Demographic Factors for Developing Apparel Sizing Systems in USA

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More than half of all US consumers have garment fit problems with the current sizing system (Intellifit Corp., 2003). In the United States, people who have different ethnic backgrounds often experience poor fit due to their unique body proportions, and each ethnic grouping requires a different amount of ease as determined by proper fit (Kim, 2003). The fit problems are associated with apparel sizing systems that have been based on old demographic data. The current population is becoming more ethnically diverse in the United States. According to the U.S. Census Bureau (2001), the U.S. immigrant population grew rapidly during the 1990s and the foreign-born population grew by 57% during the decade nationwide.

Recognizing fit problems, researchers and apparel manufacturers are seeking solutions to provide customer's needs for better fitting garments. The Body Shape Analysis Scale (BSAS©) was developed in a National Textile Center (NTC) project (Connell, et al., 2002) to evaluate a complex set of body shape variations. Alexander, et al (2003) analyzed a data set of 529 body scans using the BSAS© to define whole and component body shapes of females. The shape analysis showed that the conventional hourglass body shape was present in only 33.6% of the women subjects (Alexander, et al., 2003). Shape identification software, Female Figure Identification Technique© (FFIT), was developed to analyze current female body shapes so that more correct sizing systems could be developed (Istook, et.al, 2002). Using SizeUSA data and the FFIT software, Istook (2006) determined that approximately 46% of women were classified as rectangular, in which the bust and the hips are generally the same size, and the waist is less than nine inches smaller than the hips or the bust. However, the industry still uses a sizing system that is based on the hourglass figure, ignoring various body shapes. The various body shapes might be due to demographic factors such as diverse ethnicity and age.

The purpose of this study was to investigate various body shapes according to ethnicity and age as demographic factors for developing apparel sizing systems in the United States. Data from the SizeUSA national sizing survey was used in this study. Textile/Clothing Technology Corporation ([TC]²), located in Cary, NC, USA, is the non-profit organization that conducted the SizeUSA national sizing survey between 2002 and 2003. They used a [TC]² body scanner that is now widely used for customized apparel and fit research. The SizeUSA survey recorded a representative sample of the entire U.S. population by scanning about 10,000 people in 13 cities. In this study, the 6310 females were grouped by their ethnicity and ages by running simple query language (SQL). The following is a demographic profile: 53% of the female subjects were Caucasian and the remaining were African American (18%), Hispanic (6%), Mexican (7%),
Asian (8%) and Others (8%). In age, 24% of the sample was between 18-25, and the rest of age groups included 26-35 (23%), 36-45 (21%), 46-55 (18%), and 56-65 (10%), and 66+(4%).

Prior to investigating demographic factor for the sizing systems, body shape distributions by ethnicity were compared according to Istook’s body shape definitions (Istook, 2006): Rectangle, Spoon, Inverted Triangle, Hourglass shape, Top Hourglass, Bottom Hourglass, and Triangle shapes. When the body shapes were analyzed by each ethnicity, the rectangular body shapes appeared in 50% of the Caucasian group, 49% of the Hispanic group, and 45% of the African-American group. These results supports Istook (2006)’s findings that 46% of overall women were classified as rectangular in the United States.

A single factor analysis of variance (ANOVA) was used to investigate body dimension differences according to two demographic factors: (1) age group and (2) ethnic group. The tested body dimensions were upper body (Waist, Bust, Shoulder slope, Arm length) and lower body (Hips, High hips and Thigh). When body dimension differences were found among groups through ANOVA procedures, a Tukey test was used for multiple comparisons to determine which groups were similar or different with significance level set at $\alpha=0.05$. According to the analysis and multiple comparison tests, US females have various body shapes based on the two demographic factors: 1) Age and 2) Ethnicity.

First, significant body dimension differences among age groups were found in this study. For example, Bust ($F=90.667, p<.05$), Hips ($F=73.169, p<.05$), Waist ($F=101.666, p<.05$), Armscye ($F=114.556, p<.05$), Scye depth ($F=97.74, p<.05$), Upper arm ($F=93.729, p<.05$), and Neck base ($F=93.129, p<.05$) were significantly different among age groups. According to the analysis of variance and multiple comparison tests, there were significant body differences among age groups by rejecting the null hypotheses with a significance level set at $\alpha=0.05$: Age 18-35 was distinguished from older age groups (age 36-65). For example, the age 18-25 group’s waist was distinguished from over 66 age group’s ($q=15.01 > 4.096 (q 0.05, 6304, 6)$). In the results, the older age groups had larger body dimensions (bust, waist, hips, armscye, upper arm, and neck base) although age over 66 shows smaller waist, hips, and bust than age 56-65. The over 66 age group’s back waist length was similar to the age 18-25 group’s (Back Waist length 16.93": $q=4.06423<4.096 (q 0.05, 6304, 6)$). Greater shoulder slopes were found in older age groups. When the variances were compared among age groups, Waist, Hips, and Bust shows larger variances. Age 26-35 shows larger variances in Bust ($s=27.49$). Age 36-45 shows larger variances in Hips ($s=27.09$). Age 46-55 show larger variances in the Waist ($s=30.79$). This indicates that each age group has different size variations between 36 and 45, and body shapes could be various in each age group.

Second, significant body dimension differences among ethnic groups were found in this study. For example, Waist, Hips, Bust were significantly different among ethnicities ($F=51.033; F=92.723; F=78.038, p<.001$). The group similarities and differences were found from the Tuckey tests ($q$ value $> q 0.05, 6304, 6$) with significance level at $\alpha=0.05$. African-American and Asian groups have significantly different waist, hip, and bust. Compared to other groups, the Asian group showed the smallest body sizes on average (Waist=31.44; Hip=39.42; Bust=37.33), while African American group showed the largest body sizes (Waist=35.79; Hip=44.91; Bust=42.31).
In the waist, hip, and bust categories, Hispanics and Mexicans are shown as the same group through the multiple comparison tests (Waist $q=2.95$; Hip $q=0.84$; Bust $q=2.8 < q 0.05$, 6304, 6). Caucasians show similar body dimensions to Hispanics. However, the shoulder slope measurement is significantly different between Hispanics and Caucasians ($q=12.81 > q 0.05$, 6304, 6). Hispanics’ shoulder slopes (19.79”) were smaller than Caucasian’s (21.56”). In Waist and Bust categories, the Mexican group ($q=2.79 < q 0.05$, 6304, 6) was similar to the African American’s. Caucasians were distinguished from other ethnic groups in the following body categories: Waist length back (17.53”), the Scye depth (4.21”), and the Arm length (21.11”) ($q$ value > $q$ 0.05, 6304, 6). When variances were compared among ethnic groups, Waist, Hips, and Bust showed larger variances than other body categories. African-American showed large variances in waist (24.43”~ 61.85”), hips (32.15”~71.13”), and bust (31.13” ~ 60.3”).

In summary, this study revealed several factors that may help define diverse female body shapes in the U.S. population. Even though half of the females in the study possessed rectangular shapes, they have various body shapes based on demographic factors of age and ethnicity. As the age of the subjects increased, body measurements in the waist, hip, bust, neck base, and upper arm were larger until age 66. Subjects over age 66 showed slightly smaller measurements than the age groups below, but with a greater shoulder slope. There were large size variances in the middle age group. Asians has smaller hips, waists, and busts with greater shoulder slope. On the other hand, African American has larger hips, waists, and busts. The Hispanic and Mexican populations have similar body sizes. Hispanics had similar body measurements as Caucasians in waist, hip, and bust. However, the degree of the Hispanic’s shoulder slope was smaller compared to the Caucasian’s. This shoulder slope differences might have an effect on developing women’s clothing such as dresses, jackets, and blouses. The results clearly show that the differences among age groups and ethnicity have an effect on the apparel market. It is important for apparel manufacturers and retailers to understand the idea that people have different shapes and these body shapes vary by the ethnicity and age. Therefore, apparel manufacturers must be aware of the differences in age and ethnics in order to develop women’s apparel market. Further study should be done for defining body shapes with detail shape differences such as shoulder shapes and crotch lengths in order to develop precise sizing systems for mass customization.

References
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