Improving Pant Fit among Young Chinese Consumers: Evidence from Female College Students in Hangzhou, China

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Background and Purpose. Garment pattern-making, known as garment structure design, is based on the body's shape. Thus, accurate body shape analysis is a critical prerequisite to ensure garment pattern-making meets the wearer's requirements for fit. The current Chinese National Standard Size system for women's clothing (GB/1335.2-2008) is based on the results of large-scale national survey of body measurements taken from 1985 to 1987 (Zhou, Ou, & Chen, 2006; Wang, Chen, & Xu, 2010), and includes four body type categories: *Y* body type (the chest-waist difference > 19cm), *A* body type (14cm < the chest-waist difference < 18cm), *B* body type (9cm < the chest-waist difference < 13cm), and *C* body type (the chest-waist difference < 8cm). The percentages of these four categories are 14.8%, 44.1%, 33.7%, 6.5% respectively across China. However, this sizing system exhibits several limitations. First, with significant lifestyle changes in China, Chinese body shapes and measurement sizes have changed accordingly. A study comparing the somatotype characteristics of Chinese urban Han residents between 1979 and 2013 showed that the Manou Riers Skelic Index of females increased by 1.2 and the Acromio-cristal Index increased by 1.5 (Tu et al, 2018). Thus, the lower limbs became longer and the width gap between upper and lower trunks became narrower during the last two decades. Second, there is a large age span, ranging from 13-60 years old, without separating young and middle-aged women. This limits the effectiveness and relevance of the standard size system because the body characteristics of young women are quite different from the sizes listed in the national standard. He et al. (2018) divided a body shape sample of 110 female college students aged 18-25 in Tianjin into three body types by the K-means clustering method, including standard-size, H body type (over-size) and Y body type (extra-small). Among them, the Y body type accounted for 30.8%, much higher than the distribution of Y body type in the national standard, which is 15.2%. Niu et al. (2019) conducted a body shape analysis of young women in Henan province, China, and found that 26.4% of samples were underweight (BMI < 18.5) and the Y body type accounted for 20% more than the national standard.

Research suggests that the most obvious differences between young women and older women were the waist and hip shapes. For instance, Zhang, Guo, and Liu (2019) compared the waist and hip shapes between young women aged 18-25 and middle-aged women 30-45 years old in Zhejiang and Jiangsu, two provinces located in southeastern China. Their study found that for middle-aged women, the waist was thicker; the internal concave curve of the posterior waist was

not obvious, and the hip convex angle was smaller than young women. As the A and B body types (normally middle-aged women have) accounted for 77.9% in the national standard size system, only a small number of companies offer sizing for the Y body type (He & Zhang, 2007). Therefore, a lot of garments, especially pants, do not meet the requirements of comfort and fit for young females with the Y body type (Chen, Hu, & Zhao, 2009). To fill this gap, the purpose of this study was to investigate young females' fit issues with pants.

Method and Results. Three studies were conducted to address the research purpose. In Study 1, a survey was conducted to investigate the body types of female college students in Hangzhou, Zhejiang, China, and their fit problems with pants. A sample of 258 participants aged 18-25 was selected from college students in Hangzhou. The results showed that 36.4% of survey participants were underweight (BMI < 18.5) and 24.8% had a Y body type. Furthermore, in terms of fit preferences for pants, frequency statistical analysis of the 58 students, who were underweight and had Y body type, revealed that 65.5% were willing to buy fitted pants. Analysis of the open-ended question, "What is the biggest fit problem of your most recently purchased pants?", shows that the main fit problems for pants were too loose at the waist and too tight at the hip and thigh.

In Study 2, a total of 78 female college students (18-25 years old) from different universities in Hangzhou, Zhejiang, China participated. Data was obtained by the BOSS-21 body scanning system. All respondents met the requirements of being underweight (BMI < 18.5) and having the Y body type. 23 measurement items were used, including 6 height items (height, waist height, hip height, straight body rise, knee height, and back neck height), 3 length items (length of upper arm, lower arm, and thigh), 3 width items (depth of waist, hip, and abdomen) and 11 circumference items (neck girth, shoulder length, back width, and girth of chest, waist, hip, abdominal, thigh, knee, calf, and ankle). Measurements were based on the Chinese national standard of Basic Human Body Measurements for Technological Design (GB/T 5703-2010). The results of the one-sample Kolmogorov-Smirnov test and Normal P-P plot showed that all measurement data were normally distributed, thus the normality assumption was met. To detect relationships between the measurement items, correlation analysis and linear regression analysis were used. Results indicate that height had high association with the other 5 height items ($P < 0.01$); thigh length, upper arm length, lower arm length, and chest girth have high association with neck girth, shoulder length, back width, waist girth, and hip girth ($P < 0.01$). Moreover, waist girth had high association with hip girth, abdominal girth, thigh girth, and knee girth ($P < 0.01$), and association with calf girth, ankle girth, waist depth, hip depth, and abdominal depth ($P < 0.05$). Multiple linear regression analysis was performed and used to calculate the sizes for building the virtual model in Study 3.

In Study 3, 3D simulation technology was introduced to create 3D views of the virtual model. CLO 5.0 software was used to build the virtual model and check fit of the patterns. Mean values of height (160cm), chest girth (80.5cm), and waist girth (60.5cm) obtained from Study 2 were used for building a virtual model using CLO 5.0. Pants were produced using patterns following the basic methods for Y body type using the Chinese National Standard Size data (Liu, 2008) and fit the patterns to the virtual model in the simulation. The tension map displayed points and areas of

pressure applied by the garment on the avatar. The information gathered in the 3D simulation process revealed fit problems in the waist and crotch areas, enabling pattern modifications to improve the overall fit.

Conclusion. This research examined fit issues among Y body type young consumers using data collected from female students in Hangzhou, China. Findings show that these females are thinner and account for a higher percentage than reflected in the Chinese National Standard Size system. The research highlights an urgent need for updates to the system so that it reflects current female consumer body types, and for apparel firms to adjust patterns to produce better fitting products.

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