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Classification and Regression Modelling of Abdominal Convexity Morphology in Middle-aged and Elderly Women

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Abstract

Abdominal protrusion is increasingly common among middle-aged and elderly women, and the current standard sizing system fails to properly their body shape change. To improve the classification of abdominal bulge morphology in middle-aged and elderly women and enhance the garment fit, this paper screened 133 samples with abdominal bulge among 165 Chinese women aged 50-59 years old based on 3D anthropometric techniques and obtained abdominal morphological dimensions. Five main morphology parameters affecting abdominal convexity were summarized, and the abdominal morphology was classified into four types for simulation. The abdominal regression models and girth fitting models were established and validated by combining the feature indexes related to pants. Results showed that each abdominal convexity type has obvious and specific clustering characteristics, and the regression models are valid and practical for personalized clothing development.

Keywords: Body Classification; Abdominal Convexity; Middle-aged and Elderly Women; Shape parameter; Regression Modelling; Cluster Analysis

1 Introduction

Various factors such as age, heredity and environment affect women's body shape, resulting in body deformation and specific body types [1]. It has been found that abdominal convexity is common among middle-aged and elderly women and affects garment fit [2]. However, China's standard sizing system does not reflect their body type characteristics [3]. The body type and garment aspects of middle-aged and elderly women have been studied at home and abroad. Some scholars have studied their body shape pattern and classification to systematically revise the current size standards [4-6]. There are also comparative studies on middle-aged and elderly body shapes that revealed the abdomen begins to protrude and the back curves with age, waist, abdominal and increase in hip circumferences [7-9]. The design and structural optimization of

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special body garments have also been studied using innovative techniques such as digital correction and surface flattening to meet the needs of middle-aged and elderly groups [10-14]. But fewer studies are focusing on the abdominal convexity morphology of middle-aged and elderly women, and the characterization and classification studies need to be further improved.

In this paper, we conducted body measurement experiments. The abdominal convexity samples were collected from Chinese women aged 50 to 59. The main abdominal feature parameters were obtained through morphological analysis to explore the abdominal convexity morphological classification rules of middle-aged and elderly women. Regression models based on abdominal bulge characteristics were established, which can provide data references for developing personalized clothing for middle-aged and elderly women.

2 Methodology

2.1 Body Measuring Experiments

This experiment randomly selected 165 middle-aged and elderly women aged 50 to 59 years for body shape data collection and statistics, mainly using the Anthroscan 3D body scanner with manual measurements. 3D data can be used to acquire the length, circumference, area etc of the human body [15]. The sample 3D point cloud data were denoised and reduced using Geomagic Studio software, and then measured for waist, abdominal and hip dimensions that mainly affect the shape of the abdominal convexity. 23 measurements containing height, circumference, width and other feature parameters were obtained, and derived variables such as waist sagittal transverse diameter ratio were calculated, as shown in Table 1 and Fig. 1.

Table 1: Measurement items

Parameter indicators	Detailed Measurement Items
Height (cm)	Height (H), Waist height (W_H), Abdominal convexity height (AC_H), Hip height (H_H), Height between abdominal convexity and waistline (W_H-AC_H), Height between abdominal convexity and hipline (AC_H-H_H)
Circumference (cm)	Bust (B), Waist (W), Hip (H_C), Abdominal circumference (A_C), Anterior abdominal circumference (AA_C)
Depth (cm)	Waist depth (W_D), Hip depth (H_D), Abdominal depth (A_D), Anterior abdominal depth (AA_D)
Width (cm)	Waist width (W_W), Hip width (H_W), Abdominal width (A_W)
Length (cm)	Crotch length (C_L), Front crotch length (FC_L), Rear crotch length (RC_L)
Angle (°)	Upper ventral convex angles (UV_A), Lower ventral convex angles (LV_A)
Derived variables	Waist sagittal transverse diameter ratio ($W_R = W_D/W_W$), Abdominal sagittal transverse diameter ratio ($A_R = A_D/A_W$), Hip sagittal transverse diameter ratio ($H_R = H_D/H_W$), Abdominal convex height ratio ($AH_R = W_H$-AC_H/AC_H-H_H)