p = 0.046$). The only significant difference between German and British respondents is light-weight (55.2% British, 34.9% Germans, $\chi^2(1) = 8.6$, $p = 0.003$). Participants could have had difficulties distinguishing whether a material is light- or heavy weight as they were not able to touch or lift it, since besides cotton, also polyester and the cotton/polyester blend received high percentages regarding light-weight. The determination of weight might additionally be challenging, since sport shirts in general are not being perceived as heavy in comparison to other garments humans are used to wearing.

Assessing the overall selection of the most favourite fibre type (Figure 6), cotton, polyester and the blend show similar popularity. Clearly wool is chosen as last in the left diagram (6.6%) and received most percentage as the least favourite fibre type (right diagram: 72.8%).

Figure 6 here

The results are once more split by sex and nationality (Figure 7). It seems that women prefer cotton for sports garments (36.4% females, 24.6% males) and significantly more males prefer polyester (34.1% males, 22.2% females, $\chi^2(1) = 9.0$, $p = 0.030$). British respondents seem to favour cotton (34.4% British, 21.1% Germans). This is in accordance with the study by Byrne *et al.* (1993) who found that consumers in both Newcastle and Sydney preferred fibres for sportshirts in the order of cotton, silk, polyester and nylon. They also found that UK students expressed a wish for slightly softer, smoother and less resilient fabrics than the Sydney students. The effect of a preferred cotton material in females is present in both the German and the British population. However, polyester was judged similarly by male and female British respondents and the effect of a preferred polyester material in males is only existent in the German population. These results lead to a conclusion that especially German males prefer t-shirts made

out of polyester due to the cold touch and its light weight whereas females prioritise a warm, soft-felt and natural material such as cotton. In a study by Byrne *et al.* (1993) they also found a preference for natural fibres in female consumers. Furthermore, for some sports, such as yoga, which had predominantly been selected by women (79.3% females, 20.7% males), there is usually less demands for a functional textile having cooling effects but rather for a warm and soft-felt material.

Figure 7 here

The comparison to the available literature additionally reinforces that garment comfort is influenced by fibre type (Hyun *et al.*, 1991). The hand feel of textiles is a crucial element influencing the purchase decisions of garments by individuals (Ciesielska-Wróbel and Van Langenhove, 2012). Furthermore, a study by Lee *et al.* (2003) confirms that nationality, age and sex have an influence on the hand-feel of textiles. It is therefore important to analyse the perception of materials regarding sex and nationality.

IMPLICATION AND CONCLUSION

Sportswear is subject to various demands, problems, and concerns. These can be anything from having a perfect fit on individual body proportions, supporting a comfortable feel on the skin, up to demanding a superior thermoregulatory function of the garment.

Nowadays, internet retailing is experiencing a growth due to cheaper prices, convenience and the influence of social media. However, a missing factor when shopping online and a crucial factor when shopping in a store is the ability to feel and perceive materials. Webpages are only stating the fibre composition of the garment; however, consumers must be knowledgeable about the actual feel of the material.

When purchasing sports garments, consumers do not seek a single attribute, they often consider multiple values within the product to satisfy their desires. Especially respondents practising

sports more frequently (10+ hours per week) make higher functional demands on their sportive equipment. The importance of the physiological comfort parameters in sports garments in comparison to the psychological and physical ones are increased.

Furthermore, fit, and comfort are closely linked together, as fit is an integral part of the clothing comfort concept. Females put more emphasis on garment fit than males. Additionally, females, showed higher preference for tactile input in making product evaluations. Males, on the other hand, prioritised physiological comfort descriptors for a good thermoregulatory support. There was a trend where females had a more positive perception towards cotton and males towards polyester.

The survey showed significant differences between German and British respondents regarding attributes contributing to comfort and the perception of textile materials. The observed cultural as well as sex nuances should be considered when developing sports garments for an international market, since customers are the driving force behind product development. The economic interests are big and drive towards innovation (Bielefeldt Bruun and Langkjær, 2016). For the apparel industry, information on product attributes from a consumer perspective is crucial. A better understanding of the importance of different attributes in consumers' minds helps an effective product development and marketing strategies (Zhang *et al.*, 2002).

TAKE HOME MESSAGES

- E-commerce is experiencing constant growth; however, the haptics properties of materials is a crucial missing parameter in the current online format
- Males prioritise physiological comfort descriptors for a good thermoregulatory support
- Higher physiological comfort demands on sports garments when practising 10+ hours of sports per week

- Sex and nationality (German/British) has an impact on preferences; more precisely, on the perception of parameters contributing to comfort as well as on the perception of different textile materials (especially regarding cotton and polyester)

LIMITATIONS

The English language could have an influence on participants being born in non-native-English speaking countries, since there was no translation of the survey into other languages. Furthermore, the impersonality of online surveys is a critical factor. A face-to-face experiment loses anonymity with an experimenter being present, which therefore produces a greater commitment (Stieger *et al.*, 2007).

In the scope of this research paper, no particular focus on a specific sports activity was set. Aim was to gain initial insights in the perception of textile properties and set a basis for further haptic research, e.g., specialist sports clothing such as compression garments or integrated protective designs.

Additionally, further research on this topic could be conducted by distributing the survey amongst a greater range of continents or countries. This would allow a broader comparison of consumer expectations and perceptions on clothing comfort in sports garments in other, diverse cultures.

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585

1 **TITLE**

2 Consumer expectations and perception of clothing comfort in sports and exercise garments

ABSTRACT

Purpose

Sports garments play an important role in the well-being of an athlete by protecting the wearer from changing environmental conditions and providing a comfortable feel. Clothing requirements have changed in recent years and demand for apparel with a higher comfort performance have been rising. Hence, the purpose of this study was to explore consumers' expectations and perception of comfort, and to examine how different textiles are perceived by consumers to provide useful knowledge that allows to engineer comfort into fabrics and sports garments.

Design/methodology/approach

This online survey comprised 292 respondents, classified by sex, age, nationality, and physical activity. The respondents were asked a total of 18 questions through the Bristol Online Survey (BOS) tool to explore expectation, perception and preference of clothing comfort, specifically of sportswear.

Findings

Fit and comfort are closely linked together, both forming part of the clothing comfort concept. When purchasing garments online, the haptics of fabrics was identified as a crucial missing parameter. However, priorities of attributes within the concept varied according to the person's sex and nationality. Females put more emphasis on garment fit and showed higher need for tactile input, whereas males prioritised physiological comfort descriptors, i.e., properties which facilitate thermoregulation. Furthermore, there is an increased importance of physiological comfort parameters for people exercising for 10 or more hours per week. Finally, it was possible to identify common associations and preferences for textile materials (cotton, polyester, cotton/polyester blend and wool). However, consideration should be taken concerning sex and nationality.

28 ***Originality/value***

29 Sex and nationality are parameters modulating the clothing comfort concept and the
30 conceptualized feel of materials. Therefore, sex and nationality of the end-consumer should be
31 considered during the development phase of sports garments, and particular attention should be
32 given to the targeted market in which these will be sold.

33 **KEY WORDS** Clothing comfort, Sports garments, Purchase behaviour, Material perception,
34 Fibre preferences, Haptics

35 **PAPER TYPE** Research paper

INTRODUCTION

The apparel industry faces challenges in satisfying consumers' need due to the change of priorities in the previous decades. During the 80s and 90s, consumers tended to buy fashionable clothing, whereas today, consumers are generally more value-orientated (Freire Castelo and de Oliveira Cabral, 2018). Understanding consumers' perceptions of apparel's quality is essential for providing satisfaction, which could lead to a potential competitive advantage, larger market share and higher revenue for apparel companies. In this regard, one clothing aspect that has to be studied and quantified is comfort. Human's perception of clothing comfort is made when sensory information is received, processed and then compared to past sensory experiences, ultimately representing people's expectations (Rahman, 2011; Freire Castelo and de Oliveira Cabral, 2018). These perceptions lead to the formulation of different clothing attributes, which have different importance for the consumers, and affect purchase decisions. Therefore, having a good understanding of these attributes can help in the product development phase and marketing strategies (Zhang *et al.*, 2002).

Literature review

Past studies have focused on the evaluation of determinant attributes in the perception of apparel products. In a study by Zhang *et al.* (2002), it was found that fit, comfort, colour and workmanship were the most important attributes during the purchase decision of casual wear, and that perceptions were affected by geographic and demographic factors. The geographic location was found to impact attributes such as style, colour and brand; for instance, consumers in northern cities of China were relatively less concerned with colour, whereas consumers in Shanghai paid more attention to colour as well as brand name. Differences are difficult to pinpoint, however these can be traced back to tradition and culture. Furthermore, regarding sex, females place more emphasis on fit, comfort, style, colour, and easy care.

61 Workman and Cho (2013) also indicated that individual preferences are affected by the culture
62 in which a person is exposed to growing up, as well as individual differences such as sex.
63 Additionally, females showed greater preferences for in-store shopping channels than men.
64 Many studies categorised attributes determining consumers' quality perceptions into two
65 general types: extrinsic and intrinsic cues (Hatch and Roberts, 1985). Intrinsic cues are inherent
66 to the physical composition and cannot be modified without changing the overall product: fibre
67 content, fabric structure, garment construction, quality, style, comfort, and fit. Extrinsic
68 attributes are product related, however, are not part of the physical product. Examples for
69 extrinsic cues are price, brand label, store, and country of origin (Hatch and Roberts, 1985;
70 Swinker and Hines, 2006; Rahman, 2011; Freire Castelo and de Oliveira Cabral, 2018). In the
71 perception of quality across a wide range of products intrinsic cues are considered to be more
72 important than extrinsic ones (Fiore and Damhorst, 1992). This is consistent with findings by
73 Rahman (2011), where intrinsic factors regarding denim products were found to play a more
74 significant role than extrinsic factors.

75 Comfort in general is of multifactorial nature; in sports garments in particular it influences the
76 overall performance and utility of the garment. A subdivision of three related major groups can
77 be performed: psychological/ergonomic, physical (sensorial/tactile) and physiological comfort
78 (Kamalha *et al.*, 2013). The psychological/ergonomic comfort includes personal aspects such
79 as personality and cultural background, as well as style, aesthetics, fashion, design, colour, fit,
80 and freedom of movement (Bartels, 2005). The physical (sensorial/tactile) comfort refers to the
81 skin-clothing interaction, which triggers various sensory receptors leading to a rise in
82 psychophysical perception. Sensations felt can be tactile (smoothness, roughness, softness,
83 stiffness, scratchiness), thermal (warmth, coolness, breathability), moisture (wetness,
84 stickiness) and pressure sensations (lightweight, heaviness) (Bartels, 2005; Bishop, 1996; Das
85 and Alagirusamy, 2010). Lastly, the physiological comfort refers to body thermoregulation (Li,

2005). Rahman's (2011) interpretation of comfort in apparel products involves thermal effects of a garment (warmth, breathability), sensory characteristics (tactile feeling), and mobility (ease of movement). In a more recent study (McCann, 2015), comfort is defined as a combination of appropriate shape and fit, including freedom of movement, thermal regulation via moisture wicking and quick drying properties, as well as lightweight, protection and durability. These factors contributed to the overall 'feel good' factor for the wearer.

When purchasing a sports garment in a shop, direct involvement such as touching, feeling or trying-on the garment is a natural tendency before making a final purchase decision (Rahman, 2011). In-store shopping is still leading over online, however, online purchases have been catching up (Mintel, 2018) especially during the COVID-19 lockdown periods (March/April, October 2020, January 2021). Nike expects a permanent shift to online sales. The US company recorded a digital sales increase of 82 % during the June to August quarter in 2020 (BBC, 2020). Similar to Nike, Adidas' online sales surge by 93 % in the second quarter and 51 % in the third (Meyers, 2020). Apparel companies have had to adapt to changing consumer behaviour during the pandemic by focussing on investments in online direct-to-consumer sales. It is therefore important to investigate people's purchase behaviour to be able to prioritise resources across different channels (e-commerce, physical stores). Regarding e-commerce, a big limiting factor could be represented by the difficulty to feel the garment by hand, especially if haptic response plays a major role in the purchase decision. In a study by Hines & O'Neal (1995) consumers evaluated quality using attributes that they associated with social, psychological, economic, physiological, and aesthetic characteristics. When evaluating garment quality, fabric material was the only attribute identified by most of the participants. According to the study, if fabric does not meet the requirements and expectations, all other factors like aesthetic, economic/performance, physiological and social/psychological may become unimportant since fabric is an integral part of clothing. Fabric was perceived to have a noticeable effect on the

overall appearance and performance of the garment. This is in accordance with Fiore & Damhorst (1992) who also stated that fabric is the best predictor of perceived quality of apparel. Product information labels of sports garments are usually stating fibre content and finish, which is helpful in the way of identifying the product composition; however, the consumer must be knowledgeable about which properties are associated with each product component (Hatch and Roberts, 1985). How are materials perceived in consumers' minds? Wool for instance traps air and forms an insulating microclimate between the layer of clothing and the body, which creates an association of wool being a warm fibre. With a soft and natural touch it is comfortable to wear, according to Tomar (2010). However, for sports applications wool is normally not the first choice. A combination of natural and synthetic fibres in knitted and woven materials are commonly used in sports garments. A cotton/polyester blend enhances durability, resilience, and dimensional stability (Horrocks and Anand, 2000). Synthetic materials are generally considered to be a good choice for sportswear as they are able to provide a valuable combination of moisture management, softness, lightweight, and quick drying properties (Uttam, 2013). Polyester e.g. is durable, yet light in weight, easy to care and a dimensionally stable material that absorbs very little moisture and has a high resistance to stretching (Tomar, 2010; Uttam, 2013). Cotton on the other hand provides a good combination of softness and comfort, however has a tendency to absorb and retain moisture (Uttam, 2013). When purchasing online, it is important that the consumer has an understanding of what a material is like to inform their choices. Therefore, understanding the knowledge of materials that user have is important to aid the definition of the garment properties.

132

133 *Research questions*

134 Understanding consumers' perceptions of apparel's comfort is essential for providing (post
135 purchase) satisfaction. The purpose of the study is to identify factors influencing in-store

purchases and establish those factors lacking in the emerging online environment irrespective of sporting activity. Furthermore, the importance of comfort in sports garments and the prioritisation of garment type in relation to comfort was investigated, as well as the consumer attitudes towards specific textile materials in relation to sex and nationality. People from diverse countries have different cultural norms that influence their perception and behaviour. Studies comparing concept of comfort and textile fibre preferences in apparel products have not been undertaken. Increased knowledge of preferences will contribute on garment designs to satisfy the requirements of sports garment users. Based on the existing literature and reflecting current comfort advances in garments as well as changing consumer behaviour, the following research questions were developed.

RQ₁: What are factors influencing the choice of online and in-store shopping?

RQ₂: Is comfort an important attribute in the purchase of sports garments?

RQ₃: Identification of the main attributes contributing to comfort and is there an influence of sex and nationality?

RQ₄: For which garment type is wear comfort most important?

RQ₅: Does the amount of physical activity affect the comfort priorities of sport clothing?

RQ₆: Is there a preconceived opinion regarding the feel of different textile materials?

METHODS

Data collection

A structured questionnaire was designed to explore clothing comfort in sports garments. Data were collected through the Bristol Online Survey (BOS) tool (<http://www.onlinesurveys.ac.uk>). Pilot-tests were carried out with academics as well as laypersons. The conceptual model for the evaluation of the perception of comfort in sports garments derived from the evaluated literature.

All procedures have been approved by the Loughborough University Ethics Approvals Sub-Committee (Project-ID: 1257).

The survey comprised eight pages with a total of 18 questions. It started off with questions regarding fitness level and type of physical activity typically undertaken. After that, the individual purchase behaviour (online/in-store) was questioned, and respondents were asked to report the three most important attributes when purchasing sports garments. If respondents ticked 'comfort' as one of the three answers, the question "How would you describe comfort in sports garments for you?" was included to gather additional individual information. Furthermore, the conceptualised hand-feel of sports t-shirts and consumer attitudes regarding specific fibre types such as cotton, polyester, cotton/polyester blends and wool was investigated. Additional questions regarding attributes contributing to comfort in sports garments and which types of garments ought to be most comfortable were asked.

Participants were recruited online using Facebook, LinkedIn, the Loughborough University blackboard, and mailing lists within the Loughborough University. The survey was carried out between the 20th of April 2020 and 15th of May 2020.

Data analysis

Respondents who did not wear sports garments¹ were excluded from the study. A missing data analysis was completed and resolved, and data evaluation was performed using descriptive statistics. Frequency distributions and multiple response frequency analyses as well as crosstabulations were run to investigate various interdependencies using SPSS version 26. For the analysis of the research questions regarding the comparison of sex and nationality (categorical data) a Chi-square (χ^2) test of independence (Pearson) was performed. Independent variables were gender (male/female) and nationality. A probability level of $p < 0.05$ was defined

¹ For reporting purposes in this study, sports and exercise garments are referred to as sports garments

as the threshold for significance. For the analysis of the open answer question, a qualitative data analysis was performed using NVivo version 12 (12.6.0). A word frequency query was used to identify themes and word trends.

RESULTS AND DISCUSSION

The final sample comprised 292 respondents, classified by sex, age, amount and kind of physical activity undertaken, and nationality. A greater response sample of German and British respondents was elicited; this was primarily due to the two research groups being based in these countries. The representative sample is shown in Table I.

Table I here

The most popular sports activities among the participants are running, gym and outdoor sports. It is most likely that factors such as changes in lifestyles and demographics, as well as physical and mental benefits helped boosting outdoor sports activities. Running in particular provides the opportunity to participate as an individual or a group at any time of the day or week without the need of special equipment. Furthermore, environmental and educational trends support getting active outdoors, especially with an increase in outdoor sporting events such as running or cycling (Outdoor Industries Association and Sport England, 2015; Technavio, 2016; Iliades, 2018).

RQ1: What are factors influencing the choice of online and in-store shopping?

In-store purchases

Factors responsible for in-store purchase are sizing/fit (91.4%), feel (68.6%) and look/appearance of the garment (54.3%). When looking at the purchase behaviour in relation to sex it is notable that there is a trend for females to purchase sports garments in a store because

they are able to feel the garment (72.7% females, 62.7% males). Females have a higher need for tactile input when purchasing sports garments in a store. This is in line with a study of Citrin *et al.* (2003) who found that more females, in comparison to males, require tactile input in making product evaluations, and that individuals do not purchase clothing products online due to a lack of accessibility to touch. However, the only significant difference between males and females is look/appearance (60.1% females, 46.1% males, $\chi^2(1) = 4.5, p = 0.034$) and the category 'other' ($\chi^2(1) = 4.3, p = 0.038$), which mostly contained answers of purchasing garments second hand. Regardless of sex, men and women differ on how they think, feel, and act vis-à-vis their bodies. Females hold more negative body-image attitudes than males do and place more cognitive and behavioural emphasis on managing their appearance (Cash and Brown, 1989).

Online purchases

The biggest influencing factor for an online purchase is a cheaper price (63.2%), followed by convenience (58.0%), less time consuming (53.3%) and a greater range of designs (45.8%). Looking once more at a sex separation, it can be concluded that significantly more males buy sports garments online due to a cheaper price (73.5% males, 54.4% females, $\chi^2(1) = 7.6, p = 0.006$) and significantly more females due to advertisements in social media (21.9% females, 8.2% males, $\chi^2(1) = 7.8, p = 0.005$).

Sporting goods gained from the COVID-19 e-commerce boom of 2020. While consumers shopped online before the pandemic, they were pushed to rely on digital retailers even more during the COVID-19 lockdown periods, as many physical stores were closed (Palmer, 2021). Furthermore, e-commerce is experiencing constant growth with globalisation being in motion and social media as a big influencer. Facebook, Instagram, etc. are used to promote, market, and sell products through the apps (Kulach, 2017; Mintel, 2018). Internet retailing increased its share of sportswear sales in Western Europe as consumers have increasingly selected it for its

easy price comparisons and convenience (Euromonitor, 2019). To push e-commerce further sports companies could focus not only on stating information regarding the material composition of the garment, but possibly on how the materials feel on the skin since this is a missing crucial parameter when shopping online and a major factor when purchasing sports garments in a store.

RQ₂: Is comfort an important attribute in the purchase of sports garments?

When evaluating the question “What are the three most important attributes you look for when purchasing sports garments” ‘comfort’ resulted in the second most frequent selected attribute (61.6%), just after fit (tight/loose) (63.7%). The third and fourth most important attribute when purchasing sports garments is price (45.5%) followed by functionality (43.5%). In the study of Rahman (2011) investigating in the comfort of denim jeans, fit was also reported as the most important and frequently mentioned attribute, followed by style, quality and comfort. Also Zhang *et al.* (2002) found that fit, comfort, style, colour and workmanship were the most important attributes in the purchase decisions of casual wear, however, geographic and demographic factors had impacts on the perceptions. It is questionable, however, whether fit is not already an integral part of the clothing comfort concept. Consumer demand for comfort is nothing new nowadays, however, in the UK it became more prominent in 2019 (Euromonitor, 2020). Not only is it affecting the well-being, but also the performance and efficiency of athletes and consumers, which ultimately influences their success (Bartels, 2011).

RQ₃: Identification of the main attributes contributing to comfort and is there an influence of sex and nationality?

Respondents selected three to four answers on average to answer the question “what is comfort in sports garments for you”. Considering the overall responses, the three most important

descriptors are freedom of movement (73.3%), fit on the body (60.3%) and a nice feel when wearing the garment (58.6%). If comfort had been selected in the previous question as one of the three most important attributes, respondents were asked to describe comfort in sports garments in their own words. The qualitative evaluation of the written words showed good agreements with the fixed answer possibilities. The word cloud (Figure 1) is a visual representation of the text data descriptions of comfort by the participants. The importance and frequency of the keywords is shown with font size: Bigger terms have greater weight.

Figure 1 here

Feel and fit are the most prominent words, which moreover had obtained a high ranking in the fixed answer question. Words were grouped together in stems for a clearer overall picture of the total of 155 answer phrases. The least prominent words in the word cloud appear only once in the overall answer phrases and were mostly combined with more prominent words. For instance, “loose/baggy” with “fit” or “smooth/soft” with “feel”. “Tight” was predominantly used in a negative context; it was typically stated that garments should not be (too) tight. The written phrases of the participants showed that fit is indeed integral part of the clothing comfort concept.

The perception of comfort is further investigated by taking sex and nationality into account. The sex division (Figure 2) shows that significantly more males prioritised physiological comfort descriptors such as protection from environmental conditions (52.7% males, 39.9% females, $\chi^2(1) = 4.8, p = 0.029$) and heat and moisture removal properties (49.6% males, 36.2% females, $\chi^2(1) = 5.3, p = 0.021$).

Figure 2 here

The comparison according to nationality shows a significantly different response rate for fit ($\chi^2(1) = 18.2, p = 0.000$) and feel ($\chi^2(1) = 4.6, p = 0.031$) (Figure 3).

Figure 3 here

Significantly more British respondents selected fit on the body compared to Germans (79.2% and 50.5%, respectively, $\chi^2(1) = 18.2, p = 0.000$) and more Germans chose a nice feel when wearing the garment compared to the British (68.8% and 54.2%, respectively, $\chi^2(1) = 4.6, p = 0.031$). This was further investigated by looking at the interrelationship between German and British females, and German and British males. In the category “when you do not even recognize that you are wearing anything”, a significant difference was found between the German and British males (60.4% and 35.1%, respectively, $\chi^2(1) = 5.6, p = 0.018$). Within the category “nice feel when wearing it” only males showed a significant difference (73.6% German males, 48.6% British males, $\chi^2(1) = 5.8, p = 0.016$). Fit had a significant impact on both female-German and female-British females ($\chi^2(1) = 11.6, p = 0.001$) and male-Germans and male-British males ($\chi^2(1) = 5.9, p = 0.015$), German and British. It is reasonable to suggest that different cultural groups may show varying responses due to interpersonal influences. In a study in six cities within China, respondents were asked to rank 15 different attributes on a 5-point-scale. The most important attributes were fit, comfort, style, colour and workmanship. More importantly, the geographic location was found to have an impact on the relevance of style, colour and brand (Zhang *et al.*, 2002). People from different countries have different cultural setups that motivate their (purchase) behaviour. Even though the world is becoming more and more globally oriented, one has to stay culture sensitive. There are cross-cultural differences and cross-cultural awareness is essential (Kulach, 2017).

RQ₄: For which garment type is wear comfort most important?

Respondents were asked to select up to two garment types which ought to be the most comfortable (Figure 4). Males selected t-shirt (79.1%, $\chi^2(1) = 93.8, p = 0.000$), pants (69.8%, $\chi^2(1) = 50.0, p = 0.000$) and socks (27.9%, $\chi^2(1) = 25.7, p = 0.000$), whereas females selected sports bras (83.4%, $\chi^2(1) = 201.5, p = 0.000$), leggings (56.4%, $\chi^2(1) = 77.8, p = 0.000$) and

pants (28.2%). Furthermore, significantly more males chose jacket ($\chi^2(1) = 5.4, p = 0.020$).

~~However, it~~ should be kept in mind that fewer males wear leggings and only females wear sports bras.

Figure 4 here

The outcome that female respondents consider that sports bras should be the most comfortable sports garment is not surprising. Breast asymmetries as well as the variety of individual breast shapes make it difficult to find well-fitted sports bras and general garment types for the upper body of an individual female. Losken *et al.* (2005) also found that natural breast asymmetry exists, and more precisely that differences in size and shape between the left and right breast with the left breast being on average larger than the right.

Male participants stated that t-shirts and pants should be the most comfortable pieces of clothing. T-shirts are of great relevance, since this type of garment, similar to sports bras for females, is in direct contact with the skin. This is especially relevant when talking about moisture management properties of textiles. The fabric close to the body, can take up sweat from the skin and spread it to a larger area on the fabric, as well as transport it from the inner to outer surface where heat loss due to evaporation takes place (Wang *et al.*, 2013). Surprisingly, socks also gained a higher percentage amongst male respondents. Socks are regarded as an important component within the foot-shoe system and particularly of interest for runners. Exercising without a sock enhance a perception of foot wetness, stickiness and thermal discomfort. Socks have a positive impact on the reduction of tactile and mechanical inputs generated between the foot and the shoe and is therefore relevant for the overall improvements in foot-wear comfort (West *et al.*, 2021). Furthermore, Barkley *et al.* (2011) investigated the role of socks within the shoe-foot system and determined how the perception of comfort was influenced during a treadmill run with different socks. The study found that even though foot temperature did not differ statistically, participant perceptions of foot temperature did not

coincide with physiological foot temperature and are strongly influenced by sock characteristics. The outcome of these studies as well as the relatively high survey response rate for socks amongst the male population indicates that socks are indeed relevant for the overall improvements in comfort.

RQ₅: Does the amount of physical activity affect the comfort priorities of sport clothing?

The overall evaluation of comfort priorities regarding the frequency of practising sports showed that people spending more time exercising (10+ hours) set priorities in garments differently; more precisely, they make higher demands on sports garments than respondents spending less time practising sports (1-10 hours). The importance of the physiological comfort parameters in comparison to the psychological and physical ones is increased. This is plausible since efficient thermoregulation of the human body has critical influence not only on wear comfort but also on the sport performance. Fabric is not only a passive cover for the skin, it also modifies the heat regulating functions of the body (Zhang *et al.*, 2002). In a clothing system with poor breathability, the heart rate and the rectal temperature of the person will increase much more rapidly than with breathable apparel (Umbach, 2001). Consequently, it is unlikely to withstand high levels of performance for a longer period of time in a non-optimal garment.

RQ₆: Is there a preconceived opinion regarding the feel of different textile materials?

Throughout the survey participants relied on information about their previous experiences with the fabrics. A consumer attitude regarding cotton, polyester, cotton/polyester blend and wool was investigated and analysed (Figure 5). The characteristics for wool were warm-feeling (73.6%), scratchy (54.5%), natural (51.7%) and heavy-weight (46.6%). Cotton is considered as a natural (65.4%), soft (53.8%) and smooth (50%) material with a warm feeling (46.2%). 26.7% of respondents selected heavy-weight and 19.5% light-weight. Polyester is judged as synthetic

(75%), light-weight (62.7%), and with a cold feeling (41.1%). When analysing the results of the attitude towards the cotton/polyester blend, it is notable that the characteristics of cotton and polyester, when considered separately, are present in a combined manner. Surprisingly, the blend is mostly judged as synthetic (32.9%, 8.2% natural) with a similar number of respondents selecting a warm- or cold-feeling. Possibly, it was difficult for respondents to distinguish between a cold- and a warm-feeling without being able to touch appropriate textiles. The number of respondents selecting 'not applicable' (8.9%) indicates that some people were overstrained with characterising the feel of the cotton/polyester blend.

Figure 5 here

To further investigate the feel of the selected fibre types a separation was performed between sex and nationality. There was a statistically significant difference in the way in which males see cotton as heavy (34.1% males, 20.9% females, $\chi^2(1) = 6.5, p = 0.011$) and warm (55% males, 39.3% females, $\chi^2(1) = 17.1, p = 0.000$). Both, heavy-weight and warm-feeling in regard to sports clothing are attributes with negative associations.

Looking at German and British responses separately, there is no agreement in the characterisation of cotton for its thermoregulating properties. ~~Significantly more~~ More Germans associate cotton with a warm-feeling ($\chi^2(1) = 17.1, p = 0.000$), ~~significantly whereas~~ more British with a cold-feeling ($\chi^2(1) = 15.3, p = 0.000$). This could possibly stem from cultural peculiarities where the presentation of materials in familiar surroundings could be different. The surface texture of cotton for instance can generally be smooth or brushed (e.g., in bed sheets). This could have an influence on humans' thermal perception of textiles.

The attitude regarding polyester was significantly different amongst sex in the attributes of cold-feeling (35.0% females, 48.8% males, $\chi^2(1) = 5.7, p = 0.017$) and stiff (4.9% females, 0.8% males, $\chi^2(1) = 4.1, p = 0.042$). The comparison between Germans and British shows a

significant difference in the cold-feel (55.0% Germans, 27.1% British, $\chi^2(1) = 16.4, p = 0.000$) and scratchiness (5.5% Germans, 14.6% British, $\chi^2(1) = 4.8, p = 0.029$).

The comparison of the cotton/polyester blend broken down by sex shows that significantly more males perceive the material as silky (17.8% males, 9.8% females, $\chi^2(1) = 4.0, p = 0.046$). The only significant difference between German and British respondents is light-weight (55.2% British, 34.9% Germans, $\chi^2(1) = 8.6, p = 0.003$). Participants could have had difficulties distinguishing whether a material is light- or heavy weight as they were not able to touch or lift it, since besides cotton, also polyester and the cotton/polyester blend received high percentages regarding light-weight. The determination of weight might additionally be challenging, since sport shirts in general are not being perceived as heavy in comparison to other garments humans are used to wearing.

Assessing the overall selection of the most favourite fibre type (Figure 6), cotton, polyester and the blend show similar popularity. Clearly wool is chosen as last in the left diagram (6.6%) and received most percentage as the least favourite fibre type (right diagram: 72.8%).

Figure 6 here

The results are once more split by sex and nationality (Figure 7). It seems that women prefer cotton for sports garments (36.4% females, 24.6% males) and significantly more males prefer polyester (34.1% males, 22.2% females, $\chi^2(1) = 9.0, p = 0.030$). British respondents seem to favour cotton (34.4% British, 21.1% Germans). This is in accordance with the study by Byrne *et al.* (1993) who found that consumers in both Newcastle and Sydney preferred fibres for sportshirts in the order of cotton, silk, polyester and nylon. They also found that UK students expressed a wish for slightly softer, smoother and less resilient fabrics than the Sydney students. The effect of a preferred cotton material in females is present in both the German and the British population. However, polyester was judged similarly by male and female British respondents

and the effect of a preferred polyester material in males is only existent in the German population. These results lead to a conclusion that especially German males prefer t-shirts made out of polyester due to the cold touch and its light weight whereas females prioritise a warm, soft-felt and natural material such as cotton. In a study by Byrne *et al.* (1993) they also found a preference for natural fibres in female consumers. Furthermore, for some sports, such as yoga, which had predominantly been selected by women (79.3% females, 20.7% males), there is usually less demands for a functional textile having cooling effects but rather for a warm and soft-felt material.

Figure 7 here

The comparison to the available literature additionally reinforces that garment comfort is influenced by fibre type (Hyun *et al.*, 1991). The hand feel of textiles is a crucial element influencing the purchase decisions of garments by individuals (Ciesielska-Wróbel and Van Langenhove, 2012). Furthermore, a study by Lee *et al.* (2003) confirms that nationality, age and sex have an influence on the hand-feel of textiles. It is therefore important to analyse the perception of materials regarding sex and nationality.

IMPLICATION AND CONCLUSION

Sportswear is subject to various demands, problems, and concerns. These can be anything from having a perfect fit on individual body proportions, supporting a comfortable feel on the skin, up to demanding a superior thermoregulatory function of the garment.

Nowadays, internet retailing is experiencing a growth due to cheaper prices, convenience and the influence of social media. However, a missing factor when shopping online and a crucial factor when shopping in a store is the ability to feel and perceive materials. Webpages are only stating the fibre composition of the garment; however, consumers must be knowledgeable about the actual feel of the material.

When purchasing sports garments, consumers do not seek a single attribute, they often consider multiple values within the product to satisfy their desires. Especially respondents practising sports more frequently (10+ hours per week) make higher functional demands on their sportive equipment. The importance of the physiological comfort parameters in sports garments in comparison to the psychological and physical ones are increased.

Furthermore, fit, and comfort are closely linked together, as fit is an integral part of the clothing comfort concept. Females put more emphasis on garment fit than males. Additionally, females, showed higher preference for tactile input in making product evaluations. Males, on the other hand, prioritised physiological comfort descriptors for a good thermoregulatory support. There was a trend where females had a more positive perception towards cotton and males towards polyester.

The survey showed significant differences between German and British respondents regarding attributes contributing to comfort and the perception of textile materials. The observed cultural as well as sex nuances should be considered when developing sports garments for an international market, since customers are the driving force behind product development. The economic interests are big and drive towards innovation (Bielefeldt Bruun and Langkjær, 2016). For the apparel industry, information on product attributes from a consumer perspective is crucial. A better understanding of the importance of different attributes in consumers' minds helps an effective product development and marketing strategies (Zhang *et al.*, 2002).

TAKE HOME MESSAGES

- E-commerce is experiencing constant growth; however, the haptics properties of materials is a crucial missing parameter in the current online format
- Males prioritise physiological comfort descriptors for a good thermoregulatory support

- Higher physiological comfort demands on sports garments when practising 10+ hours of sports per week
- Sex and nationality (German/British) has an impact on preferences; more precisely, on the perception of parameters contributing to comfort as well as on the perception of different textile materials (especially regarding cotton and polyester)

LIMITATIONS

The English language could have an influence on participants being born in non-native-English speaking countries, since there was no translation of the survey into other languages. Furthermore, the impersonality of online surveys is a critical factor. A face-to-face experiment loses anonymity with an experimenter being present, which therefore produces a greater commitment (Stieger *et al.*, 2007).

In the scope of this research paper, no particular focus on a specific sports activity was set. Aim was to gain initial insights in the perception of textile properties and set a basis for further haptic research, e.g., specialist sports clothing such as compression garments or integrated protective designs.

Additionally, further research on this topic could be conducted by distributing the survey amongst a greater range of continents or countries. This would allow a broader comparison of consumer expectations and perceptions on clothing comfort in sports garments in other, diverse cultures.

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Fig 1.

Figure 1: Word cloud representing the description of comfort by the participants (“How would you describe comfort in sports garments for you?”).

Fig 2.

Figure 2: “What is comfort in sports garments for you?” Comparison of comfort descriptors broken down by sex. * indicates a significant difference between the two groups.

Fig 3.

Figure 3: “What is comfort in sports garments for you?” Comparison of comfort descriptors broken down by nationality (German and British) (n=205). * indicates a significant difference between the two groups.

Fig 4.

Figure 4: “When undertaking physical activity choose up to two garment-types which are most important to be most comfortable.” Most comfortable sports garment type broken down by sex. * indicates a significant difference between the two groups.

Fig 5.

Figure 5: “What characteristic attributes apply when thinking about the feel of a t-shirt made out of cotton, polyester, cotton/polyester blend and wool” Consumer attitude regarding different fibre types (a) cotton, b) polyester, c) cotton/polyester blend, d) wool).

Fig 6.

Figure 6: “Please sort the fibre types from most favourite (1) to least favourite (4) one in your sports garments.” Comparison of most (left) and least (right) favourite fibre type in sports garments.

Fig 7.

Figure 7: "Please sort the fibre types from most favourite (1) to least favourite (4) one in your sports garments." Favourite fibre type broken down by sex (left) and nationality (right). * indicates a significant difference between the two groups.

Table

Table I:

Table I: Respondent profile. Nationality “other” consists of respondents within Europe (e.g., Spanish, Italian, Dutch, etc.) and from continents other than Europe (e.g., Asia, Africa, North and South America).

	Male	Female
Sex	44.2%	55.8%
Age [years]		
18-25	25.6%	37.4%
26-35	53.5%	35.6%
36-45	7.0%	12.9%
46-55	10.1%	8.0%
above 55	3.9%	6.1%
Weekly hours [h] of sports		
0-1	0.8%	0.6%
1-2	5.4%	9.8%
2-5	43.4%	45.4%
5-10	34.9%	31.3%
10+	12.4%	5.5%
No sports	3.1%	7.4%
Nationality		
German	41.1%	34.4%
British	28.7%	36.2%
Other	30.2%	29.4%

Clothing Comfort in Sports Garments

Page 1: Your opinion is very valuable!

When purchasing a sports garment, consumers are very limited on time for deciding whether they like the garment's textile. The purpose of this study is to find out which clothing and comfort attributes influence people when purchasing sports garments and to identify the consumer attitude in regards to specific materials. Understanding and satisfying consumer needs are crucial for the growth of clothing and textile industry. One of the most important issues is to understand what the concept of clothing comfort means and how it can be engineered into fabrics and sports garments.

This research is part of a PhD project investigating the haptics of sports textiles. We would like to ask you to give us your personal and honest opinion. The survey will take about **10-15 minutes** of your time.

Page 2: Informed consent

The purpose and details of this study are clear to me. I understand that this study is designed to further scientific knowledge and that all procedures have been approved by the Loughborough University Ethics Approvals (Human Participants) Sub-Committee.

I understand that all the personal information I provide will be processed in accordance with data protection legislation on the public task basis and will be treated in strict confidence.

I understand that information I provide will be used for publications, reports, and research outputs.

1. I voluntarily take part in this study. * Required

☒ Yes, I agree.

Page 3: Exercising and sports

2. Do you undertake physical activity on a regular basis?

- ☐ yes
☐ no

2.a. What kind of physical activity do you undertake regularly?

- ☐ Team sports (Basketball, Football, etc.)
☐ Running
☐ Cycling
☐ Water sports (Swimming, Surfing, etc.)
☐ Racket sport (Tennis, Squash, etc.)
☐ Gym
☐ Athletics
☐ Outdoor sports (Hiking, Skiing, etc.)
☐ Yoga/Pilates
☐ Other

2.a.i. If you selected Other, please specify:

2.b. How many **hours per week** do you undertake physical activity?

- ☐ 0-1
☐ 1-2
☐ 2-5
☐ 5-10
☐ 10+

3. Do you wear sports garments?

- ☐ yes
☐ no

Page 4: Purchase behaviour

4. Where do you usually purchase sports garments?

- ☐ Online
- ☐ Store
- ☐ Both, online and store

4.a. Which type of online shop or actual store do you usually purchase sports garments?

- ☐ Specialist (Intersport, Sports Direct, Decathlon, JD sports, etc.)
- ☐ Non-specialist (H&M, Zara, C&A, etc.)

4.b. Why do you purchase sports garments in a store?

- ☐ Consulting service
- ☐ Feel of the garment
- ☐ Sizing/fit of the garment
- ☐ Support of local business
- ☐ Look/appearance of the garment
- ☐ Personal experience
- ☐ Pleasant pastime
- ☐ Promotions (Sales)
- ☐ Impulse purchase
- ☐ Other

4.b.i. If you selected Other, please specify:

4.c. Why do you purchase sports garments online?

- ☐ Less time consuming
- ☐ Greater range of sizes
- ☐ Greater range of designs
- ☐ Pleasant pastime
- ☐ Convenience
- ☐ Brand is only available online
- ☐ No influence of other people's opinion
- ☐ Advertisement (social media, etc.)
- ☐ Cheaper price
- ☐ Other

4.c.i. If you selected Other, please specify:

5. Have you purchased any sports garments in the last 6 months before the COVID-19 lockdown period started?

- ☐ yes
- ☐ no

5.a. Where did you purchase the garment(s)?

- ☐ Online
- ☐ Store
- ☐ Both, online and store

6. I am using sports garments...

- ☐ ... for sports or fitness purposes
- ☐ ... for casual wear
- ☐ ... to look sportive
- ☐ ... to follow a trend
- ☐ Other

6.a. The sports or fitness purpose I use the garment for is...

- ☐ ... only the specific sports the garment was designed for
- ☐ ... also sports other than the one for which the garment was designed for

6.b. If you selected Other, please specify:

7. What are the **three** most important attributes you look for when purchasing sports garments?

Please select exactly 3 answer(s).

- ☐ Comfort
- ☐ Fit (tight/loose)
- ☐ Style
- ☐ Colour
- ☐ Brand name
- ☐ Durability
- ☐ Functionality (moisture management, breathability)
- ☐ Price
- ☐ Ease of care
- ☐ Country of manufacturing (made in ...)
- ☐ Type of material
- ☐ Environmental impact
- ☐ Discounts
- ☐ Improvement in personal performance
- ☐ Other

7.a. How would you describe comfort in sports garments for you?

7.b. What kind of material would you prefer in sports garments?

- ☐ Natural
- ☐ Synthetic

7.c. If you selected Other, please specify:

Page 5: Feel of sports shirts

8. What characteristic attributes apply when thinking about the feel of a t-shirt made out of...

	smooth	rough	warm-feeling	cold-feeling	scratchy	soft	synthetic	natural	heavy-weight	light-weight	stiff	silky	not applicable	Other	If you
Cotton	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	<input type="text"/>
Polyester	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	<input type="text"/>
Cotton/Polyester Blend	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	<input type="text"/>
Wool	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	<input type="text"/>

9. Please sort the fibre types from **most favourite (1)** to **least favourite (4)** one in your sports garments

Please don't select more than 1 answer(s) per row.

Please don't select more than 1 answer(s) in any single column.

	1	2	3	4
Cotton	☐	☐	☐	☐
Polyester	☐	☐	☐	☐
Cotton/Polyester Blend	☐	☐	☐	☐
Wool	☐	☐	☐	☐

10. When undertaking physical activity choose **up to two** garment-types which are most important to be most comfortable.

Please select no more than 2 answer(s).

- ☐ Sports bra
- ☐ T-shirt
- ☐ Pants
- ☐ Socks
- ☐ Jacket
- ☐ Leggings
- ☐ Other

10.a. If you selected Other, please specify:

11. What is **comfort in sports garments** for you?

- ☐ When you do not even recognize that you are wearing anything
- ☐ Heat and moisture removal properties
- ☐ Nice feel when touching it
- ☐ Nice feel when wearing it
- ☐ Design and style
- ☐ Protection from environmental conditions (keeping you warm, water repellent, etc.)
- ☐ Support of your body's thermoregulation

- ☐ Fit on the body
- ☐ Freedom of movement
- ☐ Other

11.a. If you selected Other, please specify:

Page 6: Your personalized sports t-shirt

12. Imagine you could design your own individual running-shirt from scratch. Pick the fibre type for the production of your running t-shirt for summer.

13. What attributes are **important** in your running t-shirt for summer?

- ☐ Roughness
- ☐ Natural touch
- ☐ Breathability
- ☐ Warmness to the touch
- ☐ Stretchability
- ☐ Smoothness
- ☐ Synthetic touch
- ☐ Thickness
- ☐ Coolness to the touch
- ☐ Lightweight
- ☐ Softness
- ☐ Flexibility
- ☐ Other

13.a. If you selected Other, please specify:

14. What **attributes do not matter** in your running t-shirt for summer?

- ☐ Roughness
- ☐ Natural touch
- ☐ Breathability
- ☐ Warmness to the touch
- ☐ Stretchability
- ☐ Smoothness
- ☐ Synthetic touch
- ☐ Thickness
- ☐ Coolness to the touch
- ☐ Lightweight
- ☐ Softness
- ☐ Flexibility
- ☐ Other

14.a. If you selected Other, please specify:

Page 7: Anthropometric data

15. Are you?

☐ Male

☐ Female

16. What is your age?

☐ 18-25

☐ 26-35

☐ 36-45

☐ 46-55

☐ above 55

17. What is your continent of origin?

☐ Europe

☐ North America

☐ South America

☐ Oceania

☐ Africa

☐ Asia

18. What is your nationality?