What are Whole Body Shapes for Plus Sized Women in the United States?: Implications for New Product Development

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Background and Significances: Obesity and problems from being overweight are increasing among Americans, and approximately 30% of adults are overweight and 36.5% are obese (cdc.gov). Overweight and obese (OWOB) cause significant body changes and fit problems for two reasons: (1) The amounts of fat deposition on certain body areas (e.g., bust, abdomen, buttocks) are significantly higher than not OWOB women; and (2) It is a $21 billion industry for plus-size women's clothing, but limited numbers of apparel companies focus on plus sized female consumers (Meyersohn, 2018) given the significantly large number of OWOB adults in the United States.

August (1981) categorized female's whole body shapes from the front view into 5 shapes based on shoulder (the end of shoulders), waist and the widest points between the waist and crotch, which were circle, pear, rectangle, inverted triangle, and hourglass with 1-5 scale between two body shapes. From the side views of body shapes, bust shapes (i.e., l or r), abdomen shape (i.e., B or b), and buttocks shape (i.e., d) were rated from very flat (1) to very prominent (5). Although August (1981) and others (e.g., Connell, Ulrich, Brannon, Alexander, & Presely) defined the silhouette and profile of the body, the ways of categorizing body shapes caused difficulty to apply to a traditional pattern making method (Song & Ashdown, 2011). Body measurements extracted from a 3D body scanner have been primarily used in categorizing lower body shapes among 18-35 year-women focusing on female with 34.1 BMI or under (Song & Ashdown, 2011). Because there have been no studies to date to categorize the whole body shape among OWOB women, it is necessary to include OWOB women in a wider age range from 18 and over 66 years as an initial stage of identifying the whole body shapes. Thus, the purpose of this study is to categorize the whole body shapes in OWOB female in the United States.

Method: The SizeUSA data among female with BMI of 25 or over was used in this study. A total of 1097 data was chosen. Subjects were aged 18 and over with the value of BMI from 25.1 to 60.35. In addition to the SizeUSA data, the software of [TC]2 allowed us to extract additional body measurements (i.e., width and front and back points for body's sideview to calculate depths) from the body scans in a rbd format offered by [TC]2. Following to Song and Ashdown (2011)'s study, a total number of 106 body measurements were initially included to select shape defining measurements including 60 raw measurements (i.e., full girth, front/back arc, width, full depth, length, and height) and 46 drop values between raw measurements. The depth drop values were calculated based on the raw measurements and differences between side seam depth (formula by Song & Ashdown, 2011) and front and back depths at bust, waist, abdomen, and hip levels. Additionally, back arc at each body level was obtained by subtracting front art from full

girth. Through bivariate correlations, 44 measurements (i.e., 12 raw measurements and 32 drop values) related to body shapes were identified regardless of body size, which showed low correlation values (r = -.07-.34) between the factor and weight. Then, to reduce the number of variables and combine similar variables into appropriate dimensions, principle component (PC) analysis was used. Lastly, K-means cluster analysis was conducted to specify the possible number of body shapes for the OWOB women.

Results: As a result of PC analysis, a total of 12 drop values and a buttocks angle was found to be useful to categorize body shapes of OWOB female. Four PCs with eigenvalues greater than 1.0 were extracted, which explain 78.6% of the variation of the 13 variables. The PCs are as follows: PC1 – Back lower body side silhouette, PC2 – Upper body front silhouette, PC3 – Upper body side silhouette, and PC4 – Abdomen prominence. PC1 had high loadings with four back arc drop values (i.e., hip – waist, top hip-upper hip, hip – top hip, top hip - waist) and the buttocks angle. PC2 had a high correlation with three drop values (i.e., bust – waist full girth, bust – waist front arc, bust – waist width). PC3 had high loadings with three depth drop values (i.e., bust-waist full depth, bust-waist front depth, bust-waist back depth). PC4 had a high correlation with two drop values (i.e., upper hip – waist front arc, abdomen – waist front depth).

K-mean cluster analysis was performed using the four PC scores to categorize whole body shapes. After experimenting two, three, and four clusters, the four-cluster model was chosen (cluster 1: n = 372, 33.9%, cluster 2: n = 306, 27.9%, cluster 3 = 47, 4.3%, cluster 4: n = 372, 33.9%). The results of the one-way ANOVA showed the overall F was statistically significant for 13 variables ranged from 46.2 to 534.1. Cluster 1 (full bust-curvy shape) has a curviest silhouette between waist and hip level from the side view and the full bust from the front view. Cluster 2 (straight-oval shape) has a non-curvy silhouette at the upper body from the front view and represented an oval shape for overall silhouette from the side view. Cluster 3 (straight-pear shape) has the most significant fat distribution at the front upper body areas from the bust to waist levels and a straight silhouette between the bust and waist level from the front view. Cluster 4 (full bust-tilted shape) has the full bust from the front view and their front lower body is tilted toward the front.

Conclusions and Implications: Four whole body shapes among OWOB female in the US were categorized: full bust-curvy shape, straight-oval shape, straight-pear shape, and full bust-tilted shape. The body shapes of OWOB female were mainly identified based on their side views as three PCs explained the characteristics of their body from the side silhouette and one PC related to the upper body from the front view. The results implied that OWOB female's whole body shapes were significantly differentiated from the side views.

Identifying whole body shapes among OWOB women in the US contributes significantly to apparel companies who target the markets of plus sized women to develop new sizing system. Furthermore, this study contributes to body related literature by filling gaps in missing whole body shape categories among OWOB female. This study has a methodological implication in that PC analysis and cluster analysis were useful methods to categorize the whole body shapes simultaneously from the front and side views.

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