



Addressing Clothing Needs of Ability-Diverse Populations: Development of Guidelines for Designing Inclusive Apparel Products

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Most clothing available in the marketplace is not designed to meet the needs of people living with disabilities (PLWD), thus excluding them as customers (Clarkson et al., 2003). Only a few retailers and brands offer adaptive apparel designed specifically for PLWD or older people who may have difficulty using clothing, such as getting dressed and undressed (Azher et al., 2012). Despite the current success of Tommy Hilfiger's adaptive line (Brinkley, 2016), brands offering adaptive apparel still face challenges to mass-produce and diversify existing products. Even though some companies have been successful in incorporating special design features such as magnetic closures in garment design and production processes (McBee-Black, 2021), these special design features have not been popularized yet because of (a) higher product costs and (b) relatively low demand due to a limited population size with specific disabilities (Carroll & Gross, 2010). As a result, the clothing needs of people with various difficulties using apparel remain largely unmet.

One of the ways to solve this problem is to have clear recommendations for designing inclusive apparel products (Lamb, 2001; Kosinski et al., 2018). Inclusively designed apparel describes clothing that people with diverse abilities can use; in other words, clothing with extended usability includes people with difficulties using the products (Cho & Karpova, 2021). Inclusive design features make apparel easier to use by everyone, regardless of their capabilities (Carroll & Gross, 2010). The **purpose of this concept paper** was to develop guidelines for designing inclusive apparel products that accommodate the clothing needs of ability-diverse populations.

Inclusive Apparel Design Framework. Inclusive design principles offer a comprehensive approach for designers to (a) identify population segments with distinct capabilities and their specific product needs and (b) choose appropriate design strategies to meet the needs of people with different types and levels of difficulty using the product (Clarkson et al., 2007). Cho and Karpova (2021) proposed an Inclusive Apparel Design (IAD) framework that focuses on the three types of capabilities directly applicable to the use of apparel products: (a) reach, (b) dexterity, and (c) mobility. Reach capability refers to using arms and hands (Waller et al., 2013). Dexterity defines fine motor skills as smaller movements in the wrists, hands, and fingers (Clarkson et al., 2007). Mobility refers to the ability to move around in the environment (Waller et al., 2013). For each of the three capabilities (reach, dexterity, and mobility), the framework distinguishes between the three levels of difficulties using apparel: (a) minimal; (b) moderate; and (c) severe. In this research, the IAD framework was applied to develop guidelines for designing inclusive apparel that ability-diverse populations can use.

Method. The guidelines for designing inclusive apparel were developed based on an extensive review of scholarly literature and an analysis of best industry practices. A comprehensive review of the literature included dozens of studies on clothing for people with any special needs, living with disabilities, and older populations. Analysis of best industry practices examined trade publications and websites of brands offering adaptive lines. Systematic analysis of product images and descriptions was conducted for brands such as ABL denim, Adaptations by Adrian, Chairmelotte Wheelchair Couture, Able 2 Wear, Rollitex, and Tommy Adaptive.

Our study focused on garments for the lower part of the body (down from the waistline), such as pants, shorts, and skirts. Scholars have developed design recommendations for tops intended for people with different disabilities (Cho & Morris, 2018; Shin & Chun, 2011). However, no study focused on bottoms. First, we applied the IAD framework and Inclusive Design Toolkit (Clarkson et al., 2007; Waller et al., 2013) to the context of apparel products focusing on reach, dexterity, and mobility, which determine motions necessary for donning/doffing as well as using garment functional elements (e.g., pocket). The three capabilities were analyzed to provide specific guidelines for designing inclusive apparel for ability-diverse populations. Next, building on previous research (e.g., Huck & Bonhotal, 1997; Tullio-Pow, 2016) and best industry practices, we developed guidelines for the use and placement of garment construction features for each of the three capabilities at the three levels of difficulty using apparel: (a) minimal, (b) moderate, and (c) severe.

Guidelines for Designing Inclusive Apparel Products.

Reach capability determines the ease of accessing functional garment features (such as closures) and the ease of donning and doffing (Carroll & Gross, 2010). The proposed guidelines reflect the capabilities of reaching down, to the side, and the back for the three difficulty levels (minimal, moderate, and severe). The guidelines include instructions for placing design features (e.g., closures or pockets), taking into account: (a) the wearer's "optimum grip area" (Sperling & Karlsson, 1989, p. 100); (b) the maximum reach range (Klopčar et al., 2007); and (c) the exertion required to operate a closure (Watkins & Dunne, 2015). Specific requirements for different closures to ensure easy access are developed for the three levels of reach difficulty (minimal, moderate, and severe).

Dexterity capability determines the ease of manipulating functional garment features such as closures (Watkins & Dunne, 2015). To operate zippers or buttons, individuals use small muscles to coordinate the movement of hands and fingers. Design considerations related to the ease of using closures are (a) size and roughness; (b) level of protrusion; and (c) ease of manipulation. Together, these characteristics determine the ease of grasping, squeezing, holding, and manipulating closures and other design features by people with different levels of dexterity difficulty. The proposed guidelines include specific recommendations for selecting the types and sizes of closures to extend the garment usability to people with the three levels of dexterity difficulty (minimal, moderate, and severe).

Mobility capability is one's ability to move around (Waller et al., 2013). For people with limited mobility, especially those using wheelchairs, the garment's ability to expand and contract is critical to increasing the ease of movement and the comfort of a garment (Watkins & Dunne, 2015). Design considerations related to the different levels of mobility include: (a) using stretchable fabric; (b) increasing garment ease; (c) adding expandable design features; and (d) adding slits or additional closures to the waist and/or leg openings. The proposed guidelines include specific recommendations for selecting types of fabric, adjusting the amount of ease, and utilizing special design features (such as tucks, pleats, stretchable inserts, or placements of additional closures) to account for the three levels of mobility difficulty (minimal, moderate, and severe).

Conclusions. This is the first study that utilized inclusive design principles to develop guidelines to design inclusive apparel for the lower part of the body (bottoms). These guidelines provide a clear sequence and principles for designers and manufacturers to design inclusive apparel. They can be used to develop new or evaluate existing apparel products to determine which populations are included or excluded when different design features are used. Applying these guidelines will extend garment usability to populations with different levels of reach, dexterity, and mobility, thus responding to diverse user needs.

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