

INVESTIGATION OF FABRIC TACTILE CHARACTERISTICS FOR DIFFERENT CLOTHING BASED ON ELDERLY PERSPECTIVES

Pithalai Phoophat^{1,*}, Aussama Soontrunnarudrungsri² and Rungsima Chollakup³

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Abstract

Thailand has an aging society which is affected by the social and economic dimensions of the country. Products and services for the well-being of the elderly are becoming very competitive markets. This study investigated Thai elderly preferences toward apparel fabrics. In total, 40 Thai elderly women were interviewed on their purchasing behavior relating to clothing and their attitudes to different types of fabric. The free sorting task method was applied to 28 fabric samples based on their suitability for different applications by elderly people. The results showed that the factors influencing apparel purchasing by the elderly were price, tactile properties, and apparel pattern design. The elderly considered sensorial comfort, breathability, and softness as important components of good quality in a fabric for well-being. The sorting task produced 6 groups. The sleeping wear group was associated with all knitted fabrics and related to soft and stretched textures that provided comfort, while loungewear had a high association with the fabrics made of linen fiber based on the descriptive words 'soft', 'comfort', 'airy', 'natural', and 'stiff'. Business professional wear had a high association with fabrics made of silk, linen, and cotton based on the descriptive words 'thick', 'stiff', and 'look expensive'. These findings could provide guidelines for designing and manufacturing fabrics whose characteristics match the demands of the elderly, as well as guiding the fabrics to use to create clothing providing well-being for the elderly.

Keywords: Elderly, Sorting Task, Fabric Properties, Sensorial Comfort

¹ Department of Textile Science, Faculty of Agro-Industry, Kasetsart University, 50 Ngamwongwan Rd., Ladyao, Chatuchak, Bangkok, Thailand. E-mail: pithalai.p@ku.th

² Department of Product Development, Faculty of Agro-Industry, Kasetsart University, 50 Ngamwongwan Rd., Ladyao, Chatuchak, Bangkok, Thailand. E-mail: aussama.s@ku.th

³ Kasetsart Agricultural Agro-Industrial Product Improvement Institute, Kasetsart University, 50 Ngamwongwan Rd., Ladyao, Chatuchak, Bangkok, Thailand. E-mail: aaprmi@ku.ac.th

* Corresponding author

Introduction

The world's population is rapidly transforming as many countries are moving toward an aging society due to the declining birth rate and increasing longevity. In the ASEAN countries, Singapore was the first to reach the status of an aged population, followed by Thailand and Vietnam. Thailand reached the status of an aged society in 2005 when 10% of the population was aged 60 years or more. It was estimated that Thailand would become an aged society in 2022 or within three years at the earliest with 20% of the population being 60 years or older. It is likely that Thailand will be the first country among developing countries to become an aged society and thereafter a super-aged society by about 2032. The situation will definitely have an impact on the social and economic dimensions of the country. Markets for products and services for the elderly will expand and increase in value, leading to a more attractive market.

Successful competition in this developing market will require designing, developing, and improving product features, styles, and quality, especially adapting the quality to satisfy the physical and emotional wellbeing of the elderly consumers. The key to designing and developing a product that could win-over the competitors and satisfy the consumer is to deeply understand the target consumer. It applies to all market, including products for the elderly. More and more of the elderly have decided to live by themselves and to move toward preventive healthcare rather than curative healthcare. With their buying power, they are likely to spend money on their own health, wellbeing, and happiness. Clothing, as one of the four requisites, is contributing to elderly wholesomeness (Smathers and Horridge, 1978; Civitci, 2004; Twigg, 2007).

The cloth selections should be a high priority to the senior person, being both aesthetically pleasing and practical for the activities of daily living for this demographic. Adaptive clothing is an example of wellness design. This type of clothing is created for individuals who have difficulty dressing on their own, such as the elderly or people who are disabled (Hoffman, 1979; Bumphrey and Steven, 1981; Goldsworthy, 1981; Thorton, 1990). In addition to their numerous specialized capabilities, the fabrics have been treated with collagen that is either antibacterial or antiaging. In addition to the item's aesthetic appeal, its tactile properties can heavily influence the ultimate purchasing choice made by customers. Utilizing sensory analysis, which is driven by individual preferences, one can determine the level of fabric quality as well as the texture of the material.

Sensory analysis has been used to gain more insight into the weave structure, weight, drape, stiffness, and wearability of a fabric, amongst other features. First developed in the 1940s, sensory assessment has been put to use to find solutions to a wide range of issues that have plagued the food processing industry based on using the five human senses. Touch has traditionally been considered the most reliable and useful sensory evaluation modality when it comes to assessing textiles. Brand (1964) applied trained and untrained panelists in discriminating fabric samples. Bishop (1996) used trained panelists to evaluate yarn and fabric quality. Cardello *et al.* (2003) used an example involving military clothes to illustrate the concept of handfeel spectrum descriptive analysis. Chollakup *et al.* (2004; 2005) used a method called sensory analysis to evaluate the effects of blending type during spinning, types of silk waste, and silk content on the quality of silk and cotton mixed yarn and fabric. Their findings made it abundantly clear that this instrument, which was at first developed for use in the food industry, could also be useful for defining the texture of knitted clothing, particularly that which is constructed from a variety of blended fibers. This is particularly the case with clothing that is made from a combination of different fiber types.

Fabrics used in clothing should be comfortable and suitable mechanically and thermally for the human body under normal or specific conditions. The term "fabric hand" is commonly used to evaluate the tactile perception of a fabric. Fabric hand refers to the sensations experienced when a fabric is touched or smoothed with the fingers and palm (Hatch, 1993; Cieielska-Wrobel and Langenhove, 2012). It is dependent on the construction of the fabric, which includes the fabric's thickness, surface, and any other properties it may have. The subjects' own individual experiences and views are used to form their own subjective assessments of the fabric hand. The incorporation of a tactile and sensory review into the product development process can be beneficial. Tactile sensory evaluation is a useful tool for product development. Sensory evaluation is required to create a new fabric design and to develop the quality of the fiber and fabric that have a specific sense, such as a silk-like fabric, peach-like fabric, or microfibers and Lyocell. For such garments, product attributes can be assessed by: 1) physical properties measurement using instruments; 2) sensory evaluation; and 3) consumers' perceptions of fashion style (Zhu *et al.*, 2010). Since then, countless following investigations have included the incorporation of apparatuses for evaluating the 'hand' of the fabric. The Kawabata Evaluation System for Fabric (KES-F) is a method that may be

used to determine the tensile, shear, and bending properties of a fabric (Kawabata, 1980; Kawabata and Niwa, 1991; Bishop, 1996). This method has been utilized in a great number of studies to demonstrate that there is a correlation between the subjective and objective assessments of cloth hand qualities (Kawabata and Niwa, 1989, Jacobsen *et al.*, 1992, Alimma *et al.*, 2000, Cardello *et al.*, 2003, Mahar *et al.*, 2013). In this manner, the opinions of customers regarding the textiles can be expressed in part by their physical values, which is important for the purpose of enhancing the quality of the product. There has been limited research done to decide whether different age groups should be allowed to use particular fabrics.

The ultimate goal of the current study was to provide the essential information to design fabrics that people of retirement age will find appealing and comfortable, through the use of sensory analysis to understand the attitudes and opinions of the elderly on the quality of the different types of fabric and to integrate this information with the data obtained from an instrumental analysis (KES-F).

Materials and Methods

Participants

The 40 subjects who participated in the experiments were elderly Thai women aged between 60 and 78 years. One-half of the subjects had graduated with a bachelor's degree or higher and 26 had retired from work.

Materials

In total, 28 fabric samples (Figure 1) were collected from a garment textile market in Thailand based on various fiber materials, fabric structures, yarn densities, thicknesses, and weights. The specifications of all the fabrics are shown in Table 1. Most of these fabrics were made from cotton yarn, 7 fabrics were made from polyester, 3 from linen, 1 from silk, and 3 fabrics were blended with 2 different fiber materials (cotton/polyester and rayon/silk). Most fabrics were woven, 4 were knitted, and 1 was lace.

Procedure

In-depth Interview. In total, 40 elderly Thai woman participated in individual in-depth interviews. The interview was divided into 3 parts. The first part was about their demographics and lifestyle. The second part was about their purchasing

behavior relating to clothing, such as the top-three factors influencing their purchasing decision, their favorite clothes and brands and why they preferred those brands, different types of fiber materials, fabric requirements, and changed purchasing behavior during the COVID-19 pandemic. In the final part of the interview, the participants were asked about their attitudes and opinions on the components of good quality in a fabric for well-being and the fabric characteristics appropriate for different types of clothes (sleeping wear, loungewear, casual wear, business professional wear, and formal evening wear). All interviews were recorded for analysis.

The use of human subjects for sensory analysis in this research was approved by The Kasetsart University Research Ethics Committee, which requires any relevant research to be carried out in compliance with the international guidelines for human research protection as stated in the Helsinki Declaration, the Belmont Report, CIOMS Guidelines, the International Conference on Harmonization in Good Clinical Practice (ICH-GCP), and 45CFR 46.101(b) (KUREC-SS64/191).

Free sorting task. The 28 fabric samples were simultaneously exhibited on a table in a random order to the participants. The consumers were asked to arrange the fabrics into groups based on their perceived similarities (Figure 2) with no criteria provided. They were free to decide the number of groups and the number of fabrics they assigned to each group (Phoophat *et al.*, 2018).

Descriptive task. Once the participants had completed the sorting task, they were asked to provide 3-5 descriptive words describing their perceived emotions for each group of fabrics regarding fabric appearance, texture, or touch on feeling (Figure 2).

Matching task. The participants were asked to match each fabric group they had made with the appropriate clothing types (sleeping wear, loungewear, casual wear, business professional wear, formal evening wear, or any applications they thought were appropriate), as shown in Figure 2 (Phoophat, *et al.*, 2019).

Analysis

The interview recordings were transcribed. The qualitative data were analyzed using content analysis. Then, the frequency usage of each word was counted and presented as a percentage.



Figures 1. Scanned image of the fabric samples

Table 1. Sample specifications

Sample	Fiber Type	Structure	Thickness (mm)	Weight (gsm)	Warp/ Course	Weft/ Wale
F01	Cotton	woven	0.650	64.967	117	78
F02	Cotton	woven	0.777	348.883	64	120
F03	Polyester	woven	0.545	54.500	159	100
F04	Cotton	woven	0.288	28.833	67	59
F05	Linen	woven	0.485	48.533	28	42
F06	Linen	woven	0.333	33.333	37	65
F07	Linen	woven	0.332	200.380	57	44
F08	Cotton/ Polyester	woven	0.777	243.893	100	87
F09	Cotton	woven	0.667	331.557	172	41
F10	Polyester	woven	0.228	96.283	109	264
F11	Cotton	knitted	0.549	181.100	40	65
F12	Cotton	woven	0.331	175.230	52	58
F13	Cotton	woven	0.352	229.627	152	90
F14	Polyester	knitted	0.550	156.743	40	50
F15	Cotton	knitted	0.648	224.650	45	45
F16	Cotton	woven	0.239	128.797	119	201
F17	Cotton	woven	0.398	39.767	129	85
F18	Cotton	woven	0.457	267.830	149	66
F19	Cotton/ Polyester	woven	0.774	313.740	86	48
F20	Cotton	woven	0.431	43.067	151	198
F21	Cotton	woven	0.358	35.767	104	43
F22	Cotton	woven	0.219	21.867	63	50
F23	Rayon/ Silk	woven	0.241	24.067	119	124
F24	Silk	woven	0.310	166.747	92	42
F25	Polyester	woven	0.126	72.560	66	122
F26	Polyester	woven	0.379	165.840	156	73
F27	Polyester	lace	0.549	146.103	n/a	n/a
F28	Polyester	knitted	0.839	271.950	27	45

The data from the sorting task were analyzed using the distatis function from XLSTAT 2022 program by Lumivero. The free sorting task included correspondence analysis and multiple correspondence analysis with hierarchical cluster analysis. Figure 3 shows the flowchart of analysis for the free sorting task. First, each participant's results were encoded in an individual co-occurrence matrix, where the 28 fabrics were arranged in columns and rows. A value of 1 at an intersection indicated that these two fabrics belonged to the same group, whereas a value of 0 indicated that they belonged to different groups. Then, the individual co-occurrence matrices for each subject were summed to create a single similarity matrix, which was then converted into a distance matrix by subtracting each element from the total number of subjects. Third, sorting task data analysis was performed on the distance matrix using the XLSTAT package to draw a map of the fabrics based on perceptual distances, where a great distance between fabrics on the map represented dissimilarity between those fabrics, while a small distance between fabrics indicated similarity.

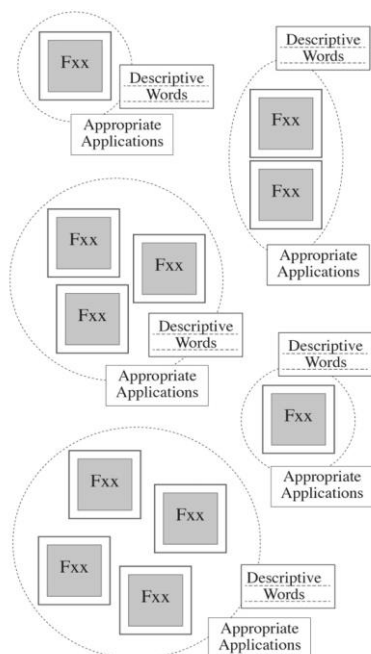
The frequency of each descriptive word that was freely verbalized regarding each group of fabrics was counted, and a contingency table was created with the 28 fabrics as the columns and the descriptive words as the rows.

Results and Discussion

Elderly women's clothing purchasing behavior and their perspectives regarding fabrics

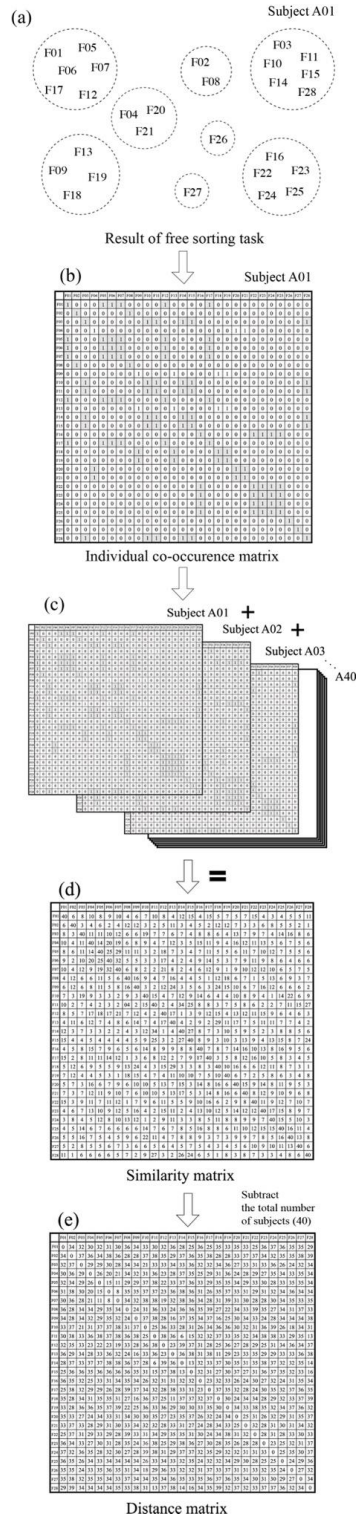
The results of the interview data showed that the elderly women prioritized price, hand feel of fabric, apparel pattern design, comfort, and color, respectively, as the factors considered in clothing purchase decision-making. They preferred to shop at a department store, flea market, or via an online market. Majority of participants (70%) made a purchase decision on their own, and the remaining (30%) were influenced by others, such as, their children, husband, siblings, or friends. The fiber materials made for clothes that they usually wore and bought for sewing were cotton (43%), linen (12%), and silk (12%), which were all natural fibers.

The preferences for fabric and clothes among older individuals changed from when they were young. As they aged, they preferred more comfortable, casual, basic, and good-looking clothing in neutral colors. Sixty percent of the elderly thought that the COVID-19 pandemic had had an impact on purchasing behavior. They had



Figures 2. Schematic illustration of free sorting task combined with descriptive task and matching task

reduced the number of purchases because most of time they had remained at home, though some of them had started shopping online.



Figures 3. Analysis flow chart for free sorting task

The characteristics of fabrics that the elderly women preferred were breathability (30%), light and easy to drape (18%), soft (17%), elastic and wrinkle resistant (11%), and not too tight that it was uncomfortable (9%), respectively. This was in accordance with their attitudes toward the components of good quality in a fabric for well-being.

The fabric characteristic requirements of different types of clothes were investigated. Elderly people need soft, breathable, stretchy, and lightweight fabric for their sleeping and loungewear, which may be made of cotton. They require stretchy, soft, breathable fabric for casual clothing, such as that seen in t-shirts and jeans. They favor shirts and slacks that are comfortable, stretchy, and may be made of cotton for business professional wear. For formal evening wear, they prefer to wear lace or silk.

Sensory perception of fabrics by the elderly

The sensory perception of several types of fabric used to make clothing for elderly people was investigated through a free sorting task. A distance matrix (Figure 4.) was created using the sorting results, where a lighter yellow indicated that the distance between the two fabrics was closer, while a darker blue indicated that they were distinct. Consistent patterns along the columns or rows in the heat map suggested that these fabrics were more alike than to other fabrics. In this regard, we discovered several fabric groups that were remarkably related, for example, F05/F06/F07 (woven fabrics made of linen fiber) and F09/F13/F18 (woven fabrics made of cotton fiber), as opposed to F11/F14/F15/F28 (knitted fabrics); however, they are all made of cotton and polyester. This finding suggested that the elderly people categorized fabric similarities based on fabric structures and fiber materials.

Validation of clear groupings was carried out based on sorting task data analysis on the distance matrix to provide a two-dimensional map with perceptual distances. The sorting task could be divided into 6 groups. The two largest groups in the middle of the map were woven fabrics. The left group was comprised of fabrics made of linen fiber (F05, F06, and F07), cotton fiber (F04, F12, and F20), silk fiber (F24), blended silk/rayon (F23), and polyester (F25). Thickness and weight in this group were in the ranges 0.126–0.485 mm and 24.07–200.40 gsm, respectively. Except for F20 and F23, the yarn density was loose for both the warp and weft. The right group in the middle comprises of fabrics made of cotton fiber (F01, F16, F17, F21 and F22) and polyester (F03, F10, and F26) with

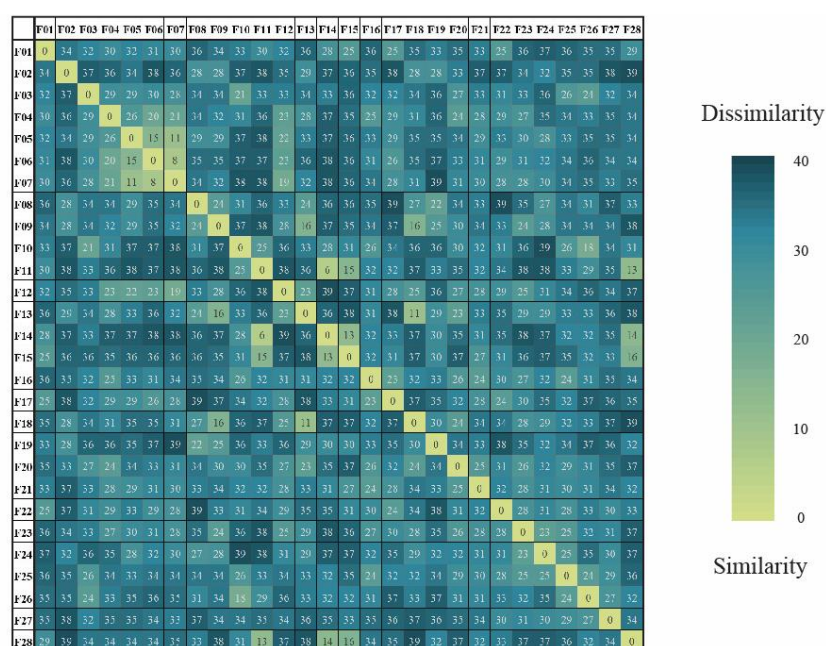
a thickness range of 0.219 to 0.650 mm and weighs between 21.87 to 165.80 gsm. These fabrics have a high density due to the number of ends and picks, except for F22 which had low density in both warp and weft. In the upper-right quadrant, the knitted fabrics (F11, F14, F15, and F28) were grouped into a distinct cluster. In the upper-left quadrant, the thick and heavy woven fabrics formed another cluster with thickness and weight in the ranges 0.352-0.777 mm and 229.6-331.60 gsm. This group of fabrics consisted of cotton fiber fabrics (F09, F13, and F18) and cotton/polyester blended fabrics (F08 and F19), with a high density in the warp direction. The fabrics F02 and F27 were separate from the other groups. Compared to the other fabrics, F02, a three-layered woven fabric, was the thickest and heaviest. F27, a lace fabric, had a distinctive appearance.

Association among fabrics, descriptive words, and appropriate apparels.

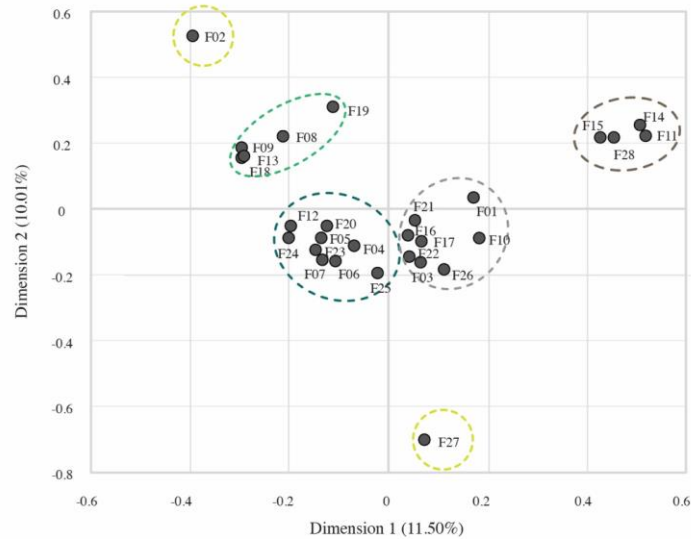
After the sorting task, the participants were asked to describe each category of fabrics. In total, 215 words were generated by all participants to describe the fabric categories. The 23 descriptive words that were cited more than 50 times in total were used to create a contingency table with the words as rows and the fabrics as columns. A contingency table should reveal patterns along the fabric columns if they are related with the same group of words. The suggested groups of fabrics were supported by a balloon plot of the contingency table (Figure 5). For example, F08, F09, F13, F18,

and F19 had a similar pattern associated with words such as 'thick', 'warm', and 'stiff' whereas F11, F14, F15, and F28 exhibited a different pattern associated with words such as 'soft', 'elastic', 'comfort', and 'smooth'.

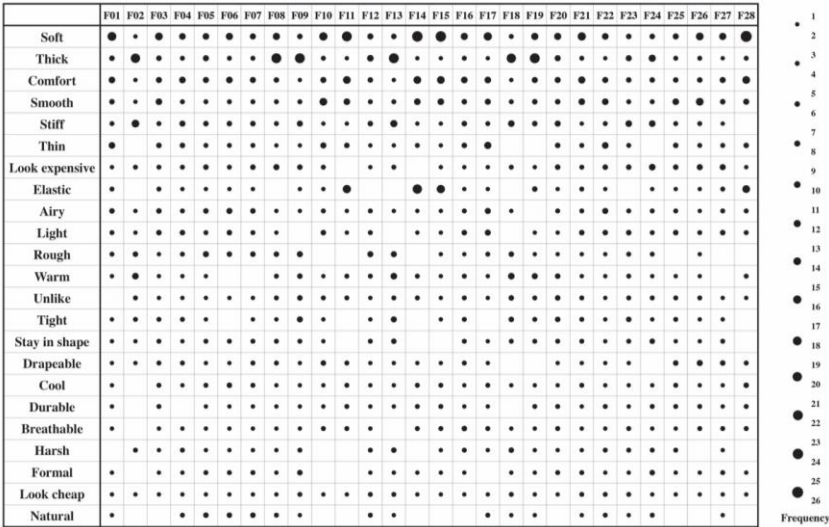
The sorting and descriptive task were followed by a matching task. Participants were asked to match each fabric group they had made with the types of clothing they considered it would be appropriate for. The frequency data were used to form a contingency table with the clothing type as rows and the fabrics as columns shown as a balloon plot in Figure 7. The stronger the relation between fabrics and clothing types, the larger the balloon. For sleeping wear, it demonstrates a strong correlation with fabrics F28, F14, and F11 which they are all knitted fabrics related with the descriptive words 'soft', 'elastic', 'comfort', and 'smooth' (Figure 6). For loungewear, it shows a high relation with fabrics F06 and F07 which they are fabrics made of linen related with the descriptive words 'soft', 'comfort', 'airy', 'natural', and 'stiff'. The relationship between fabrics and casual wear was not well demonstrated. For business professional wear, it shows a high association with fabrics F24 (silk), F05 (linen), and F09 (cotton) which related with the descriptive words 'thick', 'stiff', and 'look expensive. The last, formal evening has a high relation with fabrics F27 and F24 related with the similar words that is 'look expensive'.



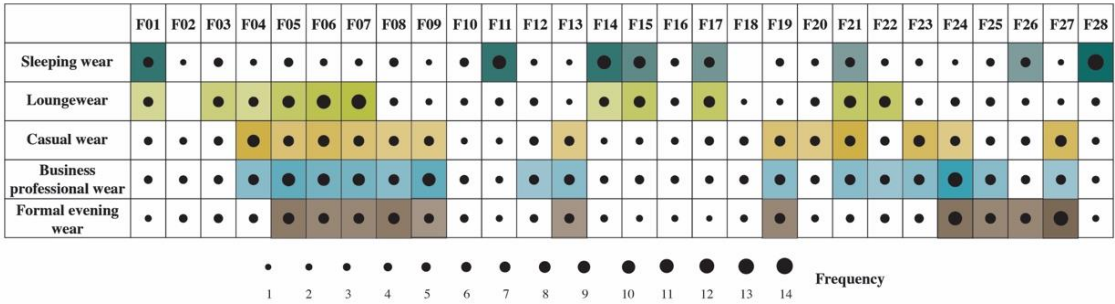
Figures 4. Distance matrix developed from free sorting task



Figures 5. Two-dimensional perceptual distance map from sorting task data analysis



Figures 6. Contingency table balloon plot between descriptive words and fabrics



Figures 7. Balloon plot of contingency table relating types of clothing and fabrics

Conclusions

Sensorial comfort, breathability, and softness were considered important components of good quality in fabric for well-being from the elderly's perspective. However, the elderly still sought different fabric properties in what they would wear on different occasions. The major findings indicated that the 28 fabric samples could be classified into 6 groups, with fabric samples that were appropriate for lounge wear should be soft and airy to feel comfortable. The elderly people looked for thick, stiff fabrics for business professional wear and formal evening wear since these properties were related to luxurious and expensive clothing. Sleeping wear was preferred if it was soft and stretched to be comfortable during the night. This was a crucial piece of information, since apart from eating properly, having enough, good quality sleep was important to the health of the elderly and significantly affected their well-being.

The findings from this research could provide guidelines for designing and manufacturing fabrics with characteristics that matched with the demands of the elderly, as well as identifying the types of fabric to use in clothing that suited different occasions.

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