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Evaluation on an ergonomic design of functional clothing for wheelchair users

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ABSTRACT

Researchers have pointed out that people with physical disabilities find it difficult to obtain suitable clothing. In this study a set of wheelchair user oriented functional clothing was designed. Attention was paid to the wheelchair users' daily living activities related with clothing. An evaluating system combined with sports tournament and rehabilitation medicine was introduced to assess the new designed clothing. Six wheelchair users (3 males and 3 females) were invited to wear the clothing. A set of normal functional clothing was employed as a comparison (Control). The time required to complete three different daily living activities, i.e. dressing and undressing, going to toilet and bathing were recorded. Results showed that with the new clothing wheelchair users' competence of managing toilet was increased by 52.9%. The time needed for toilet was reduced by 45.7%. Their capability of managing dressing and undressing was improved by 24.6%. The study indicated that the newly designed clothing could facilitate wheelchair users' daily living activities related with clothing.

1. Introduction

People with physical disabilities either due to chronic sickness or aging or some other reasons have to spend a large part of time in a seated posture or confined to wheelchairs (Ng et al., 2011). Due to their physical difference with the non-disabled, the physical access issue and the lack of available transport, their participation in daily activity and communication is usually obstructed (Chang et al., 2009; Reid et al., 2001). Even the daily living activities, such as dressing and undressing, are difficult for the disabled and are required to seek the help of others (Kumar, 1997). For those stroke survivors who use wheelchairs, dressing and bathing are the most common self-care problems for them (Reid et al., 2001).

Some researchers have pointed out that people with physical disabilities find it difficult for them to obtain suitable clothing (Thoren, 1997; Chang et al., 2009). Their clothing needs individual adaption. The reason, as is accounted for by Thoren (1997), is that most of the disabled do not fit into the current size system, i.e. their body dimensions differ from those represented in the size system. For the disabled people, anatomical changes will occur, such as their spines curve forward (Ng et al., 2011) and their body heights decrease (Civitci, 2004), either due to the long-time seated posture or aging (a big proportion of disabled people, especially the wheelchair users are the elderly). Also previous studies have compared the anthropometric characteristics of the disabled with the able-bodied and have found the difference between these two groups (Goswami et al., 1987; Lucero-Duarte et al., 2012; Das and Kozey, 1999).

For the disabled people appropriately dressed individuals had bigger chance at job acquisition than those inappropriately dressed persons (Christman and Branson, 1990). Another study has indicated that the redesign of wheelchair users' clothing can help reduce the physical strain and work load of their personal helpers (Nevala et al., 2003). Therefore, it is meaningful and beneficial to design disabled people oriented clothing to meet their physical demand, as well as psychological demand.

In this study, a set of new functional clothing for the wheelchair users were designed. Much attention was paid to their daily living activities, i.e. dressing and undressing, going to toilet and bathing. An evaluating system deriving from rehabilitation medicine and sports tournament was introduced to assess the new functional clothing. It was hypothesized that the newly designed clothing could facilitate the wheelchair users' daily living activities.

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2. Methodology

2.1. Questionnaire programme

Clothing designs should be user oriented to meet the end users' consuming need. It should provide protection and comfort and should offer values such as self-esteem, respectability, status and confidence, etc. (Rosenblad-Wallin, 1985). Hence, questionnaires were distributed to 58 interviewees, including men and women, to know about their needs and preferences on the clothing. They all had an experience of using the wheelchairs. The results of the questionnaire survey were summarized as follows. First, pants with easy dressing and undressing function were required. Second, the location of the joints should be given more design consideration for easy limb movement. Third, soft and water absorbent fabrics with the property of keeping warm were preferred.

2.2. Functional clothing design

Based on the results of the interview, a set of new functional clothing for the wheelchair users was designed (Fig. 1) and attention was paid to the above three requirements. Liners and extra layers were added at the body regions of the head, the lower back and the knee, since these areas need higher insulation to keep warm. The upper clothes had a hood to keep the head warm. At the inner side of the elbow darts were designed and the outside were pleats. This design feature could give the elbow more flexibility to move. Soft and water absorbent knitted fabrics were used for the clothing. Thick polyester woven fabrics were used for the extra layers at the elbow.

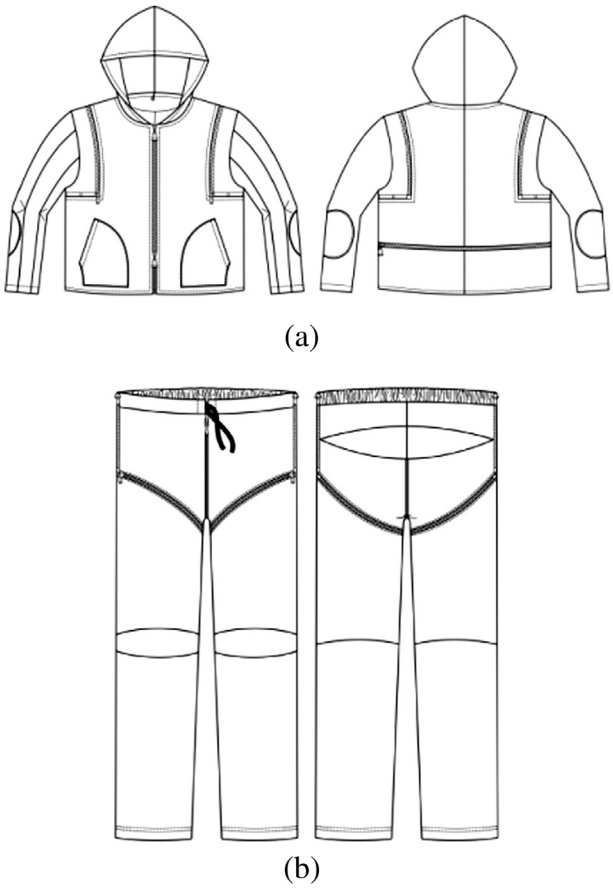

Fig. 1. The design of the new functional clothing. (a) jackets; (b) pants.

In order to facilitate the wheelchair users to go to toilet, a special design of the crotch was made (Fig. 2). Zippers were used to connect the front part of the belly and the back part of the buttocks to make a whole pants. This special design could either be installed or detached to facilitate toileting and cleaning. If a toilet pot was placed under the wheelchair with a special cushion that could be opened into two halves, just open the zippers of the pants, the users could go to toilet without their personal helpers lifting them from the wheelchair.

2.3. The evaluating system

2.3.1. The usage of the degree of difficulty

In sports tournament the degree of difficulty was commonly used for assessing how difficult sports programmes could be completed. One sports programme comprised of several movements and each movement was given a value of difficulty. Then the degree of difficulty of one sports programme was calculated. In the study, the degree of difficulty was introduced for accessing the activities of daily living (ADL). It was calculated according to formula (1):

$$D = \frac{\varepsilon_i}{\sum(\varepsilon_i)} \tag{1}$$

Where, D is the degree of difficulty; ε_i is the value of the difficulty of one movement; $\sum(\varepsilon_i)$ is the value of the difficulty of one activity which includes several movements. It is the sum of the values of all the movements. In the study, the value of difficulty of one movement related with the clothing was obtained by asking the wheelchair users to give values for each movement. The 58 interviewees were invited again for this purpose.

The level of competence of wheelchair users coping with ADL could be calculated as follows:

$$L = D_1 \times k + D_2 \times k + \ldots + D_n \times k \tag{2}$$

Where, L is the value of the competence of coping with the ADL; D_i is the degree of difficulty of one movement; k equals 1 if the wheelchair users can complete the movement by themselves, otherwise it equals 0.

2.3.2. The usage of the modified Barthel index (MBI)

In rehabilitation medicine the competence of the activities of daily living is used for the evaluation of the recovery of the patients. The most commonly used index for evaluating the competence of ADL is Barthel index (BI) and the modified Barthel index (MBI) (Mahoney and Barthel, 1965; Shah et al., 1989). In this study, 5 levels were used for evaluating the competence of the wheelchair users in handling the ADL (Fig. 3).

From Level 1 to Level 5 the wheelchair users had an increasing difficulty in coping with the ADL. Each level was given a value to

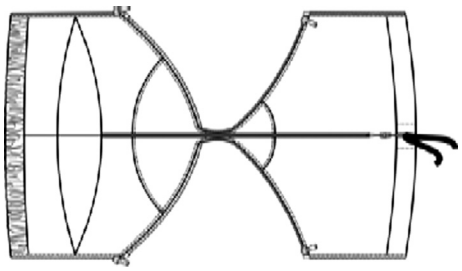

Fig. 2. The special piece of the crotch.