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The importance of understanding the shape of diverse ethnic female consumers for developing jeans sizing systems

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Keywords

Consumer ethnicity, apparel products, jeans, sizes, sizing systems, fit.

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Abstract

This study has been conducted to investigate the fit issues related to the current apparel pants and jeans sizing system for diverse consumers, identifying body shape differences among ethnic groups. A total of 1335 women in a certain size range (*Misses* figure type sizes 2–20) were selected in the study. A *Misses* figure type size category is commonly used for adult women of average proportion and height. First, the body dimension differences among ethnic groups were examined with a single factor analysis of variance. Second, the fit of pants and jeans for the diverse consumers within the same size category was examined with the current standard sizing system, ASTM D5585 for adult female *Misses* figure type sizes 2–20. Three cases were programmed within a database: When each consumer selects a size for a pair of jeans based on (1) *waist* size; (2) *hip* size; and (3) *waist height* (usually pants length). And last, the results were analysed with fit comparison plots. Current jean consumers are racially diversified in the US and globally as well. This study revealed that ethnic groups had different fit problems and significant body shape differences. Even within the same figure type size category, a variety of body dimensions existed in each ethnic group. According to the fit problem assessment in this study, consumers within the same body figure type size category could not find the right fit of the pants and jeans within the current sizing system. Half of the female consumers could not find a garment to fit based on waist height (pants length) because the current sizing systems overlooked the effect of diverse consumers. This study will be useful for standardizing organizations to modify current sizing systems for diverse ethnic consumer groups as a demographic factor so that apparel companies could provide better quality of fit for their consumers in the global and local market.

Introduction

Jeans and pants are popular apparel items for consumers. Women, especially, between the ages of 35 and 54 years spent \$31 billion to dress themselves in 2005, which was a 4.5% increase from the previous year. However, they were outspent by their daughters and younger sisters, ages 18–34 years, who shopped to the tune of \$36.34 billion during the same time period (Nachman, 2005). Jeans drove 75% of the denim market in 1998, accounting for the largest growth in women's denim apparel. Since women's jeans totalled 174 million pairs in 1997, with a value of \$2.3 billion, the quantities of women's jeans have increased (US Census Bureau, 1998). Jeans sales still remain mostly about the young, although older consumers are also adopting jeans.

Jeans are globally accepted as fashion items. Cotton Inc. (2005) provided evidence of global acceptance in its *Global Lifestyle Monitor*TM survey in nine countries (Brazil, China, Colombia, Germany, India, Italy, Japan, the UK and Hong Kong), evaluating

the ownership of denim apparel items by person and country. Denim ownership was highest in the US (13 items), Germany and Colombia (12.9 items) and lowest in India (3.1 items) and China (7.9 items). Casual dressing at work is now accepted at 58% of the offices of Global Monitor's worldwide respondents. In Colombia 78% of the offices allow casual dress. Although the US is not a premier production site for denim, it is a premier consumption market for Jeans (Allen and Huffman, 2005).

Modern jeans were invented by Levi Straus for hard-working men, but today wearing stylish jeans has become a fashion trend. Currently popular brands include Gap, Guess, True Religion, Seven For All Mankind, Earl Jean, Citizens of Humanity, Notify, James Jeans and AG Jeans. *Levi's* is also quite strong in Europe. Over the decades, styles have noticeably changed in jeans with a tighter fit and a lowered waistline placement. Growing jeans fashion trends have caused changes in apparel production and consumption. Premium denim, loosely defined as a pair of jeans selling as high as \$70 or more by the *Monitor*TM survey (Cotton

Inc., 2005), is considered a 'must-have' for young female consumers. From 1998 to 2004, the percentage of women who would pay more than \$70 for a pair of good fitting jeans increased from 2% to 10% among 16- to 19-year-olds and from 3% to 12% among 20- to 24-year-olds (Cotton Inc., 2005). Fit is the most concern for two reasons: comfort and vanity (Strategic direction, 2005). Both are equally important and a great fit helps create confidence.

The demands for good fitting jeans drive many apparel companies to mass production of individually customized goods and services (Pine, 1993). Consumers are willing to pay more and willing to wait for the customized products. For instance, chino and jeans sales on Lands' End's website are now mass customized garments that have more pants fabric options and styles (Lands' End Inc. 2006). However, often consumers are still not satisfied with their purchases even after they have tried on multiple jeans to find an appropriate size and style.

Goldsberry *et al.* (1996) found that 69% of over 4000 female respondents were dissatisfied with fit. According to Kurt Salmon Associates Consumer Outlook, 59% of US shoppers claimed inconsistent fit within one brand, and 57% stated fit problems with standard sizes (Intellifit Corp, 2003). As a result, 40% of the purchased clothing is returned and 28% of consumers are reluctant to order from catalogues because of their concern about getting the right size (Telmat Industrie, 2002). These fit problems are associated with current sizing systems that overlook the diverse ethnicity that encompasses the full range of variation in body shapes existing in the population.

A sizing system includes a range of sizes based on graduations of dimensions for a body type. Apparel companies identify body types that are representative of their target customer and develop what they perceive to be appropriate proportions for each size and graduation between sizes (Glock and Kunz, 2005). Size labelling suggests to consumers the suitability of a garment for their body dimensions. Sizes are grouped together into following size classification according to gender, age and body type of consumers: *Petite*, *Junior*, *Misses* and *Plus* sizes (Tigert *et al.*, 1996). For example, the *Misses* size designation was originally designed to fit the adult woman of average proportion and average height. They are also commonly referred to as *missy* sizes (Brown and Rice, 2001). The ASTM (2004) (*American Standard Testing and Material*) D5585 standard suggests *Misses* sizes as even numbers from 2 to 20.

According to research conducted in the Chicago market during the 1990s, half of the female customers' body types were *Misses* sizes (55%) and the remainder were *Plus* sizes (23%), *Petite* sizes (18%) and *Junior* sizes (8%) (Tigert *et al.*, 1996). However, several body types have not been well served by the apparel industry or considered for diverse ethnic consumers. For example, Fu (2004) studied body shapes in overweight *Plus*-sized female figures and found that they were shorter and fell into a *Petite* size category. Previous research (Ashdown, 1997; Anderson *et al.*, 1998; Hwang and Istook, 2001; Jo *et al.*, 2003) indicated that problems with the fit of women's apparel are based on outdated body measurement data and population averages.

Sizing systems around the world have been created using a variety of schemes from elaborate statistical methods to trial and error (Ashdown, 1997). The goal of any sizing system is to choose key body dimensions that will allow the division of the population into specific size groupings. Ultimately, the hope is that the group-

ings will be developed to create the least number of sizes necessary to fit almost everyone in the population.

Although sizing systems around the world vary greatly, all are based on one key dimension that is used to define the sizes within the system. This dimension (such as waist) is generally distributed evenly across the system, in an attempt to cover the broadest range of measurements. For example, the waist measures from sizes 2–10 are 1" apart, sizes 12–16 are usually 1½" apart and sizes 18 and up are 2" apart. These ranges were developed to make the growth between sizes easy for manufacturers of ready-to-wear garments to manage. The remaining measurements that are required for a sizing system have been derived using regression statistics and averages related to the original key dimension. For example, the second most important dimension for design of a pair of pants is generally the hip measurement. Using the 1939 study (which has been the basis of all US sizing systems) the hips were generally about 10" bigger than the waist (given the fact that women at the time wore girdles and other body shaping apparel) creating basically an hourglass shape. The hip measurements for the system then increased in size in exactly the same proportion as the waist measurements. Length and height measurements increase in the same way, although with smaller proportions.

This method of size creation is clean and easy for manufacturers to use. Garment patterns from one size to the next fit nicely in a nest, and errors are easy to spot. Unfortunately, each of the sizing systems that have been developed has been based on the same assumption that the hips are generally 9" or so larger than the waist (the hourglass look) and all are generally ranged evenly from one size to the next. There are a multitude of problems related to this methodology. First, the number of people who currently have that 'hourglass' shape is significantly different than it might have been in 1939. Second, the even growth between all sizes is not logical, although it might be easier to accomplish. For example, a women 5'7" with an inseam measurement of 30" generally does not get any taller as she gets bigger (as our sizing systems indicate) and usually do not add weight evenly across all body areas. Third, regardless of the fact that women have complained of fit problems since the inception of standards in 1958, changes to the systems have actually reduced fit opportunities for these women rather than increasing them. CS215-58 (the standard originally developed from the 1939 study) had 36 different size ranges. The four classifications of women included 'Misses', 'Women's', 'Half-Sizes' and 'Juniors'. Three height groups were recognized as 'Tall', 'Regular' and 'Short'. Three hip types were recognized as 'Slender', 'Average' and 'Full' (Simmons, 2002).

Recognizing fit problems, researchers and apparel manufacturers are developing apparel sizing systems to provide customer's needs for better fitting garments. Body shape analysis is the theory for the development of apparel sizing. In the theory, as it is currently implemented, apparel sizing is based on averaged anthropometric body measurements that must fit many body shapes within a size range (Connell *et al.*, 2003). The Body Shape Analysis Scale (BSAS©) was developed in a National Textile Center project (Connell *et al.*, 2003) to evaluate a complex set of body shape variations. Alexander *et al.* (2003) analysed a data set of 529 body scans using the BSAS© to define whole and component body shapes of women. The shape analysis showed that the conventional hourglass body shape was present in only 33.6% of the women subjects (Alexander *et al.*, 2003).

The shape identification software, Female Figure Identification Technique® (FFIT), was developed to analyse current female body shapes so that more correct sizing systems could be developed (Simmons *et al.*, 2004). 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.

Current mass production and customization trends force apparel manufacturers to offer a range of selections for apparel items so that the customer can choose style and fit options. Over the decades, jeans' styles for Misses figure types have noticeably changed with a lowered waistline placement and a curved hipline. Certain jeans manufacturers have attempted to provide a variety of garments to fit the differently shaped women by adjusting the measurements in certain locations in the jeans. Style numbers then become representations of different fits, although the size numbers used to define the garments remains the same. Contrary to the standard development described earlier, the measurements that define a pair of jeans at specific points in one style may have absolutely no relationship to the measures that define another style of jeans *in the same size*. The significant differences in the fit of jeans of the same defined size appear to have no relationship to body measurement data that describe the current US population. It is important to understand current Misses figure body types to provide certain styles with correct fit.

The theory of body shapes for developing Misses sizing systems was proposed to the ASTM D13.55 standards committee; however, no standards were developed to accommodate the various body types. The current ASTM standard sizes were developed from body measurements used currently by apparel manufacturers and retail organizations and from anthropometric surveys conducted by the US Army (Gordon *et al.*, 1988, p. 2) and by the US Navy (Mellian *et al.*, 1990; Robinette *et al.*, 1990). In the ASTM D5585-04, it says 'It is important to note that the body measurements herein have been derived from designer experience and market observations and crosschecked with available databases in the attempt to identify current customer characteristics and changing proportions and not from new nationwide anthropometric research.' The way it is currently used by jeans manufacturers has not successfully accommodated various body types. The jeans manufacturers in the US still use sizing systems that are based on the hourglass figure or pear shapes which are not representative of the majority of US women.

Diverse ethnic consumers might have different types of fit problems because the US population is becoming more ethnically diverse. The US immigrant population grew rapidly during the 1990s and the foreign-born population grew by 57% during the decade nationwide (Urban Institute Immigration Studies Program, 2002). According to Census Bureau in 2001, there were 31 million immigrants living in the country, representing 11% of the population (US Census Bureau, 2001). This indicates that the influence of ethnicity and diversity in the provision and consumption of consumer goods is truly both a US and a global phenomenon.

Vrontis and Vronti (2004), in a case study of Levi's international marketing investigation, indicated the importance of understanding ethnicity by describing seven factors that could influence their decision to make global standardization or international adaptation: *Socio-cultural, Legal, Physical/environmental, Tech-*

nological, Demographic, Competition, and Economics. Two of the factors, socio-cultural and demographic, are related to fit and size issues.

Global fit vs. local fit is an important issue for a global business like Levi Strauss that aims to benefit from economies of scale and guarantees of quality that stem from worldwide advertising and standardized products (Vrontis and Vronti, 2004). In a study of body cathexis and satisfaction with fit of apparel, LaBat and DeLong (1990) emphasized that each manufacturer must successfully interpret body measurements and produce apparel that satisfies their target customer's fit. In other research, Kim and Kim (2005) provided an insight into developing different marketing strategies according to ethnicity.

Although researchers have assessed international marketing for jeans and the body shape analysis for the theory of developing current sizing systems, little research to date has assessed current sizing systems based on diverse ethnicity. Therefore, the purpose of this study was to identify body shape differences among ethnic groups and to investigate current apparel pants/jeans sizing system problems for diverse consumers. This study provides the underpinning that would allow researchers and apparel manufactures to understand the theoretical issues of diverse body shapes for the development of apparel jeans' sizing systems.

Methodology

Data collection and sample

The SizeUSA National Sizing Survey was conducted by [TC]² (*Textile/Clothing Technology Corporation*, Cary, NC, US, non-profit organization) between 2002 and 2003 in the US, and the survey data were used in this study. A [TC]² body scanning system was used for scanning and measuring subjects' body dimensions of various demographic dimensions during the sizing survey. As this research purpose was to identify current women's apparel, especially, pants/jeans sizing problems for diverse ethnic groups, women were selected within a same size category and they were divided into five different ethnic groups. In this study, a *Misses* figure type size category was selected for the same size category because it is commonly used for adult woman of average proportion and average height.

A total of 1335 of 6310 women answered that they wear *Misses* size jeans. Table 1 shows the subjects' ethnicities and ages. The majority was Caucasian people (62.92%), with the remainder being African-American, Hispanic, Mexican, Asian and others. Ages of the respondents were from 18 to 65 years old.

Table 1 Sample's ethnicity and ages who wear *Misses* sizes

Ethnics	n (%)	Age (year)	n (%)
Caucasian people	840 (62.92)	18–25	345 (25.84)
African-American	243 (18.2)	26–35	298 (22.32)
Hispanic	47 (3.52)	36–45	253 (18.95)
Mexican	71 (5.32)	46–55	251 (18.8)
Asian	71 (5.32)	56–65	140 (10.49)
Others	63 (4.72)	66+	48 (3.6)
Total	1335 (100)	Total	1335 (100)

Table 2 Misses size jean consumers in each ethnic and age group

Ethnics	<i>n</i>	% of jean consumers in each ethnic group	Age (year)	<i>n</i>	% of jean consumers in each age group
Caucasian people	737	88	18–25	332	96.2
African-American	210	86	26–35	258	86.6
Hispanic	36	75	36–45	222	87.7
Mexican	60	85	46–55	213	84.9
Asian	62	87	56–65	101	72.1
Others	56	84	66+	35	72.9
Total	1161	87	Total	1161	87

Table 2 shows the *Misses* size jean consumer in each ethnic and age group. Overall, a total of 87% of *Misses* size consumers enjoyed jeans in the *Misses* size category. Not surprisingly, 96.2% of the jean consumers were in the 18–25 years age group; however, all ethnic groups and age groups were fairly equal in percentages.

Data statistical analysis procedure

First, it was necessary to examine if the respondents had the same body figure type with the following null hypotheses, because diverse ethnic groups exist in the *Misses* figure type size category:

Ho: There will be no body dimension differences among ethnic groups.

Ha: There will be body dimension differences among ethnic groups.

Body dimension differences were examined in the waist, hips, thigh maximum circumference, crotch length, crotch height (inseam), waist height (pants length, outseam); all are measures that impact the fit of a pair of pants/jeans. The null hypotheses were tested with a single factor analysis of variance (ANOVA) with a 5% level of significance. After the ANOVAs were tested in each ethnic group, Bonferroni's multiple comparisons with significance level set at $\alpha = 0.05$ was used to find the difference between ethnic groups.

Second, pants/jeans fit was examined to identify if diverse consumers within the same size category could find the right size and fit of jeans with the current ASTM standard sizing system. For the analysis, the following three cases were programmed into a database application using the collected data from the survey:

- 1 When each consumer finds a pair of jeans based on *waist* sizes.
- 2 When each consumer finds a pair of jeans based on *hip* sizes.
- 3 When each consumer finds a pair of jeans based on *waist height* (usually pants outseam length).

Each consumer's body dimensions were matched with sizes in the standard ASTM D5585 for Adult Female Misses Figure Type Sizes 2–20. Table 3 shows the waist and hip measurements in the standard sizes 2–20 and the intervals between sizes that were used for defining a fit in this analysis.

For example, if the subject's hip girth was 38.7 inches, her pants size could be size 10. If she tried on size 8 for 38 inches, the hips would not be considered within the size range for best fit. Therefore, the size intervals were defined with following simple query languages in this case: WHERE (((ASTM_size.[Body Type]) = 'Missy 5585') AND ((USfemale.Hips) < [ASTM_size.Hips]) AND (([ASTM_size.Hips]) < ([USfemale.Hips] + 1))). And last,

Table 3 Waist and Hips measurements and size intervals in *Misses* figure type sizes 2–20

Sizes	Waist	Waist size interval	Hips	Hip size interval
2	24	–1	35	–1
4	25	–1	36	–1
6	26	–1	37	–1
8	27	–1	38	–1
10	28	–1	39	–1
12	30	–2	40	–1.5
14	31	–2	42	–1.5
16	33	–2	43	–1.5
18	35	–2	45	–2
20	37	–2	47	–2

the results were analysed in graphical plots that displayed comparison subject's body dimensions to the *Misses* figure type standard sizes.

Results and discussion

Diverse ethnicity as a demographic factor

Diverse consumers' body dimension categories were analysed using single factor ANOVA to identify fit problems in each ethnic group. Table 4 shows the results from ANOVA among diverse ethnic consumer groups. The asterisk has been placed to indicate that these pairs show statistically significant differences at the 95.0% confidence level.

The following body dimensions were significantly different by rejecting the null hypotheses ($P > 0.05$): height, waist, hips, thigh, crotch length, crotch height (inseam), waist height (pants outseam length). As there were significant body dimension differences among groups, Bonferroni multiple comparisons with significance level set at $\alpha = 0.05$ were used to determine which means were determined to be significantly different.

Table 5 shows the multiple comparison results. Asians and African-Americans were statistically significantly different at the 95% confidence level in all body dimension categories. African-Americans were also significantly different from Caucasian people in lower body dimension categories (waist, hips, thigh, crotch length, crotch height and waist height). Generally, in this study, Asians showed the smallest body dimensions (Waist mean = 31.48", Hips mean = 39.52", Thigh mean = 22.86", Crotch length mean = 26.52", Crotch height mean = 28.48", Waist height

Table 4 Results from ANOVA of the body differences among ethnic groups

	Ethnicity										F-test (F 0.05(1), 5, 1335)		
	Caucasian people (C)		African_American (Afa)		Hispanic (H)		Mexican_American (Ma)		Asian (A)			Other (O)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		Mean	SD
Body													
Height	64.963	2.19739	64.553	2.25667	62.663	2.27072	63.092	2.16241	63.464	2.27144	63.412	2.21348	25.35*
Weight	146.57	23.4876	161.587	28.4203	136.63	22.4908	145.2	24.565	131.62	22.4724	140.31	19.0693	25.70*
Waist	32.684	3.58014	33.813	4.08716	32.123	3.1249	33.793	4.24083	31.484	3.10679	32.299	3.16555	7.25*
Hips	41.918	3.27533	43.471	3.50435	40.697	2.88977	41.586	3.36065	39.527	2.43668	41.221	2.74513	20.67*
Thigh circumference	23.82	2.02198	25.711	2.41307	23.484	2.03384	23.821	1.83762	22.863	1.68011	23.746	1.89933	38.95*
Crotch length	27.98	2.44166	28.856	2.86377	27.041	2.60022	27.123	2.73822	26.521	2.4398	27.180	2.40329	14.47*
Crotch height (Inseam)	29.463	1.49522	30.022	1.49792	28.340	1.551	28.412	1.74029	28.488	1.54376	28.559	1.68918	27.56*
Waist height (pants length)	40.116	1.83375	40.588	1.96484	38.515	1.98054	38.436	2.19087	38.494	1.99363	38.807	1.99161	33.69*

* $P < 0.05$.

mean = 38.49") while African-Americans showed the largest body dimensions (Waist mean = 33.81", Hips mean = 43.47", Thigh mean = 25.71", Crotch length mean = 28.85", Crotch height mean = 30.02", Waist height mean = 40.58").

As shown in Table 5, Hispanics and Mexican-Americans were not statistically different in the lower body dimension categories. Asians were not statistically different from Hispanics but different from Mexican-Americans in the waist (mean differences = -2.30915") and hip categories (mean differences = -2.0587").

Figure 1 shows the comparison between mean body dimension values among ethnic groups. As shown in Fig. 1, Mexican-Americans had larger waists and hips than Asian and Hispanics. The Mexican-American's waist dimension was similar to the African-Americans' while the Hispanic's waist and hips were similar to the Asians'. This indicates that the Hispanics' lower body dimensions were very similar to Asians'. The African-American group was significantly different from all other groups in the thigh dimension and crotch length categories, showing a larger thigh and longer crotch length (see Fig. 1).

The Mexican-American and Hispanic groups were not statistically different from the White group in the following lower body dimensions: waist, hips, thigh and crotch length. However, they were statistically different in the crotch height (Mean differences = -1.05151" and -1.1234") and waist height (Mean differences = -1.68073" and -1.60081") categories as shown in Table 5. Both Mexican-American and Hispanic groups showed shorter crotch height and waist height than the White group's average as shown in Fig. 1. Mexican-American and Hispanic's crotch height (inseam length) and waist heights (pants length) were similar to Asian's.

These results indicate that each ethnic group has unique body dimensions. Therefore, diverse consumers in the global and the US local market could not fit within one figure body type size indicating that a real challenge exists with the issue of fit among diverse ethnic groups.

Fit problem assessment with a current sizing system

As body dimension differences were found among ethnic groups from statistical analysis, pants/jeans fit was examined if diverse consumers within a same size category could find their sizes with a current standard sizing system by testing when each consumer finds a pair of jeans base on three cases: (1) waist sizes; (2) hip sizes; and (3) waist height (pants length).

Table 6 shows the results of finding jeans fit based on the three different cases. The noticeable results were in waist height (pants length), showing that 49.29% of subjects could not find right pants sizes within the standard sizing system. It should be noted that most women's apparel companies do not provide various pants lengths. For example, women's jeans sizes are based on the waist size with only three choices such as short, regular, or long while men's pants sizes are based on waist sizes and as wide range pants length choices as well (e.g. 34/30, 34/32 and 34/36).

Waist sizes are commonly asked for pants/jeans in a retail store, but as shown in Table 6 and 15.88% of subjects' waists would not be within the current size range. When hip sizes and waist sizes were compared to find jeans fit, 92.21% of subjects could find their hip sizes within the standard size ranges.

Table 5 Multiple comparison results of the body dimension differences among ethnic groups

Contrast ethnic groups	Body dimensions					
	Waist	Hips	Thigh	Crotch length	Crotch height	Waist height
Asian: African American	-2.32949*	-3.94368*	-2.84779*	-2.33504*	-1.53416*	-2.09404*
Asian: Hispanic	-0.639923	-1.17026	-0.621282	-0.52024	0.147576	-0.0212245
Asian: Mexican American	-2.30915*	-2.0587*	-0.957876	-0.601881	0.0756874	0.0586947
Asian: Other	-0.815777	-1.69458*	-0.883017	-0.659401	-0.0719356	-0.312745
Asian: Caucasian people	-1.20082	-2.39152*	-0.956628*	-1.46366*	-0.975824*	-1.62203*
African American: Hispanic	1.68957	2.77342*	2.22651*	1.8148*	1.68173*	2.07281*
African American: Mexican American	0.0203457	1.88498*	1.88991*	1.73316*	1.60984*	2.15273*
African American: Other	1.51372	2.2491*	1.96477*	1.67564*	1.46222*	1.78129*
African American: Caucasian people	1.12868*	1.55216*	1.89116*	0.871378*	0.558332*	0.472005*
Hispanic: Mexican American	-1.66922	-0.88844	-0.336595	-0.0816406	-0.0718885	0.0799192
Hispanic: Other	-0.175854	-0.52432	-0.261735	-0.139161	-0.219512	-0.291521
Hispanic: Caucasian people	-0.560892	-1.22127	-0.335346	-0.943421	-1.1234*	-1.60081*
Mexican American: Other	1.49337	0.36412	0.0748594	-0.05752	-0.147623	-0.37144
Mexican American: Caucasian people	1.10833	-0.332825	0.00124881	-0.86178	-1.05151*	-1.68073*
Caucasian people: Other	-0.385038	-0.696945	-0.0736106	-0.80426	-0.903889*	-1.30929*

*The asterisk denotes a statistically significant difference in 95.0% confidence level.

Table 6 Results of finding jeans fit based on waist sizes, hips sizes and pants length

Size	Waist		Hips		Waist height (pants length)	
	<i>n</i>	% of female	<i>n</i>	% of female	<i>n</i>	% of female
2	0	0	3	0.22	73	5.47
4	2	0.15	3	0.22	57	4.27
6	11	0.82	28	2.10	78	5.84
8	24	1.80	57	4.27	73	5.47
10	54	4.04	98	7.34	69	5.17
12	151	11.31	185	13.86	75	5.62
14	218	16.33	277	20.75	65	4.87
16	227	17.00	235	17.60	55	4.12
18	243	18.20	207	15.51	59	4.42
20	193	14.46	138	10.34	54	4.04
Total of people found sizes	1123	84.12	1231	92.21	658	49.29
Total of people could not find sizes	212	15.88	104	7.79	677	51

Figure 1 Mean value comparison in each ethnic group.

Table 7 shows different fit problems of waist and hips among ethnic groups. Most subjects' waists were larger than size 20, and 25.35% of Mexican-American and 21.81% of African-American had waist measurements larger than 20". The African-American group shows larger hip sizes that could not fit within the current standard size ranges. On the other hand, Caucasian people, Asian and Hispanic did not show many fit problems with waist and hip sizes.

Table 7 Different fit problems of waist and hips among ethnic groups

Ethnicity	Group	n	Fit problems					
			Waist size not found			Hip size not found		
			Size 20<			<Size 2	Size 20<	
			n	%		n	%	
Caucasian people	840	126	15.00			1	0.1%	
African-American	243	53	21.81		N/A	N/A	38	15.64
Hispanic	47	4	8.51		N/A	N/A	0	0.00
Mexican-American	71	18	25.35		N/A	N/A	6	8.45
Asian	71	4	5.63		N/A	N/A	0	0.00
Other	63	7	11.11		N/A	N/A	0	0.00
Total	1335	212	15.88		N/A	N/A	103	7.72

Table 8 shows different fit problems of waist height among ethnic groups. As shown in Table 8, Mexican-American (60.56%), 55.32% of Hispanics and 56.34% of Asians have shorter waist height than the standard sizes. On the other hand, 30.04% of African-American had a longer waist height than provided by current standard sizes. This indicates that statistically different body dimensions among ethnic groups are related to different fit problems with current sizing systems.

Hip sizes seemed to be almost a perfect fit for all ethnic groups because 92.21% of people found hip sizes as shown in Table 6. For the assessment of fit, the two cases (fit based on hip sizes and fit based on waist sizes) were graphically compared to the ASTM *Misses* figure type standard sizes. Figures 2 and 3 display comparison plots of fit based on waist size (Fig. 2) and on hip size (Fig. 3) respectively.

In the results, when trying to find fit based on waist size, the hips were generally below the fit line in smaller size ranges. In addition, hips were above the fit line in larger size ranges (see Fig. 2). In other words, a consumer who usually wears a small waist size tries on a pair of jeans fitting on waist, but the consumer might find the hip to be too loose on the jeans. If a consumer who usually wore over size 20 tried on a pair of jeans which fit at the waist, but the consumer's hip would not fit appropriately in the jean. Yet, when attempting to find fit based on the hip, the waist sizes were above the fit line overall in all size categories (see Fig. 3). This indicates that neither hip sizes nor waist sizes are applicable for finding a pair of jeans which would fit well.

Table 8 Different fit problems of waist height among ethnic groups

Ethnicity	Group	n	Waist height (pants length) not found					
			<size 2		size 20<		Total not match	
			n	%	n	%	n	%
Caucasian people	840	214	25.48%		181	21.55%	395	47.02
African-American	243	52	21.40%		73	30.04%	125	51.44
Hispanic	47	26	55.32%		4	8.51%	30	63.83
Mexican-American	71	43	60.56%		7	9.86%	50	70.42
Asian	71	40	56.34%		5	7.04%	45	63.38
Other	63	29	46.03%		3	4.76%	32	50.79
Total	1335	404	30.26%		273	20.45%	677	30.26

Figure 2 Fit based on waist sizes.

Figure 3 Fit based on hip sizes.

Conclusions and suggestions

Current jean consumers are diversified in the local US as well as globally. This study revealed a factor that may help define diverse female body shapes in the US population. This study found that diverse ethnic groups had different fit problems, showing the following significant body dimension differences among ethnic groups:

- Caucasian people and African-Americans had similar waist heights (usually pants length) and crotch heights (inseam) showing taller heights than other groups. However, the Caucasian people's thigh girth average was much smaller than the African-American's.
- African-American had a large lower body dimensions, showing larger thigh and hips and waist than other groups' while Asians and Hispanics show smaller body dimensions among the groups.
- The Asian, Mexican-American and Hispanic had similar waist heights and crotch heights, showing shorter heights than other groups.
- The Mexican-Americans and Hispanics had a statistically different lower body dimensions in a *Misses* figure body type size category, showing Mexican-Americans have a bigger waist than other ethnic groups while Hispanics had a smaller waist similar to Asians.
- Asian and Hispanics in a *Misses* figure body type size category had very similar lower body dimensions, showing smaller hips and waist and shorter waist heights.

Even within the same figure type size ranges, a variety of body dimensions existed in each ethnic group. According to the fit problem assessment in this study, consumers within the same body figure type size category would not be able to find the right fit of pants/jeans within the current sizing system. When each consumer found a pair of jeans based on the three cases: (1) waist sizes; (2) hip sizes; and (3) waist height (pants length), the most largest fit problem (49.29%) was found in waist height (pants length) because most women's apparel companies provide little or no choice of pants lengths, unlike men's apparel companies who offer various pants lengths within a waist size. This indicates that a half of all female consumers can not find the right pants length and must pay extra cost for altering pants length.

Each ethnic group showed different fit problems within the current standard sizing system. African-Americans showed fit problems in waist and hips because of larger waist and hips than the defined waist and hip sizes. Mexican-Americans showed fit problems in hips because of larger hips than the defined hip sizes. Mexican-American, Hispanics and Asians had fit problems in waist height (pants length) because of the need for a shorter length than the defined pants length sizes, while African-Americans showed fit problems in waist height because of being taller than the defined pants length sizes. These unique fit problems in each ethnic group are clearly explained with the statistically different body dimensions among ethnic groups that should have been considered for a sizing system.

Compared with waist sizes, hip sizes seemed to show better matches. However, according to the plot comparisons of fit with hips vs. waist, hip was not a better fit match for finding a pair of jeans. For instance, when hip was the constraint for the fit, the waist was above the fit line overall in all sizes. Neither hip sizes nor waist sizes were applicable for diverse consumers. Just a few inch differences in hip measurement could cause a very uncomfortable fit of the tight jeans market for consumers.

Therefore, apparel manufacturers must be aware of differences in ethnicity to provide better quality of fit and the right sizes for diverse consumers in the international market, as well as the local US market. Each ethnic group has unique body shapes as well as different fit problems and preferences, so it is necessary to offer a variety of fits to ensure that the consumer will be able to find one that works for them.

The current sizing systems have not been developed for the diverse consumers. Although it is difficult for apparel manufacturers to set size ranges and grading rules to fit every figure. It is important, however, for organizations to establish standards with awareness of the demographic factor of ethnicity that has different body shapes and dimensions. Thus, sizing systems should be modified to be able to apply for the current consumers. Further study should be carried out for defining body shapes with understanding shape differences among ethnic groups.

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