Fit Analysis of ASTM Size Standards for Overweight and Obese Women in the United States based on Body Shapes

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Background and Significance

Despite the increased need to satisfy overweight and obese female adults' demands for preferred clothing in the United States, many researchers have already found that there has been difficulty meeting this demand because of unavailable sizes (Greenleaf et al., 2020). To meet overweight and obese female consumers' needs for proper fit and sizes, it is important to identify their body shapes (BS) and whether the current sizing system reflects them correctly. Only one study has categorized women's lower bodies using data from body scans of women with BMI of 34.1 or less (Song & Ashdown, 2011). Because the overweight and obese population includes those with BMI of 25 or above and a person's whole body is not limited to the lower body, further investigations are needed to identify overweight and obese women's whole BS. As an exploratory approach, the purpose of this study is to categorize the whole BS among overweight and obese women in the United States and examine the effectiveness of the current ASTM sizing systems for each whole BS. Thus, two research questions are posed, as follows:

RQ1: What are the whole body shapes among overweight and obese women in the United States?

RQ2: How effective are the current ASTM sizing standards for the identified whole body shapes?

Methods

The SizeUSA data were used in this study for women with BMI of 25 or over. Because of significant body changes in older women (Lee et al., 2012), this study used data only for women who are between 18 and 55 years. A total of 2672 data were usable in the data analysis. The subjects were aged 18-25 (n=748, 28%), 26-35 (n=422, 15.8%), 36-45 (n=821, 30.7%), and 46-55 (n=681, 25.5%). Over half (n=1401, 52.4%) were overweight (BMI of 25 to < 30) while 47.6% were obese (BMI of 30 or higher) (n=1271). Because the SizeUSA data do not provide sufficient body measurements for the BS categorization process (Song & Ashdown, 2011), we used the ImageTwin (TC2-19) software to extract additional data, such as width and depth measurements.

For the BS categorization process (RQ1), we followed Song and Ashdown's (2011) study. Among the total of 97 body measurements (i.e., 58 raw measurements and 39 drop values between them), a bivariate correlation analysis was performed to identify body measurements that were related to BSs regardless of weight. As results of the bivariate analysis, a total of 13 body measurements (i.e., 4 raw measurements and 9 drop values) with low correlations with weight (range from -.29 to .22) were chosen for further analyses: The principle component (PC) analysis and two cluster analyses (i.e., hierarchical cluster analysis for an elbow method and Kmean cluster analysis).

To identify perfect fit in the sizing system within each BS group (RQ2), both ASTM sizing standards for plus sizes for curvy and straight (ASTM D6960/D6960M-16) (ASTM International, 2016) and for misses sizes for curvy and straight (ASTM D5585-11) (ASTM International, 2012) were used for five body parts (i.e., bust, under bust, waist, top hip, hip). The formula for fit tolerance (i.e., measurement plus half of the interval) was used to determine the size appropriate for each body part (Simmons et al., 2004). Thereafter, values of perfect fit with tops (i.e., bust, under bust, and waist) and bottoms (i.e., waist, top hip, and hip) in each size standard were obtained: For tops and bottoms, '0' was recorded when there were no size differences all three parts. Then, for each BS group, we calculated frequencies and percentages of the values of perfect fit in each size standard.

Results

A series of PC analyses was performed to identify the ideal PC groups. Four PCs and a single variable (i.e., Front depth: Abdomen to Waist) with eigenvalues of 1.0 and greater were extracted with 76.3% of the variation in the 10 variables. The PCs were: PC1—Waist to hip silhouette and buttocks prominence (i.e., Back Arc: Hip to top hip and width: Hip to waist); PC2—Bust prominence (i.e., Back Arc: Hip to top hip and width: Hip to waist); PC3—Bust to waist silhouette from back (i.e., Back arc: Bust to waist and back arc: Bust to under bust), and PC4—Back curvature (i.e., Neck to waist contour back, back bump from neck to waist). A single variable (i.e., Front depth: Abdomen to waist) was changed to its Z-score, which represented abdomen prominence.

After experimenting with two to six clusters, five clusters of BS groups were identified: Rectangle-curvy shape (BS1, n=502, 18.8%); Parallelogram-moderate curvy shape (BS2: n=571, 21.4%); Parallelogram-hip tilt shape (BS3, n=348, 13.0%); Inverted trapezoid-moderate curvy shape (BS4: n=593, 22.2%), and Inverted trapezoid-hip tilt shape (BS5: n=658, 24%). BS1 had a straight front and back upper body silhouette from both the front and side views, the curviest shape for the front lower body silhouette, and the most prominent abdomen and buttocks from the side view among the five groups. BS2 had less prominent bust than waist areas and a moderate buttocks and abdomen prominence from the side view. BS3 had a more prominent belly at the waist and abdomen levels than bust level from the side view, the curviest back, and the most tilted hip. BS4 had a larger front and back depth at the bust level than that at the waist level from the side view and the flattest buttocks and abdomen from the side view among the five groups. BS5 had the most prominent bust and upper back at the bust level and hip tilt with the most prominent abdomen compared to that at the waist level among the five groups. Thus, RQ1 was answered.

To answer RQ2, the results showed that women in BS1 and BS4 would have a perfect fit with tops in the plus size curvy (BS1:12.0%, BS4:18.4%) and the misses straight (BS1: 12.2%, BS4: 16.4%) sizing systems. For women in BS2 and BS3, they would have a perfect fit with tops similarly across the three sizing standards: Plus curvy (BS2: 15.8%, BS3: 15.2%), plus straight (BS2: 14.2%, BS3: 12.9%) and misses straight (BS2: 15.9%, BS3: 13.5%). For bottoms, the plus size curvy sizing system would offer a perfect fit with tops for women in BS1 while for women in BS2 (11.9%), BS3 (14.1%), and BS4 (13.8%), a perfect fit would be obtained in the plus straight sizing system. For those with BS5, they would achieve a perfect fit with tops (15.2%) and bottoms (6.4%) in the misses straight sizing systems.

Conclusions and Implications

Five whole BS were identified among overweight and obese women in the United States: Rectangle-curvy shape; parallelogram-moderately curvy shape; parallelogram-hip tilt shape; inverted trapezoid-moderately curvy shape, and inverted trapezoid-hip tilt shape. For each BS group, approximately four fifths or more of overweight and obese female adults in the United States would find it difficult to obtain a good fit for both tops and bottoms in the current ASTM sizing systems for both misses and plus sizes. This study has implications for apparel product developers and designers in the US, in that the sizing system for overweight and obese female adults needs to be revised according to the whole BS categories. Further, this study contributes to the literature related to BS, fit, and sizing by filling the gaps for the overweight and obese female population in the United States.

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