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Ergonomic Design of Shoes for People with Lower Limb Disability ⋆

Piao-Piao Liu, Hai-Qiao Huang*

Beijing Institute of Fashion Technology, No.2 Yinghua Road Chaoyang District, Beijing 100029, China

Abstract

Based on ergonomics, this paper analyzes the foot structure, physiological and psychological needs of people with lower limb disability, and applies the concept of ergonomics to design, so as to optimize the functionality of shoes in terms of easy wear (putting clothes on and off), comfort, stability and protection. The ergonomic design scheme presented in this paper could provide shoes for them that conform to their foot structure and behavior characteristics, which are really comfortable and healthy. At the same time, it can also provide a more efficient and feasible design direction for the market, which has certain value for the further in-depth development and application.

Keywords: Ergonomic Design; Lower Limb Disability; Comfort; Shoes

1 Background

1.1 Current Situation of People with Physically Disability in China

The total number of people with disability exceeds 85 million, accounting for 6.34% of the Chinese population. About 29% of them are physically disabled [1]. Physical disability refers to the motor function loss caused by limb deformity, paralysis or restricted movement. The main causes of it are congenital (including heredity, close relatives, developmental malformation, etc.), trauma (including work injury, traffic accident, war injury and other trauma), disease (including spinal cord injury, poliomyelitis, pediatric cerebral palsy, paraplegia, cerebral palsy, tuberculous infection, etc.), and other (unknown cause) [2, 3].

Physical disability can be divided into upper extremity disability (18.43%), lower extremity disability (45.61%), trunk disability (11.43%) and compound disability (24.53%) according to the

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*Corresponding author.
Email address: fzyhhq@bift.edu.cn (Hai-Qiao Huang).

body parts of disability. Fig. 1 shows the proportion of people with different physical disabilities in China.

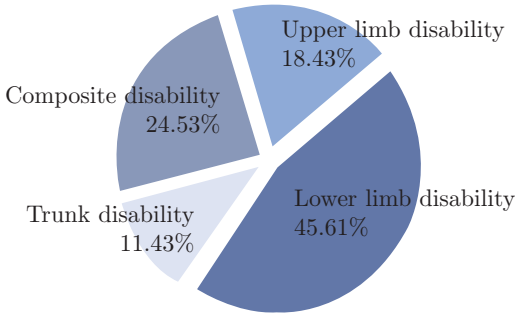

Fig. 1: The proportion of people with different physical disabilities in China

As we can see, lower limb disability accounts for the largest proportion of physical disability. The common mobility tools for people with physical disability include: wheelchair, crutches, artificial limbs, and orthotics. This paper carried out a research on the shoe needs of people with lower limb disability who often use wheelchairs. In general, wheelchair users are more severely disabled. Some of the people who are more mobile will use the wheelchair with crutches or artificial limbs alternately.

It is estimated that by 2030, China will have an additional 2 million to 2.5 million every year, with an average of 3 new disabled people every 15 to 20 seconds [1]. The increasing number year by year and the rapidly changing social structure put forward urgent requirements for improving the quality of life and public services of people with physical disability.

1.2 Insufficiency of Current Shoes

Compared with the good development of construction and industry, there is a big gap in clothing market for people with disability. At present, the research and development of their clothing is still at the initial stage, and there is a lack of relevant standards and information for shoes of them such as foot size standards.

After having conducted domestic and foreign market research, it was found that there have been some tentative designs. However, the current available shoes for them are almost all designed with two or three pieces opening. Besides most of them use thin fabric and only use magic straps for fastening. To a certain extent these products could solve the problem of putting on and off. Nonetheless, the overall design lacks functionality as well as innovation in terms of aesthetics, making it thus incapable of meeting the basic psychological needs in pursuing of beauty for people who have a lower limb disability.

Many shoes designed for them seem to solve their physiological problems, but, in fact, some are too complicated to use and the deliberate design can lead to other problems during the use. Others can also be too mechanical making it harder to integrate them into daily life, which is unexpected and increases the psychological barriers. Hence the shoe design for them necessitates further improvements in many aspects.

There are differences in physiological conditions among groups with different categories of disability. Differences are also detected in terms of data collected from each dimension of human