Misconceptions and Satisfaction in Female Body Shapes: Utilizing Supervised Machine Learning Algorithms for Identifying Body Shapes

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Background and Purpose

Fit and size are among the most important criteria to evaluate when purchasing apparel (Hsu & Burns, 2002). Given the restricted range of sizes in the ready-to-wear market, the integration of body shape classification with pattern making and sizing systems has been employed to enhance the overall fit of apparel (Armstrong, 2010; Simmons, 2003). Accurate knowledge of body shape benefits both consumers and manufacturers by reducing return rates in online commerce. Given the dynamic nature of human body shape and average body mass index for adults (Ashdown & Loker, 2010; Ogden et al., 2004), an updated and versatile sizing system becomes imperative. The current study seeks to classify the body shapes of young female adults using the latest anthropometric data and explore their perceptions of their own bodies. The specific research objectives are twofold: a) developing a predictive model for female body shapes and b) examining the association between body satisfaction, body shape misconceptions, and body mass index (BMI).

Analysis Methods

To begin, a predictive model for assessing fit levels was established using three distinct machine learning algorithms—Multinomial Logistic Regression (MLR), Random Forest (RF), and Support Vector Machine (SVM)—within the R. Training of the models were conducted on 80% of the SizeUSA dataset, which comprises body measurements of 6,300 female subjects and categorized into eight body shapes using the Female Figure Identification Technique (FFIT©) (Simmons et al., 2004). Subsequently, the performance of each machine learning model was rigorously tested and compared using the remaining 20% of the SizeUSA data to identify the most robust predictive model, as outlined by Gholamy et al. (2018). The selected predictive model was then applied to objectively assess body shapes in a new dataset collected by researchers from 212 female subjects, utilizing a Sizestream body scanner. Post each body scan, participants provided responses to questionnaires related to both subjectively perceived body shapes and overall body satisfaction, following the framework established by Avalos et al. (2005). A 7-point Likert-type scale, ranging from strongly disagree (1) to strongly agree (7), was employed for participant responses. The research data underwent comprehensive analysis to unravel the intricate relationships among body satisfaction, objective and subjective body shapes, and Body Mass Index (BMI).

Results and Discussions

The machine learning models demonstrated varying levels of accuracy, with the MLR model achieving the highest average prediction accuracy at 80.1% for female body shape prediction. Following closely were the RF model with 72.7% accuracy and the SVM model with 71.8%. Consequently, the MLR model was chosen for further exploration in identifying body shapes within the new dataset of 212 subjects. Utilizing the MLR model, the resulting body shapes were classified into four categories: Rectangle (n=120), Triangle (n=66), Inverted Triangle (n=23), and Unclassified (n=3). The MLR model also provided insights into the relative weight of independent variables, highlighting significant predictors for classification outcomes. Key contributors included circumferences of the bust, waist, high hip, hips, and thigh. Additionally, several other determinants exerted a significant influence on female body shape prediction, such as total crotch length, outside leg contour from waist to the floor, and vertical length from the cervical to the center-back waist.

A modest alignment of less than 30% was noted between objective and perceived body shapes (n=57). A one-way ANOVA revealed that there was a statistically significant difference in body satisfaction between objective body shape groups ($F(3, 207) = [8.97]$, $p = 0.0001$), subjective body shape groups ($F(4, 209) = [6.20]$, $p = 0.0001$) and BMI groups ($F(3, 210) = [11.83]$, $p = 0.0001$). Intriguingly, a majority of participants consistently categorized with either Rectangle (n=27) or Triangle (n=29) shapes demonstrated higher body satisfaction scores (M=5.06, SD=1.04) than those with incongruent body shape results (M=4.72, SD=1.48). In the context of objective body shape classifications, it was observed that individuals with Triangle and Rectangle body shapes exhibited greater satisfaction with their bodies compared to those with an Inverted Triangle shape. Participants identifying their body shapes as Oval displayed notably lower satisfaction levels.

Conclusions

The research findings show the effectiveness of creating a predictive model and identifying body shapes from a large data set using a machine learning approach, which could be a new method for other researchers to adopt. Also, this study examined how female adults feel about the shape of their bodies based on both subjective and objective body shapes and BMI. The future study will investigate improving the prediction accuracy of the proposed model and how body satisfaction may differ depending on specific key body dimensions.

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