

ABSTRACT

NEWCOMB, ELIZABETH A. Body Shape Analysis of Hispanic Women in the United States. (Under the direction of Dr. Cynthia Istook)

Sizing and fit strategies have not been used to target Hispanic women in the U.S., a recently recognized profitable segment of the market, primarily due to an absence of anthropometric information about this market. However, the release of SizeUSA data in 2004 provides the resources needed to better understand the body shapes and sizes of U.S. Hispanic women.

The purpose of this study was to analyze the body shapes of Hispanic women in the U.S. and compare them to the body shapes of women from other ethnic groups (Black, White, and Other ethnicities). Current ASTM sizing standards were then evaluated to determine their effectiveness at accommodating the body shapes of Hispanic women represented in the sample. This evaluation was then used to determine if a need existed for a new sizing standard directed at Hispanic women.

Using FFIT[®] for Apparel body shape identification software, results showed that the most predominant shape found in all ethnicities was the Rectangle shape. In addition, current ASTM standards used by the industry were found to be terribly inadequate at meeting the needs of all ethnicities. As a result, efforts were targeted at creating one sizing standard for the entire Rectangle-shaped population of women, regardless of ethnicity. The resulting Rectangle standard included sixteen sizes, and six girth measurements. While not a complete standard, these measurements served as a starting point for a final standard. The proposed

standard was then analyzed to determine its ability to meet the needs of the Rectangle-shaped Hispanic women.

Analysis of the proposed Rectangle sizing standard showed that the proposed standard performed much better than ASTM D 5585, the current Missy sizing standard, at every measurement for Hispanic Rectangle-shaped women (as well as the total population of Rectangles). Results also indicated that Hispanic women may be served by concentrating on smaller sizes, in a narrower range of sizes in the standard.

This was important research for apparel companies, as it provided a better understanding of the body shapes of Hispanic women, as well as investigated and determined the best way to target this group. Methodology used in this project may also be used to create additional shape-based sizing standards, to research other target markets, and to determine the most appropriate sizing strategies to target specific markets.

BODY SHAPE ANALYSIS OF HISPANIC WOMEN IN THE UNITED STATES

by
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DEDICATION

*To my parents, Fred and Myrtle Newcomb,
who never stopped believing in me.*

BIOGRAPHY

The author, Beth Newcomb, was born August 19, 1981 to Fred and Myrtle Newcomb. She has a twin sister, Katy. She grew up in Goldsboro, North Carolina, graduating from Charles B. Aycock High School in 1999. Upon graduation from high school, Beth started her undergraduate studies at NC State University as a Park Scholar. As an entering freshman, she was in the Biochemistry department, but during her first semester, she transferred into the College of Textiles' Textile and Apparel Management department. Since then, she has considered this college her home, graduating in May, 2004 with her Bachelor's of Science degree in Textile and Apparel Management and a Minor in Spanish. She is currently working toward her Master's degree and looks forward to beginning her doctoral studies in the Textile Technology Management department in August, 2005.

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CHAPTER ONE: INTRODUCTION

The United States' apparel industry is a mature industry, heavily impacted by increased globalization and technological advancements around the world. In a mature industry, products have relatively stable sales from year to year and the market is often saturated with many competitors (Keiser & Garner, 2003, p. 8-9). This is certainly true for the U.S. apparel industry, as it is practically inundated with competition from countries around the world. In the face of this competition, the development of a differential advantage is important for a firm to maintain market share (Keiser & Garner, 2003).

One way that firms have attempted to create a competitive advantage is by carving out niche markets, which are markets that have narrowly focused target consumers. This allows for the creation of specially designed products, advertising plans, and other marketing strategies to attract specific consumers and provide them with products that meet their specific needs. Thus, for a firm to create a successful niche market, it must first develop an intimate knowledge of target consumers, the features that attract them to products, how they differ from other consumers, and how these differences can be capitalized on to create new markets.

Niche markets may be defined by a variety of demographic, psychographic, and generational factors including gender, family size, income, spending habits, shopping preferences, occupation, education, religion, age, culture, social class, and ethnicity (Keiser & Garner, 2003, chap. 2). The focus of this research involved

segmentation of groups by ethnicity, which is becoming increasingly important as the ethnic diversity of the United States continues to grow. The widespread growth of minorities in the U.S. has resulted in large consumer groups that should not be ignored by apparel firms. The opportunities for these firms lie in their ability to define and meet the needs of these new, largely untapped markets.

This research focused on the largest minority ethnic market in the United States – the Hispanic population. The population's recent growth in size and purchasing power has caught the attention of many apparel firms trying to gain a competitive advantage by creating and supplying products to new niche markets. Recent strategies used by the apparel industry to target this group have included style adaptations (such as increased use of bright colors and embellishments) and advertising changes (such as bilingual advertisements and the use of Hispanic models). However, apparel companies have yet to target the U.S. Hispanic consumer through sizing changes. This is largely due to the fact that until 2003, the only anthropometric data available to apparel firms was information from a sizing study conducted in 1939 – a study that is not only outdated and does not account for the changes in the ethnic makeup of the United States, but was also biased at the time of its conduction and was not even representative of the population sixty years ago, much less the U.S. population of today.

The completion of SizeUSA in 2003 has provided anthropometric data that is the most representative and comprehensive of the U.S. population to date, and this data can be used to transform the apparel industry (as well as other industries).

Data that accounts for the ethnic diversity in the U.S. now exists, and can be studied to more completely understand the body shape and size characteristics of specific ethnic groups. Analysis of this data will give apparel firms a more clear understanding of how to best meet the apparel fit and sizing issues of specific ethnic groups, and in turn may allow for the creation of niche markets based on ethnicity and body shape and size.

Rationale

Apparel customers have long been dissatisfied with apparel fit of mass-produced clothing, primarily due to lack of standardization in apparel and outdated sizing standards. Voluntary sizing standards are rarely adhered to by the apparel industry, due to the fact that the anthropometric data upon which these standards are based is over forty years old. Because of the lack of data that reflects the current population in the U.S., the apparel industry has simply been ill-equipped to solve apparel fit problems.

However, with the completion of SizeUSA in 2003, the apparel industry now has access to a wealth of anthropometric information about the current U.S. population. In addition to the collection of body measurements, the National Sizing Survey for the United States also collected a variety of demographic and shopping preference information about the subjects measured. Information gathered such as ethnicity, age, and income ensured that the study was representative of the actual

U.S. population, while shopping preference information allowed for a deeper understanding of the subjects' motivations as consumers.

The type of data collection performed through SizeUSA provides the apparel industry with very powerful information, allowing for segmentation of the subjects into groups for analysis and comparison. This project utilized SizeUSA information to segment the population of subjects according to ethnicity, and then focused specifically on the Hispanic population. As the largest ethnic minority in the U.S., the Hispanic population is increasingly becoming the focus of ethnic target marketing for apparel firms hoping to gain customers from this powerful market. However, due to a lack of anthropometric information about U.S. Hispanics, no apparel firm has yet to target this group through sizing and fit. SizeUSA has provided the information that allows for a thorough study of the body shapes that predominate in the Hispanic women's population in the United States. The result of this study was a better understanding of how well current sizing standards used by the industry meet the fit needs of Hispanic women, how the body shapes of Hispanic women in the U.S compare to the general population, and how a new sizing system based on their specific body shapes could be created to improve the fit of apparel targeted to Hispanic women.

Purpose of Study

The major objective of this research was to perform a thorough analysis of the body shapes that predominate in the Hispanic women's population in the U.S.

The first goal was to use SizeUSA data to evaluate how the body shapes of Hispanic women in the U.S. compare to the body shapes of women in the overall U.S. population. Second, tests were done to determine if and how the body shapes of Hispanic women vary based on age, income or geographic location. Once the shape distribution of the Hispanic population was determined, current sizing standards used by the apparel industry were analyzed to evaluate their effectiveness at meeting the needs of Hispanic women. Based on the results of this information, this study then attempted to develop a new sizing standard directed at the specific needs of Hispanic women in the U.S. Overall, the goal of this study was to obtain a more complete understanding of the body shapes of U.S. Hispanic women and discover a method to target this group with a sizing system that improves their satisfaction with the fit of apparel.

Research Questions

The following research questions provided the backbone of this research, as well as gave organization to the research process and resulting thesis. Guiding this study were six primary research questions:

- 1. How do the body shapes of Hispanic women in the U.S. compare to the body shapes of women from other ethnic groups in the U.S.?*
- 2. Do the body shapes of Hispanic women in the U.S. differ significantly based on age, income, or geographic location?*

3. *How well do apparel sizing standards used by the industry today meet the needs of Hispanic women in the U.S.?*
4. *How do bust, waist, high hip, hip, upper arm, and thigh max measurements of Hispanic women in the Rectangle shape category compare to Rectangle-shaped women in the White, Black, and Other ethnic categories of SizeUSA?*
5. *How should a sizing standard for the most predominant shape category in the U.S. population (the Rectangle shape) be created?*
6. *How well does the sizing standard created for the Rectangle-shaped U.S. population of women meet the needs of Hispanic women in the Rectangle shape category?*

Limitations

This study was limited in the following ways:

1. The SizeUSA study is representative of the entire U.S. population only to the extent that the National Health and Nutrition Examination Survey (NHANES) III conducted from 1988-1994 was representative. Because a random sampling strategy was cost and collection prohibitive, SizeUSA decided to model its sampling strategy after the NHANES study ([TC]², 2004b). SizeUSA is considered to be representative of the U.S. population because the NHANES study was concluded to be valid. As a representative study, SizeUSA data can be generalized to the entire U.S. population. Thus, any

generalizations made about Hispanic women in the U.S. is based on the representativeness of the SizeUSA and NHANES III study.

2. Subjects in the SizeUSA study were identified Hispanic-American through survey questions administered to them before being measured ([TC]², 2004b). This type of self-identification has been shown to be the best way to identify a person as a member of a certain ethnic group, as a person who identifies with a certain group typically behaves like that group and exhibits characteristics of that particular group (Deshpande, Hoyer, & Donthu, 1986). However, simply because a person identifies herself as a Hispanic woman does not necessarily mean that she will exhibit the body shape and size characteristics of a Hispanic woman (as there are factors that influence body shape and size other than simply self-identification). For the purposes of this study, all women who described themselves as Hispanic were included in the analysis of the Hispanic group.
3. In questioning subjects regarding their ethnicity, the SizeUSA survey classified four main groups (Asian, Caucasian, African American, and Hispanic). While respondents choosing the Hispanic ethnic group could specify whether they were Mexican-Hispanic or Non-Mexican Hispanic, there was no option to further specify the Hispanic subculture or country of origin of respondents. Past studies have shown the importance of recognizing differences between Hispanics of different subcultures (such as those from Puerto Rico, the Dominican Republic, Cuba, Honduras, etc.), as these

different backgrounds can result in very different attitudes and behavior.

Experts often warn companies trying to target the Hispanic population in the U.S. against placing all Hispanics in the same group and attempting to target them all with the same strategy (Beith, 2004; Donthu & Cherian, 1994; Genn, 2004; Kelleher, 2004; Tharp, 2001, p.127-132; “Marketing to Hispanics,” 2004). While researchers acknowledge the benefit of understanding differences between subcultures in Hispanic advertising and styling, the SizeUSA data does not allow for a comparison of body shapes of Hispanic women from different subcultures.

4. The sizing standard created for this study only included girth measurements, and no length, height, or weight measurements (i.e. Petite and Tall standards were not created separately to target women in those height groups).
5. In creating a new sizing standard based on updated SizeUSA anthropometric data, the decision was made to focus solely on the Rectangle shape category. The Rectangle shape was the most predominant shape for the total population of U.S. women and Hispanic women, making up close to 50% of each population. Due to the complexity of creating a single standard, the other shape categories were not covered with a new sizing standard. As a result, only Hispanic women in the Rectangle shape category could be studied against the new standard.

CHAPTER TWO: REVIEW OF LITERATURE

Before delving into the analysis of SizeUSA data, it was helpful to review certain topics of relevance to this study. First, an overview of the Hispanic population in the U.S. and some of its most important demographics showed the driving forces behind the interest in this market. Second, a review of the apparel shopping patterns of U.S. Hispanics, and examples of how apparel companies have attempted to target Hispanics in the past highlighted some of the major reasons behind the apparel industry's increasing interest in the U.S. Hispanic market and their efforts to target them. Third, research into the history of U.S. sizing standards not only illustrated why the U.S. apparel industry is experiencing so many problems in the area of sizing and fit, but also showed why U.S. Hispanics have never been targeted through sizing. After covering these topics, the review of literature concludes with a description of the apparel industry today, including sizing and fit issues and technologies such as three-dimensional body scanning, SizeUSA, and FFIT® for Apparel that hold much promise for improving apparel sizing and were especially helpful in completing this research.

The U.S. Hispanic Population

As a whole, the Hispanic population in the U.S. has several characteristics that make it distinct and hard to ignore. This ethnic minority represents an area of

extreme, seemingly exponential, growth – not only in number, but also income and purchasing power. This growth, along with factors such as the average age, geographic distribution, and household characteristics of the population has resulted in a consumer segment that is so large and distinct that when ignored, could result in market share loss (Bertagnoli, 2001; “Marketing to Hispanics in the U.S.,” 2004; Seckler, 2003)). However, a better understanding of these characteristics of the U.S. Hispanic population could result in the type of huge market gains that are so desperately needed in the mature textile and apparel industries in the United States.

Size

The U.S. population has experienced much diversification in the last thirty years, as minority populations increased at a faster rate than the predominant White, non-Hispanic population. In 2002, the Hispanic population passed the African-American population to become the largest minority in the U.S., making up 13.5% of the total U.S. population at 38.5 million. This statistic shows rapid increase in the Hispanic population since 1970 (the first time in U.S. Census history that the Hispanic population was officially measured), when this group accounted for only 4.5% of the population (U.S. Census Bureau, 2003).

This huge growth in the Hispanic market in the U.S. has resulted in a large consumer segment that warrants respect even on the world scale. For instance, 84% of the world's countries have populations that are smaller than the U.S. Hispanic market (Telemundo, n.d.). The size of the U.S. Hispanic market also makes it the world's fifth largest Hispanic consumer marketplace. Table 1 contains an

interesting top ten list of the largest Hispanic consumer markets in the world, with the United States listed among nine other Hispanic countries around the world.

Table 1: Top Ten Hispanic Consumer Markets in the World

| | Hispanic Market | 2001 Population (in millions) |
|-----|-----------------------------|-------------------------------|
| 1) | Mexico | 99.6 |
| 2) | Colombia | 43.1 |
| 3) | Spain | 39.6 |
| 4) | Argentina | 37.5 |
| 5) | U.S. Hispanic Market | 36.2 |
| 6) | Peru | 26.1 |
| 7) | Venezuela | 24.6 |
| 8) | Chile | 15.4 |
| 9) | Ecuador | 12.9 |
| 10) | Cuba | 11.3 |

Note: From "Today's Hispanic Market," by Telemundo, n.d, Available on-line at www.nbccableinfo.com/insidenbccable/pdf/telemundo/mktanalysis.pdf

Due to continued immigration and a higher than average birth rate, the rapid growth of the U.S. Hispanic population also shows no signs of slowing down (Global Insight, 2005). From Census 2000 to July 1, 2003, the Hispanic population grew by 13% to 39.9 million people, accounting for over half of the total growth in population during that time (Bernstein, 2004). Census experts predict that the Hispanic population will continue to grow, moving from representing 13.5% of the total U.S. population in 2002 to 24.4% in 2050. The percentage growth for this group is expected to be about three times the growth for the total U.S. population (U.S. Census Bureau, 2004).

When considering population growth, it is interesting to not only look at growth in number of individuals, but also growth in number of households. Experts predict that the number of Hispanic households in the U.S. will increase by 35% between now and 2010, to about 13.5 million Hispanic households. This is an important fact for many industries supplying products for families or groups (Kelleher, 2004).

For this particular research study into the body shapes of Hispanic women in the U.S., it is helpful to consider the size of the Hispanic women's market. The most current population data separated by gender comes from the 2000 Census. At that time, Hispanic women made up 6% of the total U.S. population of men and women, and 11.6% of the population of women (U.S. Census Bureau, 2000c). This group of 17.14 million was a considerable size in 2000, but with the rapid growth of the Hispanic market, this group will become an even more formidable consumer segment in the future. The power that this segment could potentially represent is one of the key driving forces for this research.

Age

One of the most distinguishing characteristics of the Hispanic population is the average age of its members, especially when compared to the aging baby boomers in the overall U.S. population. While 25.7% of the total U.S. population is under 18 years of age, 35% of Hispanics are in this age group (U.S. Census Bureau, 2003). In addition, the median age for U.S. Hispanics is only 26.7 years, while the median age for the total population in the U.S. is 35.9 years (Bernstein, 2004).

According to one journalist covering the Hispanic population, “It is not merely that Hispanic customers are young, but that young customers are Hispanic,” (“Marketing to Hispanics,” 2004, p. 2).

The youthfulness of the Hispanic population in the U.S. is extremely important for companies providing products to this market. The Hispanic-American consumer simply has more years to consume goods and services than average non-Hispanic-Americans, meaning that those firms attracting Hispanic-Americans could be creating long-term consumers (Schreiber, 2001, p.53). Firms hoping to capitalize on this market should not only consider the affects of Hispanic culture on consumers, but also the affect of age. Younger consumers often demand different styles and product features than their older counterparts.

Geographic Distribution

The location of consumers is one of the most important factors to consider when supplying products to a particular market. Knowledge of the areas with the highest concentration of consumers can not only aid in the creation of test markets, but also suggest areas where products should first be introduced. Overall, the U.S. Hispanic population is more geographically concentrated than the non-Hispanic White population. As shown in Figure 1, more than three-quarters of all Hispanics live in the West and South, while the population of non-Hispanic Whites is more evenly distributed. More specifically, half of all Hispanics in the U.S. live in the two states of California and Texas, while three of the largest cities in these states – Los Angeles, San Antonio, and El Paso – have a Hispanic population of greater than

50% of the total population of the respective states (U.S. Census Bureau, 2003). As indicated by the choice to live in areas such as Los Angeles and San Antonio, Hispanic-Americans tend to reside most often in large metropolitan areas. New York and Miami are two other cities with high concentrations of Hispanic-Americans (U.S. Census Bureau, 2003).

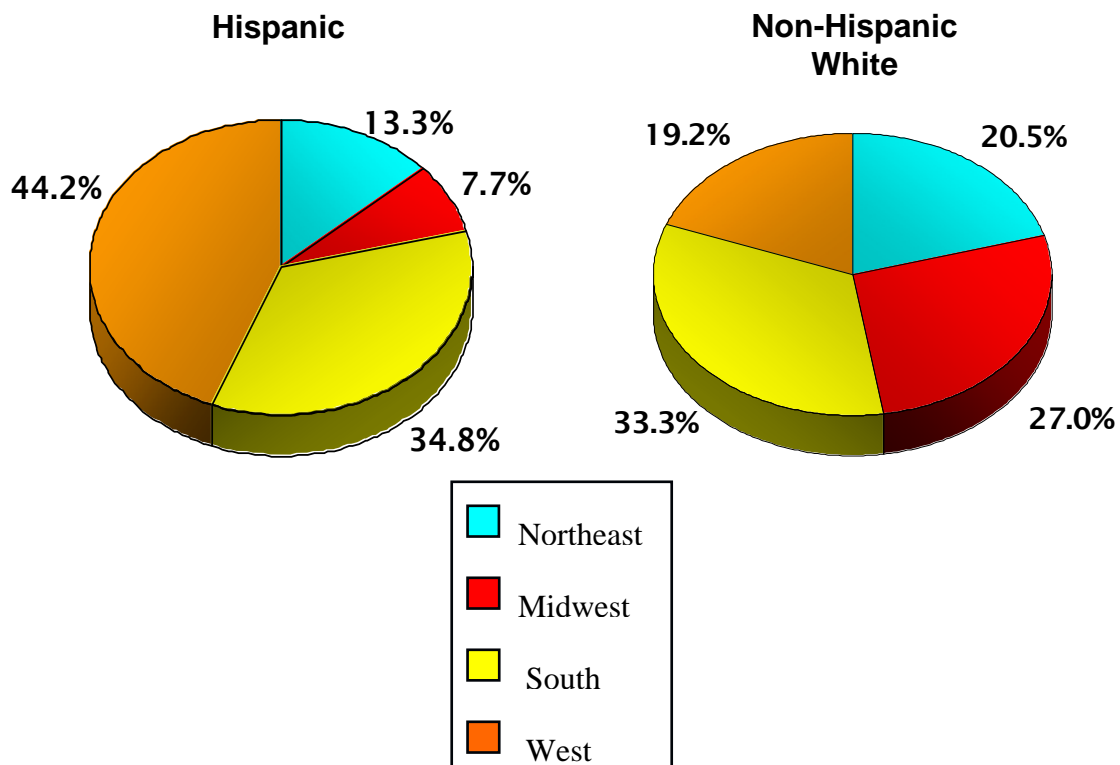


Figure 1: Regional population distribution for Hispanics and non-Hispanic Whites.

Note: From “The Hispanic Population in the United States: March 2002 Population Report” by Ramirez and Cruz (2003). Available on-line at <http://www.census.gov/prod/2003pubs/p20-545.pdf>

As the size of the U.S. Hispanic population continues to increase, these metropolitan areas will see additional gains in their Hispanic populations. However,

other areas of the United States are also experiencing growth in their Hispanic populations. As shown in Figure 2, regions of North Carolina, Tennessee, and Iowa have seen tremendous increases in their Hispanic populations, helping to spread out the Hispanic population to regions not typically occupied by many Hispanics.

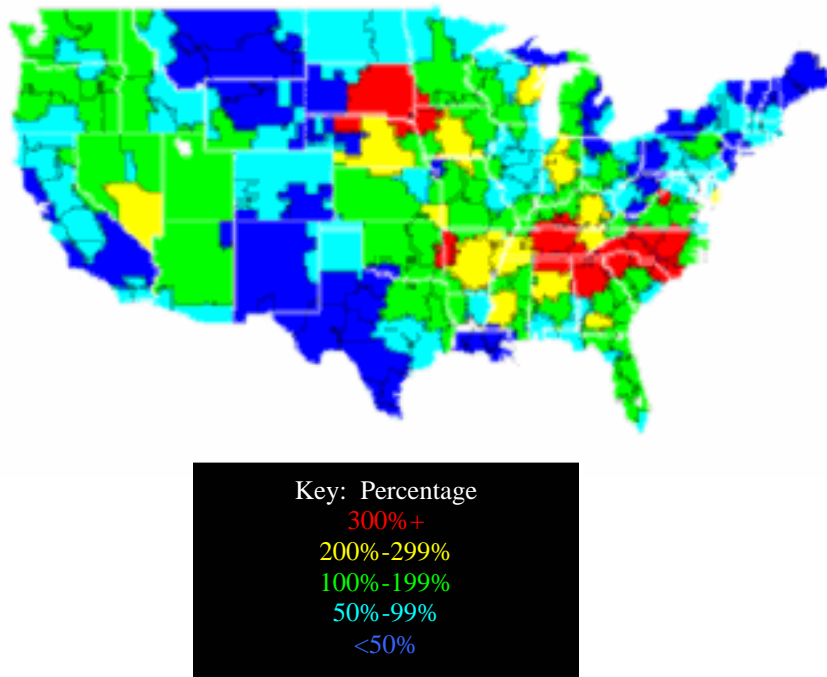


Figure 2: Percentage change in Hispanic population from 1990-2001.

Note: From "Today's Hispanic Market," by Telemundo, n.d, Available on-line at www.nbccableinfo.com/insidenbccable/pdf/telemundo/mktanalysis.pdf

However, it is important to view information such as that contained in Figure 2 with the knowledge that while it looks as though the Hispanic population in regions of Texas and New Mexico is not increasing that much, these areas already have such a large Hispanic concentration that percentage gains in these regions may equal actual number gains in some of the states with higher percentage growths.

Household Characteristics

In addition to the average age and geographic distribution of the Hispanic population, characteristics of Hispanic households are also of interest to companies attempting to target this market. For instance, the Hispanic population favors larger households with more children and extended families living together. About 11% of U.S. Hispanic families have six or more members, while only 3.5% of the general populations' families are that large ("Marketing to Hispanics," 2004). Thus, when a Hispanic-American household becomes a customer of a firm's products, the firm gains more market share than would be gained by attracting average non-Hispanic-American households (Schreiber, 2001, p.53). This is yet another reason for U.S. firms to be interested in developing and marketing targeted products to this market.

In addition, Hispanic family households are more likely than non-Hispanic White family households to be maintained by a female with no spouse present (Ramirez & Cruz, 2003). This is particularly important for companies interested in the Hispanic market in the U.S., because it influences the types of products demanded, as well as indicates who should be the primary target in advertising and marketing.

Last, just as the Hispanic population as a whole is young, Hispanic households are also far more likely to be headed by someone under 35 years of age. Only 23% of the total U.S. households are headed by someone under the age of 35. However, 38% of U.S. Hispanic households are headed by people this young (Kelleher, 2004). Once again, this youthfulness not only affects the types of

products demanded, but also influences the advertising strategies that should be used to attract them.

Purchasing Power and Income

As discussed previously, the growth in the Hispanic population is one of the key reasons firms are becoming interested in attracting this market. However, even more important than population growth is the increasing income and purchasing power of the U.S. Hispanic market. For instance, the Hispanic middle class is growing, resulting in a larger group of people with money to spend. Between 1996 and 2001, the median income of Hispanic households rose by 20%, from \$27,977 to \$33,565. During the same time, the median income for all households rose by only 6%, from \$39,869 - \$42,228 ("Marketing to Hispanics," 2004). While Hispanics earn less than the average households in the U.S., the rapid growth of income in recent years suggests that the gap could be quickly closing and the economic state of this minority population is greatly improving.

The growth in affluence experienced by the Hispanic market is also predicted to continue. Household income growth from 1990-2000 for Hispanic-American populations was 24.3%, which far surpassed the growth for white households at 14.2% (Cotton Incorporated, 2002b). Their income now accounts for approximately 8% of the U.S. GDP, and is expected to reach 10% by 2010 ("Business: Opportunity," 2004). While still a small percentage of total GDP, this rise is significant for companies targeting the U.S. Hispanic population.

Behind this rise in income is improved education and employment. Statistics have shown that while the U.S. job market has lost nearly one million employees recently, U.S. Hispanics have not been terribly affected. From 2000 to 2003, the number of employed Hispanics has grown by 450,000 (Downey, 2003).

In addition to the population growth and growth in income of the U.S. Hispanic market, the purchasing power of this large group has increased and made them a consumer segment not to be ignored. While the population itself is growing tremendously, the growth in consumer spending is growing three times faster (Downey, 2003). Estimates show the current purchasing power to be \$686 billion. According to a study performed by the Selig Center for Economic Growth at the University of Georgia (2004), the purchasing power of Hispanic consumers is expected to be \$923 billion in 2009. This would represent 9% of all U.S. buying power and would be a 347.1% increase from the buying power of the Hispanic market in 1990 (Humphreys, 2004). Substantial increases like this in the future will result in an even stronger argument for research into ways to successfully target the U.S. Hispanic market with products and marketing strategies.

The Apparel Industry's Increasing Interest in U.S. Hispanics

The growth in size, income, and purchasing power of the Hispanic market in the U.S. has caused many industries and firms to become interested in attracting consumers from this group. Due to certain apparel shopping characteristics of the Hispanic consumer, the apparel industry in particular is trying to create new markets

with specialized products and marketing techniques targeted to Hispanics. This section begins with a discussion of the apparel shopping characteristics of the U.S. Hispanic consumer, and then continues with an overview of how specific apparel companies have attempted to target this group in the past and their plans for the future.

Apparel Shopping Patterns of U.S. Hispanic Consumers

The U.S. Hispanic market spends a considerable amount of income on apparel. As an ethnic group, Hispanic apparel purchases are second only to amounts spent by African-American consumers. The average African-American consumer spends an average of \$1,427 on apparel each year, followed by Hispanic consumers at \$1,282, Asian-Americans at \$1,044, and white consumers at \$869. The amount spent by white consumers is actually \$100 less than the average consumer (Cotton Incorporated, 2002b). From September 2002 to September 2003, Hispanics spent just over \$15 billion on clothes, representing 9% of all apparel sold in the U.S. in that time (Wexler, 2004). Hispanics are also willing to spend 15% more than other ethnic groups of an extra \$500 on apparel (Cotton Incorporated, 2004b). This data shows that Hispanics are serious apparel purchasers, spending larger amounts of their discretionary income on apparel than the average U.S. consumer.

Not only do Hispanics spend more on apparel, but they also pay more per unit of apparel. Table 2 summarizes some of the major categories of apparel, and compares the average price paid for apparel in 2001 among the different ethnic

groups. While they do not spend as much as Black and Asian consumers on average, Hispanic consumers do spend more than the average consumer in all but one category of apparel covered in Table 2.

Table 2: Average Price Paid for Apparel (9 months 2001, dollars)

| | Total | Black | Asian | Hispanic | White |
|-----------------------|--------------|--------------|--------------|-----------------|--------------|
| Total Apparel | 20.33 | 24.15 | 23.66 | 21.07 | 19.84 |
| Skirts/Dresses | 30.97 | 32.77 | 35.81 | 27.95 | 30.75 |
| Slacks | 24.86 | 26.83 | 28.43 | 25.34 | 24.60 |
| Jeans | 24.60 | 28.51 | 27.49 | 27.22 | 23.91 |
| Sweat Apparel | 22.95 | 30.87 | 27.17 | 23.87 | 21.61 |
| Shorts | 15.75 | 17.95 | 17.82 | 16.77 | 15.43 |

Note: From "Understanding the Multicultural Consumer Base," by Cotton Incorporated, 2002b, Available on-line at www.cottoninc.com/TextileConsumer/1201TC.pdf

As a group, Hispanics also love to shop. A survey included as part of Cotton Incorporated's Lifestyle Monitor™ shows that while consumers indicating that they love or enjoy shopping for apparel has decreased overall from 1994-2001, this decline has not been apparent for Hispanic consumers (see Figure 3). Sixty-five percent of U.S. Hispanics responding to the survey claimed to love or enjoy shopping for apparel, representing the highest percentage of any ethnic group in the U.S. (Cotton Incorporated, 2002b). Eager consumers like this will be more responsive and willing to consider new apparel products.

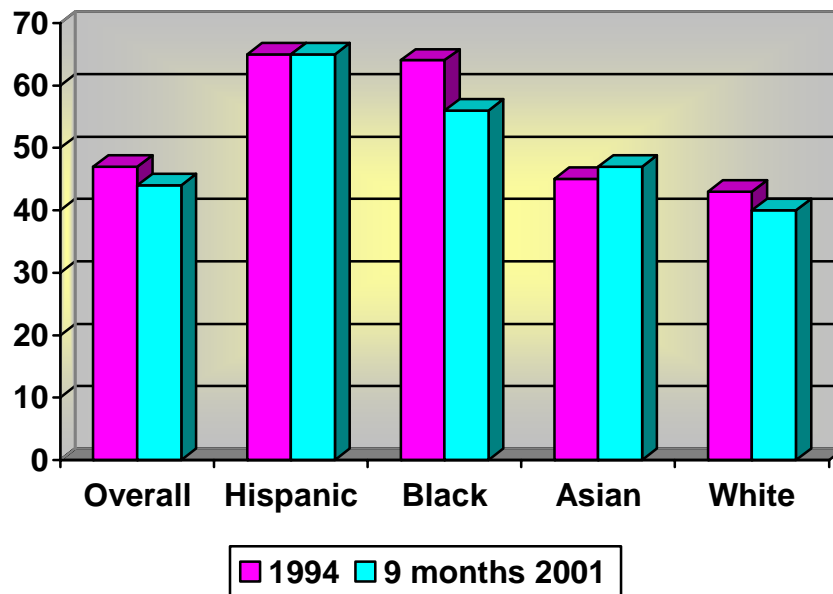


Figure 3: Percent of U.S. consumers who love or enjoy shopping for apparel.

Note: From "Understanding the Multicultural Consumer Base," by Cotton Incorporated, 2002b, Available on-line at www.cottoninc.com/TextileConsumer/1201TC.pdf

Also interesting about the U.S. Hispanic apparel consumer is where they prefer to shop. Traditional stereotypes in the U.S. would suggest that U.S. Hispanics shop most often at mass merchant or discount stores. However, this is not the case for apparel purchases; in fact non-Hispanic whites are far more likely to shop at discount stores than U.S. Hispanics, according to a survey conducted by Cotton Incorporated's Lifestyle Monitor (Cotton Incorporated, 2002b). The majority of U.S. Hispanics actually most prefer to shop at department stores for apparel. Hispanics now account for 11% of *total* department store sales, and 10% of other clothing store sales, and these percentages are expected to continue increasing (Downey, 2003). In addition to department store patronage, an area of increased

growth for U.S. Hispanics is on-line shopping. Hispanic e-spending hit \$8.1 billion last year, but Hispanic women are still the least likely of all ethnic groups to shop for apparel online (Beith, 2004). However, many companies are looking at the dollars spent last year and forecasting that Hispanic e-spending will continue to grow, and are thus putting considerable effort into marketing through this channel (Cotton Incorporated, 2004b).

According to recent studies completed as part of Cotton Incorporated's Lifestyle Monitor™, U.S. Hispanics look for certain attributes when making their decision on where to shop. According to one study, 17% of Hispanic women like to stay on the cutting edge of fashion, compared to only 13% of all other women. As fashion-forward consumers, they prefer stores with trendy assortments (Cotton Incorporated, 1998). Also not surprisingly, 28% of Hispanic women noted that their favorite clothing stores receive new merchandise every week (Cotton Incorporated, 2001). In addition, considering the larger than average households (refer to section entitled "Household Characteristics,"), many U.S. Hispanic consumers look for stores where they can find all they need to outfit their entire family – kids, husbands, and themselves (Cotton Incorporated, 2004b). This may help explain the large number of U.S. Hispanics who prefer to shop at department stores, and the fact that U.S. Hispanics are driving much of the sales at this channel.

Just as Hispanics look for specific attributes in store selection, they also weigh certain factors before purchasing apparel products. According to studies conducted by Cotton Incorporated, U.S. Hispanics shop for apparel with special

details like embroidery, unique stitching and glitter. Thus, they are also attracted to bright colors and bold prints (Cotton Incorporated, 2004b). The chart in Table 3 shows some of the most important factors when buying apparel and highlights some of the major differences among ethnic groups from 1994 to 2001. From this table, 73% of U.S. Hispanics consider price an important factor, but this percentage is less for Hispanics than for any other ethnic group. This leads readers to believe that Hispanics are less price-conscious than other groups, which is against traditional stereotypes for this group. While they do consider price to be important, they are less focused on price than other groups. However, Hispanics, more than other ethnic groups, place importance on brand name, lending support to other studies that speak of the Hispanic population's brand loyalty (Cotton Incorporated, 2002b). Researchers have hypothesized that the fierce brand loyalty exhibited by U.S. Hispanic consumers is a signal of personal status and success. According to one Hispanic shopper:

...(buying brand names) says something about my position and success,...and we're willing to pay for that. It's a statement, and (Latinas) are constantly in the position of making that statement, because unfortunately, there are still stereotypes. It's a good way of showing the world that I'm an American, I have a job, and I do well for myself." (Cotton Incorporated, 2002a, paragraph 6).

While Table 3 does not measure other factors that may be considered important in apparel purchases, it does indicate some of the most important factors and allows for comparison between ethnic groups.

Table 3: Important Factors When Buying Apparel, by Ethnicity

| Important Factors When Buying Apparel (1994 vs. 9 months 2001, percent of consumers responding) | | | | | | | | | | |
|---|--------------|------|--------------|------|-----------------|------|--------------|------|--------------|------|
| | <u>Total</u> | | <u>Black</u> | | <u>Hispanic</u> | | <u>Asian</u> | | <u>White</u> | |
| | 1994 | 2001 | 1994 | 2001 | 1994 | 2001 | 1994 | 2001 | 1994 | 2001 |
| Price | 68 | 81* | 68 | 79* | 65 | 73 | 71 | 81* | 69 | 83* |
| Fabric Content | 47 | 58* | 41 | 56* | 40 | 49 | 48 | 58* | 49 | 60* |
| Care Instructions | 34 | 48* | 37 | 44* | 33 | 39 | 26 | 44* | 34 | 50* |
| Origin of Garment | 45 | 38* | 36 | 30* | 37 | 29 | 32 | 30 | 47 | 40* |
| Brand Name | 29 | 34* | 32 | 37* | 31 | 38 | 43 | 63* | 28 | 32* |

Note: *Statistically significant change from 1994; From "Understanding the Multicultural Consumer Base," by Cotton Incorporated, 2002b, Available on-line at www.cottoninc.com/TextileConsumer/1201TC.pdf

Review of Apparel Companies' Efforts to Target U.S. Hispanics

A consideration of the apparel purchasing power and habits of the U.S. Hispanic consumer gives insight into the major reasons behind the apparel industry's increasing interest in this market. The challenge for apparel firms has been in the development of successful strategies to target these consumers and entice them to buy. Thus far, the primary methods used by apparel firms in their ethnic target marketing of U.S. Hispanics have been advertising and product changes. The Association of Hispanic Advertising Agencies has recommended that apparel stores dedicate 16% of their marketing budgets to targeting Hispanics, up from the 4% that is currently being spent. Within the apparel segment, they recommend that jeans and athletic shoes should command the largest allocation of advertising money (Seckler, 2003). Experts have suggested these increases in

spending to accommodate for the increasing purchasing power and size of the Hispanic market in the U.S.

Benchmarking the success from other industries, such as the food and service industries, the apparel industry has in the last 10-15 years initiated several campaigns designed to target U.S. Hispanic apparel consumers. These campaigns use different methods to attract Hispanic consumers – from product design changes to advertising strategies using Hispanic spokespersons. A review of some apparel companies' strategies to target U.S. Hispanic consumers is helpful and included below:

Dillard's: While some companies perform their own marketing research studies into the Hispanic market, independent marketing research firms also serve as a good resource for information. For instance, Dillard's used a company called Supreme International to obtain market research into the Hispanic consumer. This company is based out of Miami, and headed by a person of Hispanic descent. Dillard's heard about the company's success in learning a great deal about the Hispanic consumer and thus decided to forgo a formal market study of their own on the population, and instead simply use Supreme International's resources (R.Stockley, Technical Director, Dillard's Department Stores, personal communication, September 14, 2004).

Supreme International gave Dillard's information about product preferences of the Hispanic consumer and they used these preferences to design the "Contigo" line of men's apparel, which is sold in specific regions of the U.S. with high

concentrations of Hispanics. According to their research, Hispanic men tend to prefer shirts that are highly embellished (with embroidery, or the like), clothes in dark colors, and in styles that the general population might consider to be “club/going out attire”. While Dillard’s does not yet have a line of apparel targeted to Hispanic women, they do plan to introduce one in the future (R.Stockley, Technical Director, Dillard’s Department Stores, personal communication, September 14, 2004).

JCPenney: JCPenney has long been interested in the multicultural consumer and has introduced several lines targeting different ethnic groups. The product lines have included home furnishings, gifts, apparel, and accessories that reflect the ethnic heritage of groups in styling and color (“JCPenney Targets Ethnic Markets,” 1993). Based on one marketing research study into Hispanic product preferences, JCPenney introduced a men’s apparel brand, coined “Havanera” and produced by Perry Ellis International, which relies on linen drawstring waists and embroidery that typify clothing in Latin countries (Wexler, 2004). The “Havanera” line is still very popular in 2005, with the advertising strategy used for this particular brand heavily influenced by Hispanic culture (see Figure 4).



Figure 4: Advertising copy for the “Havanera” menswear line for JCPenney.

Note: From JCPenney's website (2005). Available on-line at http://www3.jcpenny.com/jcp/SpecialtySiteB.aspx?deptid=469&catid=15290&cattyp=BRD&cat=havanera+co.&dep=men%27s&pcatid=&pcat=&shopby=15290&refpage=SpecialtySite&ttyp=B&cmAMS_T=&cmAMS_C=

In addition to the menswear line, JCPenney joined forces with Jerrell Incorporated to produce an apparel line for Hispanic women in 1997. Jerrell hired Sandra Salcedo, a Latina apparel designer, to develop a line specifically for Hispanic women, in colors and styles this market favors. This line focused on bright colors and embellished styles (D’Innocenzio, 1997; Fearnley-Whittingstall, 1994).

In a study conducted by JCPenney in 1994, the firm compiled customer requests and sales reports to determine that Hispanic women are more likely to wear smaller than average shoes, and demand more petite-sized clothing (Fearnley-Whittingstall, 1994). In the absence of sizing data for the Hispanic market, JCPenney used the only resources they had to understand more about the sizes demanded by U.S. Hispanics. With the release of SizeUSA data in 2004, apparel

firms now have more concrete measurement data to compare against these customer reports and sales data.

Kmart: Kmart has been positioning itself the last several years as the ultimate mass-market destination for multicultural consumers. According the Steve Feuling, Senior Vice President of Marketing, 40% of the people who shop at Kmart have multicultural backgrounds (Scardino, 2004), and Hispanic consumers alone make up 17% of Kmart's total sales (Cotton Incorporated, 2004b).

In August 2003, they introduced an apparel line targeted towards Latinas. Named "Thalia," the line was designed by Thalia, an extremely popular singer from South America, and contains styles that appeal primarily to Hispanic women, but also to other groups. Apparel in this line tends to be bright in color, such as reds and fuchsias, and in trendier, more fashion-forward silhouettes that attract Hispanic women (Scardino, 2004). The outfits shown in Figure 5 show some of the designs offered in the "Thalia" line at Kmart. These tops were designed with embellishment such as graphic prints and glitter to attract the Hispanic woman who tends to like details in her apparel. Bold designs such as the ones seen in Figure 5 characterize this line of apparel, jewelry, and other accessories. The "Thalia" line was introduced in 335 of Kmart's 1,500 stores and has been very well-received, exceeding all expectations (Cotton Incorporated, 2004b).



Figure 5: “Thalia” shirts sold at Kmart.

Note: From Kmart’s website (2005). Available on-line at <http://www.kmart.com/catalog/search.jsp?N=0&Nty=1&Ntk=All&Ntx=mode%20matchallpartial&Ntt=thalia>

Kohl’s: In 2004, the “Daisy Fuentes” line at Kohl’s was introduced to target Hispanics primarily, but also to appeal to the general Kohl’s consumer. Their research showed that Daisy Fuentes has a broad appeal to average Kohl’s customers, but especially Hispanics. Thus, they could use Fuentes’ Hispanic culture to attract Hispanic consumers, but the line would also work for non-Hispanic consumers. In order to appeal to the broadest range of customers, the “Daisy Fuentes” line consists of “modern options that are very fashion forward” that Hispanics and other ethnic groups will enjoy (Cotton Incorporated, 2004b, paragraph 15).

L’eggs: Sara Lee Branded Apparel has performed several studies related to ethnicity and their brands. In a recent L’eggs study, researchers outlined some of the factors that make Hispanic women good opportunities for the hosiery industry.

Fifty percent of Hispanic women describe themselves as heavy to moderate pantyhose users. Seventy-two percent also claim to purchase pantyhose once a month, compared to 35% for the general market (L. Squires, L'eggs Consumer Marketing, personal communication, April 22, 2004). Based on this information, L'eggs is focusing on these markets heavily when designing new hosiery products.

Sears: Sears has also invested many resources into understanding the Hispanic consumer in the U.S. In 1993, they introduced a Spanish-language magazine called *Nuestra Gente*, which they distributed free to Hispanic households across the U.S. The first circulation of this magazine in 1993 was only 100,000, but by October of 1994, the magazine was performing so well that circulation had increased to 1.5 million (Fearnley-Whittingstall, 1994).

Sears has also used the geographic distribution of the Hispanic population to offer specific products in specific areas to best reach the highest concentration of targeted consumers. In 1994, Sears had designated 130 of its 800-store chain as "Hispanic," meaning that these stores were located in areas where at least 20% of the population was Hispanic (Fearnley-Whittingstall, 1994). This helped Sears determine the best location to introduce and market Hispanic product lines.

In 2003, Sears signed Lucy Pereda, host of the Galavision (Spanish TV) program "En Casa de Lucy," to design a new line of women's work-appropriate apparel. This line debuted in mid-September, 2003 (Wexler, 2004). Offerings of this line include flounced woven shells and off-white pinstriped suits with dramatic black floral embroidery to appeal to Hispanic apparel preferences (Scardino, 2004). The

“Lucy Pereda” line, in addition to other popular Sears brands, is offered on Sears new Hispanic website, SearsenEspañol.com. This Spanish-language website was designed to accommodate Sears’ Hispanic consumers who prefer to read advertisements in their native language (Cotton Incorporated, 2004b).

VF Corporation: In focus groups completed as part of a marketing research study of the U.S. Hispanic population, VF Corporation learned that Hispanic men wear smaller sizes and prefer dark finishes in denim. To meet these needs, VF added 28” and 29” waists with 29” and 30” inseams to denim offered in their Hispanic stores. They also added dark finishes and carpenter styles to their Hispanic stores, since they learned that Hispanic customers desired these fashions (J. Markwell, VP Men’s and Boys, personal communication, November 9, 2003). VF Corporation used focus groups in the absence of actual sizing data to determine the sizing preferences and needs of Hispanic consumers. However, the release of SizeUSA data will allow for comparison of stated needs to actual sizing information.

Many companies like the ones discussed above understand the benefits of using advertising campaigns and style changes to accommodate the needs of different ethnic groups. However, very few apparel firms have attempted to target Hispanic consumers in the U.S. through sizing changes, even if they thought that Hispanics would be better served through sizing that is not identical to the general population. The lack of anthropometric data about this population lead many apparel firms to simply rely on advertising and styling changes for their products, rather than spend the money and effort to overhaul their sizing systems simply

based on sales data and customer requests. However, the release of SizeUSA data in 2004 has opened up opportunities for a body shape and size analysis of the Hispanic population. But why did it take until 2004 for this type of sizing information to become available, especially if apparel firms have understood the benefits of ethnic target marketing for over a decade? The next section of the review of literature on the History of U.S. Sizing Standards will help to answer this question.

History of U.S. Sizing Standards

Sizing standards used by the industry today are plagued with criticisms primarily because they were created using information that dates back to the 1940s. Data from 60 years ago does not account for the changing demographics of the current U.S. population, including the aging and increasingly diverse population. As discussed in the previous section of the review of literature, apparel firms have been reluctant to target the Hispanic population through sizing changes due to a lack of information about the body shapes and sizes of this consumer group. To better understand the cause of this lack of information, it is useful to consider the history of U.S. sizing standards.

Early Efforts in Sizing

Before any consideration of sizing systems or standards, a discussion of early ready-to-wear efforts is important. At the beginning of this century, most clothing was made by tailors and dressmakers who customized fit to the individual wearer

(Tamburrino, 1992a). The readymade process for apparel had begun, but was only primitive at the turn of the century. However, the absence of war, the beginnings of industrialization, economic affluence, and a sound retail infrastructure that existed during this time facilitated extreme growth of the ready-to-wear process (Tamburrino, 1992a). During this period, manufacturers determined their own sizes subjectively, but most adhered to a common practice of labeling sizes in the following way: Women's sizes were labeled even sizes, 34-48, with these numbers corresponding to bust measurements; Misses sizes were labeled even sizes, 14-20, with these numbers referring to age; and Juniors sizes were labeled odd sizes 13-17, also referring to age (Chun-Yoon & Jasper, 1993). The ideal body shape, from which most patterns and garments were made, was the hourglass shape (Simmons, 2002).

During the 1920s, looser fitting styles in apparel caused firms to look into methods of mass production, creating a need for standard sizes among different manufacturers (Salusso-Deonier, 1982). Firms knew that mass production techniques called for more standardization than was currently being used by manufacturers. The fashion of the 1930s was characterized by tighter fitting styles that only worsened the confusion that went along with the sizing systems and labeling practices used by apparel firms. Particularly troubled with the lack of standardization were mail-order houses who experienced high returns associated with the confusing sizing (O'Brien & Shelton, 1941).

U.S. Department of Agriculture Study – “O’Brien & Shelton”

Prompted by dissatisfied consumers, apparel firms, and retailers, the U.S. Department of Agriculture authorized a sizing study of the U.S. women’s population in 1939. Until this study, measurements used to construct women’s clothing were based on measurements taken on a few women using inaccurate methods. Designed and implemented by Bureau of Home Economics specialists O’Brien and Shelton, this first scientific sizing study done for women collected 59 body measurements manually (O’Brien & Shelton, 1941).

However, the O’Brien and Shelton study was plagued with many problems. First, the study was biased because all of the 14,698 subjects were white and they were predominantly between the ages of 18 and 30. Additionally, all of the women were measured in the states of Arkansas, California, Illinois, Maryland, New Jersey, North Carolina, Pennsylvania, and the District of Columbia. Last, all of the women measured were volunteers, meaning they were most likely part of a group of women who were fairly satisfied with their bodies (O’Brien & Shelton, 1941). As a result of these problems, the subjects measured do not sufficiently represent the ethnic makeup, age distribution, geographic distribution, or body shapes of the U.S. population at that time.

Development of Sizing Standard “CS 215-58”

The O’Brien and Shelton study of 1941 did not result in a sizing standard until the 1950s. In 1958, the U.S. Department of Commerce issued a new commercial standard known as CS 215-58 based on the 1939 study. This standard used four

classifications of women (Misses, Women's, Half-Sizes, and Juniors), three height groups (Tall, Regular, and Short), a bust measurement, and three hip types (Slender, Average, and Full) to classify sizes (U.S. Department of Commerce, 1958). The sizes were based on bust measurement, height group, and drop value (difference between hip and bust circumference), and yielded over 20 sizes for use by the apparel industry (Chun-Yoon & Jasper, 1993).

However, this standard was only voluntary, meaning that manufacturers did not have to follow it. They could either revise it to fit their needs, use it as it was created, or disregard it entirely. In addition, it was based on the 1939 study by O'Brien and Shelton, and thus suffered from the same inadequacies that the study had. Due to these problems, women of the 1950's and 1960's attempted to get around a growing size problem by using corsets and girdles to mold their bodies to the shapes of the clothing produced (Agins, 1994).

Development of Sizing Standard "PS 42-70"

Despite these problems, the next step in the history of sizing standards did not occur until 1971, when the U.S. Department of Commerce released a new voluntary standard, known as PS 42-70. This standard was basically a revision of the previous standard CS 215-58, but did include modifications based on a health survey performed by the National Center for Health Statistics in 1962. This survey indicated that U.S. adults were taller and heavier than they were in 1940. Thus, the bust girth was increased by one grade interval per size code for all figures. Other changes from CS 215-58 included the elimination of "Slender" and "Full" hip options

for all figure types as well as the elimination of the “Tall” option in the Juniors’ and Women’ figure types (U.S. Department of Commerce, 1970).

Even with all of these changes to the CS 215-58 standard, the new PS 42-70 standard was still voluntary and based on the 1939 study by O’Brien and Shelton. At this time, still none of the problems with sizing systems had been confronted.

Current Standards for Women’s Clothing

No real work in the area was sizing was undertaken after PS 42-70 until the American Society for Testing and Materials (ASTM) developed two standards in the mid-1990s. Between the development of PS 42-70 in 1971 and the ASTM standards of 1995, various sizing studies were performed by the National Center for Health Statistics, NASA, the U.S. Army, and the U.S. Navy (LePechoux, 1998). However, these studies were not used by the apparel industry in the creation of new sizing standards. The following sections discuss the current ASTM sizing standards used by the apparel industry:

Misses’ Standard – ASTM D5585-95: In 1995, the ASTM released a new voluntary standard, called ASTM D5585-95, which specifies sizes 2 through 20 to be used by the apparel industry in the classification of Misses’ apparel. This standard did not rely on new measurement data, but instead was derived from the same database used in the creation of the PS 42-70 standard and updated slightly according to a compilation of what was considered to be industry “best practices” at the time (ASTM, 1995a). As a result, the standard is based on the O’Brien and Shelton sizing study conducted in 1939 and the current Missy standard suffers from

the same inherent biases found in all of the standards created up to this point. The U.S. population has dramatically changed since the O'Brien and Shelton study, influenced by increased immigration, sedentary lifestyles, changing nutrition and exercise, and growth in minority groups (LaBat, 1987, Meek, 1994, Tamburrino, 1992a, 1992b). The current Missy sizing standard does not account for any of these changes.

Over 55 Women's Standard – ASTM D5586-95: Research conducted by Reich and Goldsberry at the University of Georgia in 1993 resulted in the creation of ASTM D5586-95, a sizing standard for women ages 55 and older (ASTM, 1995b). These researchers found that PS 42-70 was terribly inadequate for the average sizes of these women due to changes that occur to the female body as it ages. Some of these changes include a decrease in stature, increases in waistline, hips, and buttocks, and changing posture (Renfrow, 1996). The fact that no sizing standard until then had confronted these issues caused many women over 55 to experience trouble in dressing rooms nationwide, and researchers expect that the results found in this study are not unique to women just over 55.

Juniors Standard – ASTM D6829-02: The most recent apparel sizing standard created for women's apparel was released in 2002. Known as ASTM D6829-02, this standard classifies sizes 0 through 19 to be used in Juniors' apparel.

These ASTM standards are the most recent official standards accepted by the industry. However, all of these are voluntary standards, and most manufacturers

interpret them differently. Thus, the fact that they are called standards is rather ironic, because the apparel industry's use of these systems is far from standardized.

As obvious from the discussion of the history of sizing standards above, standards accommodating the needs of the current U.S. population do not exist. As a result, the apparel sizing systems used by firms often ignores the needs of specific groups, such as the group of interest for this research – Hispanics. The absence of information about this population's body shapes and sizes has meant that apparel firms have not been able to use sizing as a method to target this group.

Methods Used in the Development of Sizing Standards

A variety of methods and practices have been used in the creation of the sizing standards discussed above. Some of these methods will be briefly discussed in this section, such as principal component analysis, proportionate sizing, and multiple body dimension methods.

First, principal component analysis, a type of factor analysis, works on the premise of evaluating the correlation among measurements. In this type of analysis, groups are defined based on certain body measurements. The term, principal component, refers to the fact that specific components (or measurements) are used to define and describe the variation among body types or groups (Salusso-Deonier, 1982).

Another method commonly used in the development of sizing standards is proportionate sizing theory, which was used in the development of CS 215-58, PS 42-70, and most of the current ASTM standards. According to this theory, human

bodies develop in accordance with common proportional rules. In this method, one measurement (such as bust) is chosen to predict other measurements. Often, one girth measurement may be chosen to predict the other girth measurements, while one length or height measurement may be chosen to predict the other length or height measurements. Once measurements for the base size are determined, incremental increases or decreases that differentiate one size from another, called grade rules, are then determined. The term proportionate sizing originates from the fact that size ranges are created based on proportional grading from a near average-proportioned person (which was the sample size or fit model) (Salusso-Deonier, 1982).

In multiple body dimension methods, such as height by weight systems, sizing is based on several body measurements. A common example of this type of system is the pantyhose sizing system used today, in which size designations are made based on specific height and weight distributions. This type of sizing is considered appropriate for pantyhose (even though many customers may disagree) because the stretch fabrics that most pantyhose is made out of can shift and conform to fit most body shapes. In addition, the stretch allows size ranges to be wider, accommodating more of the population in fewer sizes. However, height by weight systems, as well as other systems where sizes are determined by a few body measurements, might not be as appropriate for complicated garments, fabrics, or styles. For this reason, multiple body dimension methods are not as common as sizing systems based on proportionate sizing or principal component analysis.

Apparel Sizing Today

In the past, the apparel industry has been slow to confront sizing and fit issues, instead relying on outdated, biased data to create “standards” that are not even mandatory. However, researchers, firms and consumers today are demanding that these issues be faced. This section of the review of literature begins with a discussion of the fit issues the industry is facing today, and then continues with a discussion of the technologies and recent efforts that aim to help solve some of these issues. These topics are relevant to this research because these fit issues are driving this research, while current technologies are enabling it.

The Apparel Fit Problem in the U.S.

The Apparel Industry’s Current Use of Sizing Standards: The previous section on the history of sizing standards revealed the biases that exist with the data used to create current ASTM sizing standards. These standards were biased in respect to the U.S. population on which they were based in 1939. Due to the changing demographics in the U.S., as well as changing lifestyles and nutritional habits of the population, the data on which current standards are based is surely not representative of the current U.S. population (LaBat, 1987, Meek, 1994, Tamburrino, 1992a, 1992b). However, it is not only the inadequacies in the data itself, but also the lack of use of these standards by the apparel industry that has worsened the confusion associated with apparel sizing in the U.S.

Sizing systems used to create the apparel sold by retailers today vary widely depending on the firm. Apparel manufacturers modify (or sometimes simply

disregard) current sizing standards to create their own sizing for their particular target markets (Simmons, 2002). The following outline shows major steps used by many apparel companies in the creation of garments and the sizing of these garments, and also shows some of the reasons behind the current problem of apparel misfit:

1. *Designer's Concept* – Each apparel manufacturer begins the design of a product with an identification of the target market. This involves knowledge of the target population, predominant sizes, and needs. Once the target population is defined, manufacturers obtain measurements from that population (Al-Haboubi, 1992). This step has been extremely difficult in the past, as the only anthropometric data available to companies comes from outdated, biased sizing studies that are not representative of the current U.S. population or current target markets.
2. *Fit Model* – After the design of the product is finalized, the company chooses a fit model who is representative of the company's ideal target customer. This model's size is often the middle size of the total size range offered. Firms choose a model from this middle size because, most often, the middle size is the most abundant in the population, and by fitting the fit model, the company will supposedly fit the largest segment of the population. However, depending on the target market, the fit model could possibly be from one of the smaller or larger sizes within the size range offered. After the model is chosen, patterns are then made to fit the model, and once appropriate fit is

achieved, the pattern is graded (at key measurement points on the pattern), up and down to the other sizes in the range. The points for change in the pattern are chosen based on the style of the garment; a more detailed garment will be graded using more points of measure than a simpler garment (Tamburrino, 1992b).

3. *Mass Production* – Next, all garments are sewn at once, usually going through a production line in which each worker specializes in one task on each garment.
4. *Shipping to Store* – The next step involves the inventory being shipped to various locations worldwide. Garment sets are sold in size sets of identical styles and proportions.
5. *Try-On in Store* – Once in the store, women of varying sizes try on the garments. With only a select number of garments offered in select proportions and sizes, women of varying size bodies end up trying on the same size garment.
6. *Misfit* – The result is misfit. Garments of specific proportions made using size standards are not fitting all bodies well (process adapted from “Fit Forward,” 2003).

Vanity Sizing: Apparel sizing and fit problems are only compounded by a practice known as “vanity sizing” used by many apparel firms. Many manufacturers have realized the marketing advantage of “vanity sizing.” With vanity sizing, garments are labeled as smaller sizes than the actual body measurements would

indicate through standard sizing. Women are more likely to purchase garments of smaller sizes, simply for self-esteem and vanity purposes. As a result, many manufacturers have started to label garments smaller than actual measurements in the hopes of increasing sales (Tamburrino, 1992a). One of the most extreme examples of vanity sizing comes from Chico's, a chain that markets to women between the ages of 35 and 55. Their sizes range from zero to three, with three being equivalent to a standard size 14-16. According to Chico's executive vice president and chief merchandising officer, "Wouldn't you rather wear a 2 ½ than a 14?" (de Lisser & Zimmerman, 2003, p. D.1). Sizing strategies like these used by the apparel industry have resulted in different sizing systems for different apparel companies, with most sizes today not corresponding to any standard body measurement, but rather, arbitrarily chosen by manufacturers (Chun-Yoon & Jasper, 1993).

The Impact of Consumer Dissatisfaction with Apparel Fit: The result of vanity sizing and apparel firms' modifications of their sizing systems according to their target markets has resulted in widespread confusion and dissatisfaction for apparel consumers who cannot find appropriate fitting apparel. A study by Kurt Salmon Associates recently showed that 62% of U.S. consumers are very dissatisfied with the fit of their apparel (Kurt Salmon Associates, 1999). This statistic is horrible, considering that customers cite comfort and fit as two of the most important determinants for apparel purchases (Kurt Salmon Associates, 1998).

The apparel industry is experiencing financial problems due to the poor fit of apparel. Sirvart Mellian, an apparel program manager for the U.S. Navy has said that “quality control people at women’s and children’s apparel manufacturers said that the highest number of returns retailers get is because of size and fit” (Agins, 1994, p. B1). Returns associated with poor fit are extremely prominent in catalog and Internet retailing. It is estimated that as much as 35% of the clothing purchased from catalogs is returned because of problems with fit (Ashdown, Loker, Istook, & Adelson, 2003). This may be due to inconsistencies between the same products sold in stores and in catalogs. New York designer Cynthia Rowley said that catalog dresses are made bigger than store dresses of the reported same size. Catalog companies have discovered that shoppers are less likely to return items that are too large, but they always return those that are too small. Thus, a size 4 dress in a catalog is often bigger than the identical dress in a store (Agins, 1994). The same frustration exists in Internet shopping. An Ernst & Young survey discussed online at TextileWeb.com reported that “fear of buying the wrong size” is the single most important inhibitor of online apparel sales. Of those customers that do complete purchases, they typically return 1 in 6 of every item purchased because of poor fit (“Global Sizing,” 2000). Bain and Company has also predicted that return costs could be as much as 27% of total gross sales for online apparel retailers in 2004 (“FitMe Unveils,” 2001).

However, a focus simply on returns does not give a true indication of the fit problem. It is very often hard to quantify losses related to lost sales, brand

dissatisfaction, and time wasted in fitting rooms, which are all indicators of the costs of fit problems (DesMarteau, 2000).

Ethnic consumers are also experiencing problems with apparel fit. Voicing problems encountered by many ethnicities, Glorina Stallworth, an African-American from Raleigh, says that “finding the right size is a grueling process. All clothes fit different, and being black, one of the things (we) run into is having clothes fit appropriately because we tend to have heavier bottoms, (“Cary, N.C.”, 2002).” In addition, studies completed by JCPenney have heard requests from Hispanic consumers for smaller sizes, and more petite clothing because they feel they are being ignored by apparel retailers (Fearnley-Whittingstall, 1994).

Impact of Body Scanning

Customer dissatisfaction and financial loss due to poor fitting apparel has prompted the apparel industry and academia to research ways to solve the fit issues discussed above. One of the most revolutionary technologies impacting the apparel industry today is body scanning, and many industry players are hoping that it will enable greater research and improvements in the area of apparel sizing and fit. This section of the review of literature begins with a description of the body scanning process and continues with a discussion of some of the sizing studies and advances the technology has allowed.

Description of Body Scanning Process: When first created in the 1960s, three-dimensional body scanning technology was developed for medical and

industrial purposes. However, the technology was introduced for use in the apparel industry in the early 1990s, and has several advantages for this industry:

1. Body scanners can generate an unlimited number of measurements from the human body in seconds.
2. Measurements are more precise and reproducible than traditional manual measurement techniques.
3. Output from body scanners is in a digital format that can be integrated automatically into apparel CAD systems for size and shape analysis (Simmons, 2002).

[TC]², a company based in Cary, North Carolina, made the first body scanner specifically designed for use in the clothing industry, and NC State University was one of the first four locations to receive its own scanner ([TC]², 2003). Now, several other companies have developed scanners that can potentially be used in apparel and clothing studies. Some of these include scanners from Cyberware, Hamano, Vitronic, Human Solutions (previously Tecmath), Telmat, Wicks & Wilson, Hamamatsu, and Intellifit (Istook & Hwang, 2001). These have had (and will have) a dramatic effect on apparel sizing and fit studies.

Body scanners use white light (much like photography) to illuminate the body measure the outer surface dimensions of a subject. [TC]²'s scanning process obtains over 400,000 data points in a little under two minutes. Subjects stand inside a scanning booth as white light and computer systems process and extract measurements (see Figure 6).



Figure 6: [TC]² body scanning booth.

Note: From “An Introduction to the Body Measurement System for Mass Customized Clothing,” by [TC]², 2004a. Available on-line at <http://www.techexchange.com/thelibrary/bmsdes.html>

First, white light is flashed around the subject in the scanning booth to impel a two-dimensional patterned grating on the surface of the body (see Figure 7).



Figure 7: 2-dimensional patterned grating.

Note: From “An Introduction to the Body Measurement System for Mass Customized Clothing,” by [TC]², 2004a. Available on-line at <http://www.techexchange.com/thelibrary/bmsdes.html>

Next, sensors capture images of the body and three-dimensional data points are calculated (see Figure 8).

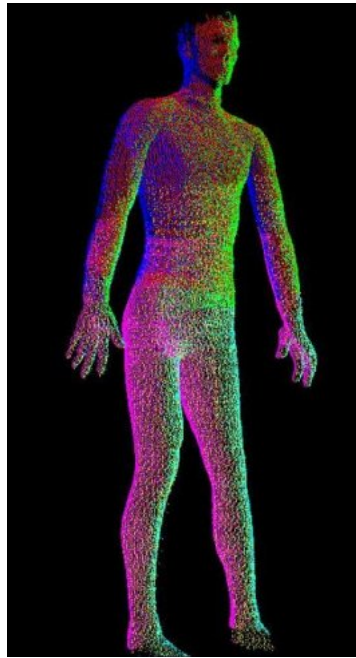


Figure 8: 3-dimensional point cloud set.

Note: From “An Introduction to the Body Measurement System for Mass Customized Clothing,” by [TC]², 2004a. Available on-line at <http://www.techexchange.com/thelibrary/bmsdes.html>

Last, the body is segmented and measurement extraction occurs when these data points are processed. The result is a printout of the actual body scan and measurements requested by the user (see Figure 9) ([TC]², 2004a).

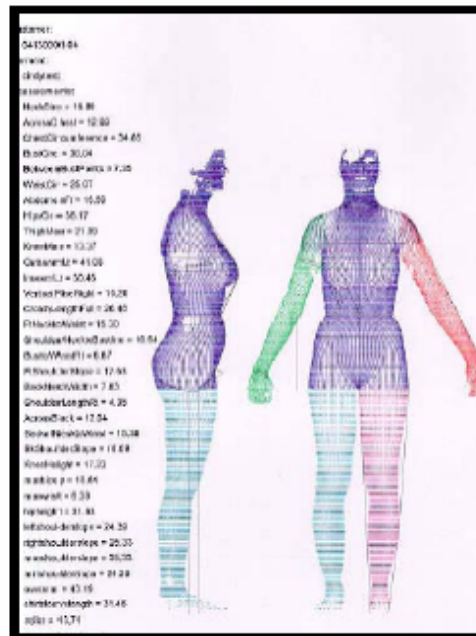


Figure 9: Printout available to subject.

Note: From “An Introduction to the Body Measurement System for Mass Customized Clothing,” by [TC]², 2004a. Available on-line at <http://www.techexchange.com/thelibrary/bmsdes.html>

Technological advances are frequently “faulted” with shortening life cycles, and thus increasing the need for new product development processes. However, technology can also *inspire* innovation and the new product development process by making things possible that were not possible before the technological advancement (Urban & Hauser, 1980). The technology of body scanning has inspired much advancement in the area of apparel sizing and fit. For instance, several apparel retailers have used body scanning to improve customer satisfaction and obtain more information about their unique target customers. Levi Strauss & Co. and Brooks Brothers have each purchased scanners that they use to scan their own customers in-store to offer customized garments. Land’s End also started a “My Virtual Model

Tour” in November of 2000, and using [TC]² scanners, they collected measurements of subjects around the nation and then made individual customized virtual models that their customers could then use on their website (D. Bruner, personal communication, November 21, 2003).

One of the most recent and promising uses of body scanning is the collaboration between Intellifit, a body scanner producer, and several apparel retailers, including David’s Bridal, After Hours Formal, Federated Department Stores, and Levi Strauss & Co. As part of this collaboration, Intellifit has established several scanning locations at its retail partners. Customers are scanned in these locations, and after scanning, receive a printout of the brands, styles, and sizes that will fit them the best. This obviously benefits consumers, but the benefit to Intellifit’s retail partners is the collection of measurement data of their actual consumers. This measurement data can then be used to revise grading or sizing strategies to best fit their actual consumers (“Intellifit,” 2005). The rest of this section will cover additional advancements that body scanning has enabled.

CAESAR: The CAESAR sizing study, undertaken by the Civilian American and European Surface Anthropometry Resource Group was the first sizing study to use a body scanner. Conducted from 1997 to 2001, this study obtained 99 measurements from 4,500 subjects, men and women, ages 18-65, from various weight groups. This sizing study did not use the body scanner entirely, but instead relied on manual methods to obtain 40 of the 99 measurements. Samples were

obtained in three NATO countries of Italy, the Netherlands, and the U.S. (CAESAR TM, 2003).

This study was done for the benefit of many different industries and was sponsored by apparel, aerospace, automotive, and other companies from various industries. Some apparel companies sponsoring the CAESAR study were Jantzen, Inc., Lee Co., Levi Strauss & Co., Sara Lee Knit Products, Sears Manufacturing Co., and Vanity Fair, Inc. The goal of the study was to compile measurements that could be used by a variety of companies in an organized useful way. The survey was successful, with sponsoring companies paying \$40,000 for the data and non-sponsoring companies paying \$250,000 (CAESAR TM, 2003).

SizeUK: The next sizing study using three-dimensional body scanners was known as SizeUK and was conducted from 2000 to 2001, using [TC]² scanners. In this national sizing study of the United Kingdom, UK government, UK apparel retailers, technology companies, and academia collaborated to obtain 130 body measurements from 11,000 subjects ([TC]², 2001).

SizeUSA: The most recent sizing study performed using body scanners was a national sizing survey of the United States funded by the U.S. Department of Commerce, known as SizeUSA. This study, conducted between July of 2002 and July 2003, is the most extensive sizing study ever done in the United States. After advancements in body scanning technology, this study cost only \$1 million, compared to the \$6 million it cost to complete CAESAR, which was actually a smaller study (D. Bruner, Vice President, Technology Development [TC]², personal

communication, November 21, 2003). Performed to benefit apparel, automotive, aerospace, commercial airlines, furniture, and health care industries, [TC]² scanners were used in locations around the nation to gather measurements from more than 10,000 subjects ([TC]², 2004b).

An interesting feature about this study is that measurements were obtained from many different demographic groups so that measurement information about specific groups could be segmented by age, ethnicity, income level, weight class, and other characteristics. Before this study, no study had allowed for a separation of information into demographic groups (Ashdown, et.al, 2003). Thus, SizeUSA is truly revolutionary, giving the apparel industry anthropometric information that is actually representative of the current U.S. population.

Hoping to gain more useful insight and data into actual body measurements of the groups that make up the U.S. population, many universities, organizations, and companies were more than eager to support the SizeUSA initiative. Some sponsors included Jockey, Sears, David's Bridal, Dillard's, Milliken, the U.S. Navy, the U.S. Army, DuPont, Liz Claiborne, NC State University, Auburn University, Cornell, Target, JC Penney, Sara Lee, VF Corporation, Russell, Land's End, and Levi Strauss & Co. ([TC]², 2004b).

According to David Bruner, an expert in body scanning technology at [TC]², the data is predicted to change sizing systems in the United States by serving as a source of better information. Rather than using the data to create one common sizing system, data from SizeUSA is expected to be used as a database resource of

measurement information. [TC]² even plans to offer an analysis service to companies wishing to have specific information about a target group. In this way, they can give companies information about their target market separated by age, gender, ethnic group, income level, education level, and other groups (“Cary, NC,” 2002).

Armed with this data, many companies are searching for ways that this data may be used to improve the standards in place, and the fit of apparel for their target consumers. According to Peter McGrath, Senior Vice President, Product Development for JCPenney, “One of the most intriguing things about the SizeUSA data is it will give manufacturers an opportunity to pull measurements out by age, gender, and ethnic background. One of the things we could do with the study is access data that allows us to establish a Hispanic size grid, for example, so we can better serve niche markets” ([TC]², n.d.). This statement applies directly to this research, as it indicates the opportunities that body scanning technology and SizeUSA now provides to apparel manufacturers.

Preliminary analysis of SizeUSA has supported what the apparel industry and consumers have known for a long time – the standards used today are inadequate at meeting the apparel fit needs of the current U.S. Population. Research conducted by [TC]² using SizeUSA data has shown that the average measurements obtained from SizeUSA do not correspond to current ASTM sizing standards. For instance, ASTM lists a size 8 (commonly considered the average size for a woman) as a bust of 35 inches, a 27 inch waist, and 37.5 inch hips. However, 69% of women scanned

through SizeUSA had hips greater than 40 inches, placing them in the size range of 12-14. Additionally, most of the women who measured a size 8 in the bust (based on ASTM sizing) had an average waist measurement of 29.6 inches and an average hip of 38.6 inches. When compared to the ASTM standard size 8, this data indicates that shape characteristics of the female population in the U.S. are not being served by current sizing standards (Campbell, 2004).

Another study using SizeUSA data to analyze how well ASTM standards fit the U.S. population was performed at NC State University's College of Textiles. This study showed that the Junior and Missy sizing standards currently used by the industry are based on the hourglass shape, but only 12.5% of the Junior population and 8% of the Misses population is actually hourglass in shape (Newcomb & Istook, 2004). These studies show that there is great work to be done to improve sizing standards, but improvements are possible through the use of SizeUSA data.

Best Fit© and FFIT© for Apparel Software: Three-dimensional body scanning has not only inspired advancement in the area of sizing and fit through enabling sizing studies. As part of doctoral research conducted at NC State's University's College of Textiles from 2000-2002, two software programs were developed that have great implications for size and shape analysis using body scanning data (Simmons, 2002; Simmons, Istook, & Devarajan, 2004). These programs were created before the release of SizeUSA data, but they can be used in the analysis of SizeUSA body scan data.

The first program, known as Best Fit[®], was created in Microsoft Access 2000 to determine how well measurement data from body scans corresponds to body measurements defined by sizing standards. Body scan data can be compared to measurement information from all current and past standards to determine not only the best-fitting standard, but also how close this standard actually corresponds to the body scan data (Simmons, 2002; Simmons, et.al, 2004).

To determine the sufficiency of the standards, this program uses three types of “differences”:

1. Percentage difference – The output for this part of the program is organized in four columns. Differences are calculated between body scan data (column 1) and data from the best fitting standard determined by the program (column 2). The resulting difference is divided by the best fitting standard data. A positive number means that body scan data is larger than the data from the best fitting standard; a negative number means that the body scan data is smaller than the best fitting standard. The larger the value, the higher the percentage difference in a particular measurement, and the farther apart the two measurements are (column 3). Column 4 shows how many of the body measurements are 5% or more different from the best fitting standard (Simmons, 2002; Simmons, et.al, 2004).
2. Tolerance difference – This component of the Best Fit[®] program uses tolerances for each body measurement location accepted by the apparel industry to compare body scan data and standard data. Table 4 shows the

tolerances used to evaluate the differences between each measurement. Output for this part of the program is also organized in four columns, with columns 1 and 2 representing the body scan data and measurement data from the best fitting standard, respectively. If the difference indicated that the body scan measurement is in tolerance with standard data, researchers label this difference as “0”. If the measurement is out of tolerance, the difference is labeled “1” (column 3). The last column indicates how many measurements were out of tolerance (Simmons, 2002; Simmons, et.al, 2004).

Table 4: Tolerances Used in the Best Fit Software Program

| Measure | Tolerance (inches) +/- | Measure | Tolerance (inches) +/- |
|-----------------|------------------------------|--------------------------|------------------------------|
| Bust | 0.5 | Hip Height | 0.25 |
| Waist | 0.5 | Front Waist Length | 0.375 |
| Hip | 0.5 | Back Waist Length | 0.375 |
| High Hip | 0.25 | Rise | 0.25 |
| Neckbase | 0.25 | Cross Shoulder | 0.375 |
| Upper Arm | 0.25 | Cross Back Width | 0.375 |
| Thigh, Max | 0.5 | Cross Chest Width | 0.375 |
| Total Crotch | 0.5 | Shoulder Length | 0.125 |
| Cervical Height | 0.75 | Arm Length | 0.25 |
| Waist Height | 0.375 | Bust Point to Bust Point | 0.25 |

Note: From “Body Shape Analysis Using Three-Dimensional Body Scanning Technology” by Karla P. Simmons, 2002

3. Weighted tolerance difference – This difference works in much the same way of the “tolerance difference,” but accounts for the fact that some measurements have more importance in the production of clothing. Output is once again organized into four columns, with the first two columns representing the body scan data and best fitting standard data, respectively. For this type of difference, if a measurement is within tolerance, it is labeled

“0”. If a measurement is out of tolerance less than two times the tolerance amount, it is labeled “1”. If a measurement is out of tolerance more than two times and less than three times the tolerance amount, it is labeled “2”. If a measurement is out of tolerance more than three times the tolerance amount, it is labeled “3” (column 3 displays these labels). The last column tallies these labels to show how far out of tolerance the body scan measurements are from the standard. By weighting the tolerances, one can determine how well the body scan data and the standard data correspond. Tolerances used in this part of the program are displayed in Table 5 (Simmons, 2002, Simmons, et.al, 2004).

Table 5: Weighted Tolerances Used for Each Measurement

| Measurement | Weighted Tolerance (inches) |
|--|---|
| Shoulder Length | $0 = \leq 0.125$ $1 = > 0.125 \ \& \ \leq 0.25$ $2 = > 0.25 \ \& \ \leq 0.375$ $3 = > 0.375$ |
| High Hip Neckbase Upper Arm Hip Height Rise Arm Length Bust Point to Bust Point | $0 = \leq 0.25$ $1 = > 0.25 \ \& \ \leq 0.5$ $2 = > 0.5 \ \& \ \leq 0.75$ $3 = > 0.75$ |
| Bust Waist Hip Thigh, Max Total Crotch | $0 = \leq 0.5$ $1 = > 0.5 \ \& \ \leq 1.0$ $2 = > 1.0 \ \& \ \leq 1.5$ $3 = > 1.5$ |
| Front Waist Length Back Waist Length Cross Shoulder Cross Back Width Cross Chest Width Waist Height | $0 = \leq 0.375$ $1 = > 0.375 \ \& \ \leq 0.75$ $2 = > 0.75 \ \& \ \leq 1.125$ $3 = > 1.125$ |

Note: From “Body Shape Analysis Using Three-Dimensional Body Scanning Technology” by Karla P. Simmons, 2002

This program has great implications for use in the apparel industry and for this research, as it can help to determine the best fitting sizing standard for a particular population, as well as show how well this standard fits the population.

The second program, known as FFIT[®] for Apparel, was developed using Visual Basic Pro, Version 6.0 in 2002 and then validated in 2003 (Simmons, 2002, Devarajan, 2003). The first software of its kind, this software uses body scan measurement data as inputs, and then classifies subjects into one of nine distinct body shapes. Specifically, it only needs six body measurements (bust, waist, hip, high hip, stomach, and abdomen) to classify a person as a particular body shape (hourglass, bottom hourglass, top hourglass, spoon, rectangle, diamond, oval, triangle, or inverted triangle). Because it only relies on these six measurements, the shapes are defined at the most elemental level, without overly complicating matters by including torso length, posture, etc. (Simmons, 2002, Simmons, et.al, 2004). Appendix A includes pictures and descriptions of each of the nine shapes defined by FFIT[®] for Apparel.

FFIT[®] for Apparel also has significant implications and uses for the apparel industry and for this research. For instance, measurement data for a specific population can be processed using the software to determine the shape characteristics for that population – which shapes predominate, which shapes do not exist in the population, etc. In addition, measurement data from sizing standards can also be processed using FFIT[®] for Apparel in order to determine the body shapes for which the standards most apply. An indication of how well specific sizing

standards are meeting the body shape needs of a certain population can be obtained by comparing the results of the standard data and the body scan data.

CHAPTER THREE: METHODOLOGY

Research Purpose

The major objective of this research was to perform a thorough analysis of the body shapes that predominate in the Hispanic women's population in the U.S., and compare the size and shape distribution of this population to the overall population of women in the U.S. This comparison provided a better understanding of specific differences that exist between the populations and helped researchers determine if and how a new sizing standard could be created to accommodate the sizing and fit needs of U.S. Hispanic women. Overall, the study resulted in a more complete understanding of the body shapes of U.S. Hispanic women and helped discover a method to target this group with a sizing system that improves their satisfaction with the fit of apparel.

Through the use of SizeUSA data and FFIT[®] for Apparel, the body shapes of U.S. Hispanic women were analyzed and compared to the U.S. population as a whole to determine how the body shapes compare in the two populations according to ethnicity ([TC]², 2004b; Simmons, 2002). A study of this kind has never taken place, because until now, there was an absence of anthropometric data that was representative of the current U.S. population. This all changed with the release of SizeUSA data in 2004 that now allows for segmentation and analysis of target markets according to many variables, including ethnicity. The methodology used in

this particular study can be used to perform a body shape analysis on any specific target population for which measurement data has been collected.

Research Questions

Framing this research were six main research questions, to be studied separately. The approach to answering each of these questions will be covered in detail in the data analysis section of this chapter.

1. *How do the body shapes of Hispanic women in the U.S. compare to the body shapes of women from other ethnic groups in the U.S.?*
2. *Do the body shapes of Hispanic women in the U.S. differ significantly based on age, income, or geographic location?*
3. *How well do apparel sizing standards used by the industry today meet the needs of Hispanic women in the U.S.?*
4. *How do bust, waist, high hip, hip, upper arm, and thigh max measurements of Hispanic women in the Rectangle shape category compare to Rectangle-shaped women in the White, Black, and Other ethnic categories of SizeUSA?*
5. *How should a sizing standard for the most predominant shape category in the U.S. population (the Rectangle shape) be created?*
6. *How well does the sizing standard created for the Rectangle-shaped U.S. population of women meet the needs of Hispanic women in the Rectangle shape category?*

SizeUSA Data Collection

The measurement data utilized for this research came from SizeUSA, the national sizing survey, that was conducted from 2002-2003. Before delving into the actual use of this data to help in this research, it was important to understand the data collection itself.

Sampling Strategy

The goal of SizeUSA was to obtain anthropometric data from a sample that was representative of the *entire* U.S. population. A random sampling strategy could not be used for SizeUSA, due to time constraints and high costs associated with the extremely large sample that would be required for random sampling. Thus, researchers decided to model the distribution of a previous validated study in order to obtain a representative sample of volunteers. The study they chose to model was the National Health and Nutrition Examination Survey (NHANES) III, conducted by the National Center for Health Statistics, an organization whose purpose is to gather and publish statistics on the health and diet of the U.S. population. This study, conducted from 1988-1994, obtained height and weight information from 33,994 subjects. Also recorded during the study were each subject's age, gender, and ethnicity (the same four ethnic groups being studied as part of SizeUSA). Due to the validity of NHANES sample and study, the SizeUSA sample was modeled after it to obtain a representative sample of the U.S. population ([TC]², 2004b).

Based on the NHANES study and preliminary research, it was determined that a sample size of 10,000 adults would result in a statistically significant sample

size for the U.S. population. The next challenge was to determine exactly who needed to make up the sample, and where the sample could be body scanned. The SizeUSA team decided that the study should obtain measurement data from six age groups (18-25, 26-35, 36-45, 46-55, 56-65, 66+), two genders (male and female), and four ethnic groups (Non-Hispanic White, Non-Hispanic Black, Hispanic or Mexican American, and Other, which include Asians). Thirteen cities across the United States were selected as scanning locations due to their proximity to volunteers who would make up the representative sample. Although the original plan was to obtain 1,000 samples from each location, this plan was modified to account for and obtain the ethnic diversity needed for SizeUSA to be representative of the U.S. population ([TC]², 2004b).

To obtain the demographic and psychographic data that would allow for segmentation and analysis of target consumer groups, SizeUSA volunteers completed a questionnaire before being scanned in the [TC]² body scanner. This questionnaire allowed subjects to respond to questions about their age group, sex, ethnic group, zip code, income, marital status, body structure, lifestyle, education, employment, preferred clothing sizes, preferred stores, and types of clothing worn. A copy of the actual questionnaire is included as Appendix B. Once the volunteer had answered the questionnaire, he/she was weighed on a medical scale and measured on a wall scale to determine height. The volunteer was then scanned and the result was 200 body measurements for each subject, which were tied to his/her answers from the questionnaire. In this way, measurement data was collected that

can now be segmented according to a variety of demographic and psychographic variables ([TC]², 2004b).

SizeUSA Sample Description

SizeUSA scanned a total of 10,001 subjects, of which 65% were women and 35% men. This section includes a demographic and psychographic description of the female population of the SizeUSA sample, as it is the female population that was used as a basis of comparison for this research. The Hispanic sample of women is described in specific detail in Chapter Four, as the Hispanic population was the focus of this study. Demographic descriptions of the entire SizeUSA sample of females and males are also included as Appendix C. All of the data discussed in this section was obtained from “SizeUSA, The National Sizing Survey, Women” ([TC]², 2004b).

Demographic Description of the Sample: As discussed before, SizeUSA established 13 scanning locations in order to obtain a representative sample from a cross-section of the U.S. Table 6 lists each of the scanning sites and the percentage of the sample scanned there. The number to be scanned at each location was calculated so the ethnic diversity of the U.S. could be acquired. This table illustrates that the bulk of the SizeUSA sample of women was obtained in Texas, North Carolina, and California.

Table 6: Scanning Locations for SizeUSA (Women)

| Scan Location | Subjects Scanned | Percent of SizeUSA Sample |
|-----------------------|-------------------------|--------------------------------------|
| 1) Cary, NC | 856 | 14% |
| 2) Columbia, MO | 632 | 10% |
| 3) Dallas, TX | 1283 | 20% |
| 4) Miami, FL | 71 | 1% |
| 5) New York, NY | 317 | 5% |
| 6) Chattanooga, TN | 295 | 5% |
| 7) Los Angeles, CA | 320 | 5% |
| 8) San Francisco, CA | 280 | 4% |
| 9) Portland, OR | 268 | 4% |
| 10) Lawrence, MA | 247 | 4% |
| 11) Winston-Salem, NC | 113 | 2% |
| 12) Buford, GA | 757 | 12% |
| 13) Glendale, CA | 871 | 14% |
| Total | 6,311 | |

Note: From "SizeUSA, The National Sizing Survey, Women" ([TC]², 2004b)

Acquiring the proper mix of ethnic diversity was one of the most important considerations in obtaining the SizeUSA sample. Due to the recent growth in ethnic minorities in the U.S., the SizeUSA team could not ignore the need to represent the separate ethnic groups appropriately in the sample. By utilizing the variety of scanning locations presented in Table 6, SizeUSA organizers obtained a rich mix of ethnic groups, with 53% of the sample belonging to the Non-Hispanic White group, 18% being Non-Hispanic Black, 13% being Hispanic, and 16% belonging in the Other category. The Other group included women of Asian ethnicities, as well as

those women who possibly identified themselves as belonging to more than one ethnic group ([TC]², 2004b).

Overall, the majority of the SizeUSA sample of women was young – more than 60% of the sample was below 46 years old, while only 4% of the sample was over 66 years old. Table 7 shows the six age levels obtained in the SizeUSA sample, and the percentage of the sample falling into each level. This distribution may slightly misrepresent the aging of today's U.S. population by not including a larger percentage of females in the over 55 age ranges. However, there was fairly equal representation of ages in the four youngest age ranges, providing large sample sizes for analysis of body shapes and sizes in these age ranges.

Table 7: Age Distribution of SizeUSA Sample (Women)

| Age | Percent of SizeUSA Sample |
|------------|--------------------------------------|
| 18-25 | 24% |
| 26-35 | 23% |
| 36-45 | 21% |
| 46-55 | 18% |
| 56-65 | 10% |
| 66+ | 4% |

Note: From "SizeUSA, The National Sizing Survey, Women" ([TC]², 2004b)

The majority of the SizeUSA sample was not extremely affluent, with 60% of the population placing themselves in the two lowest income ranges of Under \$25,000 and \$25,000 - \$49,999 per year. The SizeUSA sample was also an educated group, with over 60% of the sample being either college graduates or

having completed at least some college or technical school work. This combination of lower levels of affluence and higher education levels might initially seem to be conflicting, until one considers the employment status of the SizeUSA sample. In terms of employment, the largest percentage of the sample (29%) identified themselves as having a professional/managerial type of job. The next largest group (19%) classified themselves as students, which could account for predominance of the younger, educated, but less affluent women in the sample. While much of the SizeUSA sample appeared to be young both in age and career stage (which influenced the income distributions), many other women in the sample placed themselves in the seven other categories of employment (besides managerial and student) that were included in the survey. In addition, upper income ranges were not ignored, with 40% of the sample reporting an annual income of over \$50,000. In sum, the SizeUSA team scanned people from a variety of age ranges, income levels, employment types, and educational levels – while the majority of the sample may have been clustered together in a few of the categories of demographic descriptors, no one group was entirely ignored. This was no small accomplishment for the SizeUSA team, and great care had to be taken by organizers in determining who could be included in the sample ([TC]², 2004b).

Psychographic Description of the Sample (including Apparel Shopping Preferences): In addition to the demographic data collected through SizeUSA's survey, organizers also included questions that were aimed at finding out more about the apparel shopping preferences and lifestyle characteristics of the SizeUSA

sample. This psychographic information is especially interesting to SizeUSA sponsors and other apparel companies, because it gives insight into some of the attitudes, opinions, and motivations of today's apparel shoppers. This information is not only important to apparel companies in the design of actual garments, but also the design of marketing campaigns to reach targeted populations.

For instance, most of the women surveyed said they were about as active as others, which relates to the exercise and activity level of their lifestyle ([TC]², 2004b). The fact that 48% of the sample said they were about as active as others, while only 21% and 5% respectively said they were a little less active or much less active than others is especially important information for producers of activewear. However, it is also important for other apparel producers because it influences the types of apparel consumers want to buy. Activity level is an important consideration for designers when they choose fabrics and cuts for their garments.

Weight perception of the population also influences the types, cuts and sizes of apparel that the population wants and needs. Thirty-eight percent of the SizeUSA sample felt that they were about the right weight. However, particularly telling was that 58% of the sample said they were either a little bit overweight or quite a bit overweight. The fact that the majority of the population said they were overweight greatly influences the cuts and sizes of apparel that should be produced for today's consumers, and also lends support to the widespread current research that shows that the U.S. population is growing bigger ([TC]², 2004b).

Particularly interesting to this research was the clothing sizes worn by women in the U.S. Table 8 shows the clothing sizes worn by the SizeUSA sample. When taking the survey, respondents could choose any of the sizes that applied to them, so most of the women chose several categories of sizes. This table shows fairly equal representation in each of the Small, Medium, and Large categories, with a much smaller percentage (8%) of the population wearing the Tall or Extra Large sizes. While the sizes worn by the subjects are clearly important when deciding which sizes to produce, perhaps the most telling part of the results of this question was that so many women said they wore several different sizes. This illustrates one of the problematic sizing issues discussed in the literature review – the fact that most consumers have no idea what their true size is, and instead they wear many different sizes depending on the brand or cut.

Table 8: Clothing Sizes Worn by SizeUSA Sample (Women)

| Size Worn | Percent of SizeUSA Sample |
|--------------------------|--------------------------------------|
| Petite / Small (0-6) | 25% |
| Missy / Medium (8-10) | 21% |
| Women's / Large (12-16) | 23% |
| Tall / Extra Large (18+) | 8% |

Note: From "SizeUSA, The National Sizing Survey, Women" ([TC]², 2004b)

The last type of psychographic information collected in the SizeUSA survey included shopping location preferences and types of clothing worn by the SizeUSA sample. This information is very important for apparel producers deciding what types of clothing to make, as well as manufacturers trying to decide where to sell

their garments. In the two questions dealing with shopping location preferences and preferred clothing types, respondents could choose any and all of the stores and clothing types they wanted. Sixty-eight percent of respondents liked to shop at department stores, 52% liked specialty stores, and 46% liked to shop for apparel at off-price stores. Fewer people (17%) shopped for apparel at warehouse clubs or sport specialty stores. As far as specific stores were concerned, 50% of respondents preferred to shop at JCPenney, while 39% liked to shop at Target. Other brands and stores such as Liz Claiborne, Kmart, and Sears were not popular choices. However, the answers to this question largely depended on the geographic location of respondents and the store offerings in the respective locations ([TC]², 2004b).

SizeUSA respondents were also very clear about the clothing types they like to wear. For instance, 80% of the sample said they liked to wear jeans, while 78% liked casual pants or slacks. In addition 65% wear dresses or skirts, 60% wear outerwear jackets or coats, and 59% wear knit t-shirts. Less popular preferences included knit polo shirts, suits, and dress shirts. These preferences support recent research that shows that casual apparel is experiencing a surge in popularity due to current casual work environments, while dressier apparel is becoming less popular. (Cotton Incorporated, 2004a).

Data Analysis

This study relied primarily on the use of SizeUSA data, FFIT[®] for Apparel, and the statistical and graphical functions of Microsoft Excel and JMP (a statistical analysis program developed by SAS) to answer the six research questions presented in Chapter 1. The methodology used to approach each question is presented separately below:

Research Question 1

How do the body shapes of Hispanic women in the U.S. compare to the body shapes of women from other ethnic groups in the U.S.?

To answer this research question, a three tiered approach was used. First, SizeUSA measurement data from the total population of women was evaluated by FFIT[®] for Apparel Software. This program sorted each subject's measurement data into one of nine body shape classifications (Rectangle, Spoon, Inverted Triangle, Hourglass, Top Hourglass, Bottom Hourglass, Triangle, Diamond, or Oval, illustrated in Appendix A) and showed the body shapes that were predominant in the entire population of U.S. women. Next, measurement data of the entire population of women was sorted by ethnicity in Excel, to separate and determine the body shapes that occurred most often in each of the separate ethnic groups classified by SizeUSA (Hispanic, White, Black, and Other). Last, the distribution of body shapes in the Hispanic population were compared to the distribution of body shapes in each of the separate ethnic groups (as well as the total population), to determine if

differences existed in the body shapes that prevailed for the Hispanic population and those that prevailed in each of the other ethnic groups.

In addition to creating a graph that compared the body shapes of Hispanic women to women of other ethnicities, Excel was also used to compare the heights of Hispanic women to the total population of women and women from the other ethnicities. For this comparison, SizeUSA data was sorted by ethnicity first, and then each of the specific samples of ethnic groups were sorted by height and arranged into the following three height categories used by ASTM sizing standard committees:

1. Petite: 5'2" and under
2. Regular: 5'2.5" – 5'6.5"
3. Tall: 5'7" and over

The percentage of each of the samples (of ethnic groups) falling into each of the height groups was then graphed using Excel. The height distribution of the Hispanic sample was then compared to the distribution in each of the ethnic groups and the overall population of women.

Any differences in body shapes and heights that existed between the Hispanic population and the other ethnic groups (or total population) lend support for the need for different approaches to sizing for specific ethnic groups.

Research Question 2

Do the body shapes of Hispanic women in the U.S. differ significantly based on age, income, or geographic location?

This research question involved even further analysis of the body shapes of U.S. Hispanic women, to determine if the body shapes of Hispanic women are affected by age, income, or geographic location. To determine the effect of age on body shape, the Hispanic sample was first sorted by age into the following age ranges (used by SizeUSA in their survey):

1. 18 – 25
2. 26 – 35
3. 36 – 45
4. 46 – 55
5. 56 – 65
6. 66+

Next, the part of the Hispanic sample falling into each category was analyzed separately, to determine the body shapes predominantly found in each age range. These percentages were then graphed using Excel, allowing a comparison of body shape distributions to be made across the different age ranges. This comparison allowed for the effect of age on body shapes to be determined.

To analyze the effect of income on body shape, the Hispanic sample was then sorted by income into the following income ranges (used by SizeUSA in their survey):

1. Under \$25,000
2. \$25,000 - \$49,999
3. \$50,000 - \$74,999
4. \$75,000 - \$99,999
5. Over \$100,000 (all ranges represent annual household income)

Next, the part of the Hispanic sample falling into each income category was then analyzed separately, to determine the body shape distribution found in each income range. These percentages were then graphed using Excel, allowing for a comparison of body shapes across income levels to be made. The comparison of body shape distributions in the different income levels allowed for the effect of income on body shape to be determined.

To analyze the effect of geographic location on body shape, the Hispanic sample was sorted into groups based on the locations where they were scanned. In order to simplify the analysis, the thirteen scanning locations were grouped into the four geographical regions classified by the U.S. Census Bureau and included in Table 9 (U.S. Census Bureau, 2000a):

Table 9: Separation and Classification of Scanning Locations into Four Geographical Regions

| Geographic Region | Scanning Sites included in Region |
|--------------------------|--|
| Northeast | New York, NY; Lawrence, MA |
| Midwest | Columbia, MO |
| South | Cary, NC; Dallas, TX; Miami, FL; Chattanooga, TN; Winston-Salem, NC; Buford, GA |
| West | Los Angeles, CA; San Francisco, CA; Portland, OR; Glendale, CA |

Once the Hispanic sample was separated into these four regions, the body shape distribution in each geographic region was analyzed, with percentages of body shapes in each region being calculated. These percentages were then graphed using Excel, enabling a comparison of body shapes in different geographic regions to be made. This comparison allowed for the effect of geographic region on body shape to be determined.

Results from this part of the study showed if any other factors besides body shapes and measurements should be considered in the development of a sizing system directed at the population of Hispanic women in the U.S. For instance, if body shapes were significantly different across age ranges, then any sizing system targeted toward the Hispanic population should acknowledge this difference. Any effects on body shape based on age, income, or geographic location indicated a need for future research to create a sizing system that not only considers, but also confronts all of the issues that affect the body shapes of Hispanic women in the U.S.

Research Question 3

How well do apparel sizing standards used by the industry today meet the needs of Hispanic women in the U.S.?

The approach to this question relied primarily on a study conducted at NC State University's College of Textiles in 2004 (Newcomb & Istook, 2004). The 2004 study researched the effectiveness of current ASTM sizing standards at meeting the fit needs of the current U.S. population. Using the FFIT[®] for Apparel technique discussed previously, the SizeUSA sample of women was first broken down into

body shape classifications. Measurement data from the three current ASTM sizing standards used by the apparel industry (Junior, Missy, and Over 55) was then processed separately through FFIT[®] for Apparel, to determine the body shapes targeted by each of the sizing standards. The use of these standards is typically dictated by the age of the population being served by the apparel company using the standard (i.e. the Junior standard is for a younger population, while the Over 55 standard is used for women over 55 years old). While this is typical, the standards are not always used this way, with many companies modifying these standards or creating brand new standards for their own markets.

The graphs illustrating the body shapes targeted by each of the three current ASTM sizing standards were compared to the graphs showing the body shape distributions of Hispanic women in the U.S. and body shapes by age (created as part of research questions 1 and 2, respectively). This comparison indicated how well current ASTM sizing standards fit the body shapes that predominate in the Hispanic population (and throughout the various age ranges), and provided justification of the need for the development of a new sizing system for the Hispanic market.

Research Question 4

How do bust, waist, high hip, hip, upper arm, and thigh max measurements of Hispanic women in the Rectangle shape category compare to Rectangle-shaped women in the White, Black, and Other ethnic categories of SizeUSA?

After a complete analysis of the body shapes of U.S. Hispanic women (and how they compare to the overall population), the research project moved into a more specific comparison of measurements at specific body locations. Because of the

wide variability in body measurements and proportions that exists in different body shapes, this part of the study compared measurements of subjects in the same shape category. Because the Rectangle shape was the most predominant shape in the overall population of women as well as for the Hispanic group, the mean girth measurements of bust, waist, high hip, hip, upper arm, and thigh max measurements were compared between the Rectangle-shaped women in each of the ethnic groups – to determine if these measurements were significantly different in the different ethnic groups. Appendix D contains a description of the measurements analyzed in this research and how they were taken.

To test for a significant difference between the mean measurements of different ethnic groups, several statistical tests were used. However, before delving into statistical analyses, simple bar charts comparing the mean measurements of the Hispanic group, Black group, White group, Other group, and Total population of Women (all Rectangle shapes) were created in Excel. This graphical comparison illustrated which group had the highest mean measurement, which had the lowest, and how close (or far away) the mean measurements of the different ethnic groups were to one another. In addition, tables highlighting some of the basic descriptive statistics such as minimum, maximum, median, mean, mode, variance, and certain percentiles were presented to allow for comparison between ethnic groups. Once the graphs and tables presenting these basic statistics were created, the comparison of measurements across ethnic groups moved into more detailed statistical tests using JMP.

First, an Analysis of Variance (ANOVA) test was completed in JMP (a statistical analysis program developed by SAS), to compare the mean measurements of the four ethnic groups classified by SizeUSA and to determine if there was a significant effect of ethnicity on the measurements. The ANOVA test was performed using the following hypotheses:

H_0 : There is no significant effect of ethnicity on (bust, waist, high hip, hip, upper arm, thigh max) measurements.

H_a : There is a significant effect of ethnicity on (bust, waist, high hip, hip, upper arm, thigh max) measurements.

Significance was tested at a 0.05 alpha level (which corresponded to a 95% confidence level), meaning that a calculated p-value of less than 0.05 indicated a significant effect of ethnicity on the particular body measurement.

If ANOVA tests indicated a significant effect of ethnicity, a Tukey-Kramer HSD test was performed to determine which ethnic groups had significantly different mean measurements. The Tukey test is similar to a simple two sample t-test, except it can compare the means of four samples (to one another) without the necessity of completing repeated t-tests. Repeated t-tests increase the probability of a Type I statistical error, meaning that it is more likely to conclude that there is a significant difference in means when there actually is not. The Tukey test reduces this chance of a Type I error. The Tukey test showed whether the mean measurement of White women was significantly different than the measurement of Hispanic women, or if the mean of Black women was significantly different than women in the Other ethnic

group, etc. More specifically, this test determined which ethnic groups had significantly different mean measurements.

An important fact to remember when completing the tests for significance described above is that simply concluding that there is *significant* difference does not indicate that the difference is *important*. Larger sample sizes often increase the chances of finding significance, even when the differences may not be important. For instance, concluding that a difference between bust measurements is significant may not be important if the difference between groups is small (such as a 1 inch difference). This rule is essential to remember when analyzing statistical results in a real world situation.

Research Question 5

How should a sizing standard for the most predominant shape category in the U.S. population (the Rectangle shape) be created?

This part of the study was possibly the most ambitious, especially considering the very slow advancements in sizing systems in the history of the apparel industry. Because of the very different body proportions and measurements that exist in different body shapes, the decision was made to focus on creating a sizing standard for one particular shape category. Since the Rectangle shape was the most predominant shape category, developing a sizing system for this shape was the first step. The creation of this standard was a tedious, long process that could not have been accomplished without the use of several statistical tests and Excel.

As discussed briefly in the review of literature, there are many approaches that can be used to develop a sizing standard. For this study, a combination of regression, principal component analysis, and proportionate sizing was used to create a sizing standard for Rectangle-shaped women. Due to the complexities associated with the development of a sizing system, only the following six girth measurements were included in the standard: bust, waist, high hip, hip, upper arm, and thigh max. Using the same technique as proportionate sizing and principal component analysis, the first step in developing the standard was to find the one best predictor measurement that could be used to determine the other measurements in the standard (Salusso-Deonier, 1982). Regression analysis in JMP was used to choose the principal component, upon which the sizing standard would be based.

Once the best predictor variable was determined, the size intervals for the sizing standard were created. In this process, consideration was given to the number of sizes created, because most apparel companies do not want to have too many sizes that would increase the skus in their inventory. Thus, widths of size ranges had to be carefully determined so the number of sizes in the resulting standard would not be too large. Widths of size ranges were modeled after the current Missy standard ASTM D 5585, in that smaller sizes were separated into one inch intervals and these intervals increased to 1½ inch intervals and then two inch intervals in the largest sizes.

Because most sizing standards are presented as one number (such as one waist, bust, hip, etc.) per measurement per size rather than as intervals, the next step was to find the middle value of each size interval. This value was then used to predict the other five measurements in each size. To predict these other measurements, the regression analysis performed at the beginning of this study was revisited. In addition to calculating R squared values, regression analysis also allows for the calculation of a line of best fit (sometimes called a regression line or equation), that is actually the line that runs through the most points on the scatterplot comparing the relationship between two variables. The regression equation has the following raw form:

$$y = a + bx$$

where “y” is the best prediction of the dependent value (in this case one of the remaining five measurements) for a given value of “x” (which is the predictor measurement). The “a” in the equation represents the intercept of the line, which is the value of “y” when “x” is 0, while the “b” represents the slope, which is how much “y” changes when “x” changes by one unit. Each of the combination of measurements with the predictor variable was evaluated independently to determine the regression equation that could be used to predict each measurement using the predictor variable. The predictor measurement for each size in the standard was then separately plugged into the each of the five regression equations used to predict all of the measurements in all of the sizes in the standard.

Once the sizing standard was created using regression, the measurements, and how they adjusted between sizes was evaluated. As discussed in the literature review, apparel companies use grade rules to create smaller or larger sizes from a base size. Apparel companies commonly use consistent grading between sizes at all of the body locations. This approach was tested first, to determine if appropriate fit could be achieved by modeling the intervals between sizes according to common grade rules. However, when this was proven to be inappropriate, a different approach was used. Rather than using the precise measurements predicted through regression, bust, high hip, and hip measurements were rounded to the nearest $\frac{1}{4}$ inch, and upper arm and thigh max measurements were rounded to the nearest $\frac{1}{8}$ inch. These measurements were rounded to improve, facilitate, and create the most user-friendly sizing standard. The result of this work was a sizing standard targeted for the measurements of Rectangle-shaped women.

Research Question 6

How well does the sizing standard created for the Rectangle-shaped U.S. population of women meet the needs of Hispanic women in the Rectangle shape category?

Once the sizing standard for Rectangle-shaped women was created, its ability to meet the needs of the Hispanic women in the Rectangle shape category was evaluated. First, histograms that illustrated the fallout of Hispanic women in each of the size categories were created and compared to histograms of the fallout of the overall population of women within the standard. Rectangle-shaped women from both populations were assigned to a specific size interval based on their waist

measurements, which was logical considering that the waist measure was used as the basis in the development of the standard. The comparison of histograms not only indicated how many people from each population were covered by the sizing standard, but also showed the concentration of sizes that were most predominant in each of the populations (according to the waist measure).

After the histograms showing the distribution of sizes were compared, charts were then created in Excel to compare the proposed Rectangle standard and the current ASTM Missy standard (D 5585) against the Hispanic women in the Rectangle shaped category and the overall population of Rectangle-shaped women. Scatterplots of each of the combinations of measurements used in the development of the standard were generated to show the Hispanic population and overall population on two axes. For instance, bust vs. waist were compared to show the relationship between these two measurements for both populations studied. In addition to the scatterplots representing the two populations, the current ASTM Missy standard and the proposed Rectangle standard created during this study were also plotted on the charts. The resulting charts contained two scatterplots (one representing Hispanic Rectangles and the other representing the overall population of Rectangles) with two lines running through the points. These two lines represented the current and proposed sizing standard. Analysis of each of the five charts (representing the combinations of measurements used in creating the standard) showed how the populations varied around the standards at each body location, as well as indicated the width of size ranges needed to accommodate the

two populations. This gave an indication of not only the ability of the proposed standard to meet the fit needs of the Hispanic population, but also illustrated if the proposed standard was more effective than current ASTM sizing at meeting these needs.

CHAPTER FOUR: RESULTS

This chapter includes a description of the Hispanic sample of women from SizeUSA, and a comparison of the Hispanic sample to the Overall sample of women in order to define any differences or similarities between the populations. Data is presented to respond to the six research questions upon which this study was based.

Description of Hispanic Women from SizeUSA

The demographic and psychographic information discussed in this section is very useful for apparel companies who are interested in understanding the Hispanic market more clearly. Not only does this information give insight into price points customers can afford and the sizes they demand, but also shows the shopping locations that Hispanics prefer. All of this influences the design, marketing, and management decisions made by companies when producing apparel.

As mentioned in the literature review, the goal of SizeUSA was to obtain a statistically representative survey of the U.S. population. A representative study that accounted for the ethnic diversity of the current U.S. population would allow for the results of the analysis of this sample to be generalized to the entire U.S. population, providing very powerful information for those charged with improving apparel sizing and fit. Figure 10 shows the ethnic makeup of the SizeUSA sample of women. The

839 Hispanic women of interest in this study made up slightly more than 13% of the sample. This percentage is very close to the 11.6% of the total U.S. population of women that Hispanic women made up during Census 2000, and is likely very close to the percentage in the current population (U.S. Census Bureau, 2000b).

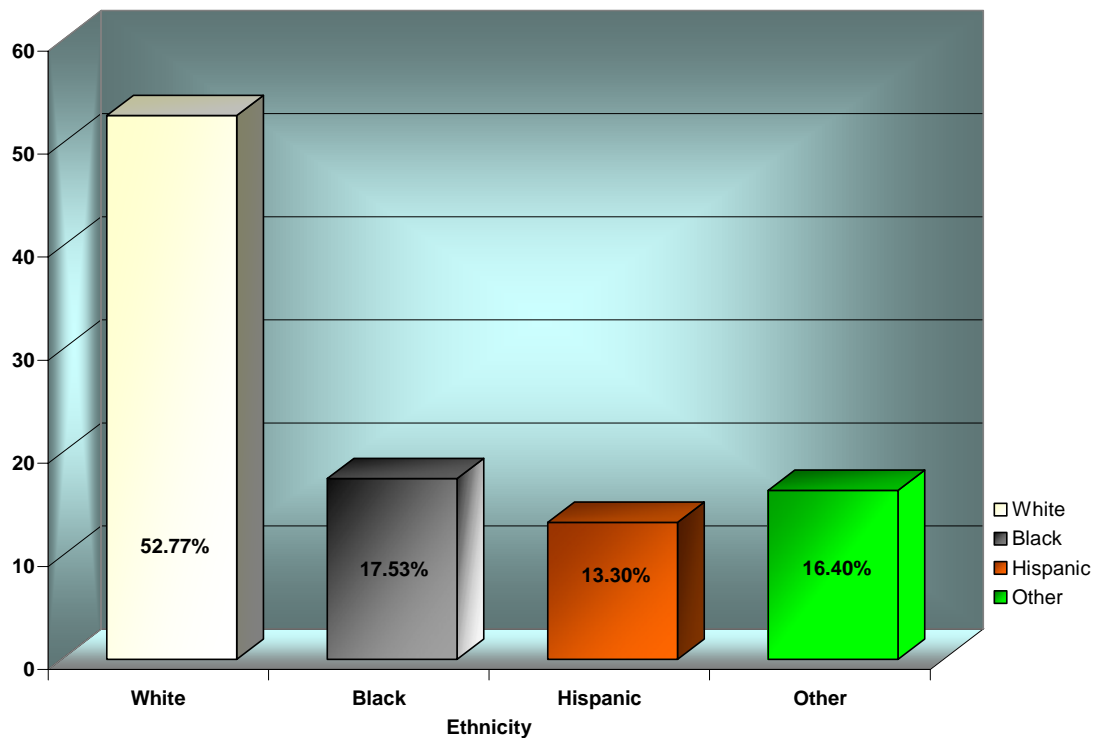


Figure 10: Ethnic breakdown of SizeUSA sample of women.

As shown in Figure 11, the Hispanic population was much younger than the total population, with 60% of the Hispanic sample being below 35 years old and less than 10% being over 56 years old. While the average population was also skewed to the right, with most of the sample falling into the younger age ranges, there were greater percentages of the average population occupying the higher age ranges than the Hispanic population. The low percentages of representation in the older

age groups may not truly represent the overall aging of the population in the U.S.

However, the youthfulness of the Hispanic population reported by the U.S. Census is definitely supported by the sample obtained through SizeUSA (U.S. Census Bureau, 2003).

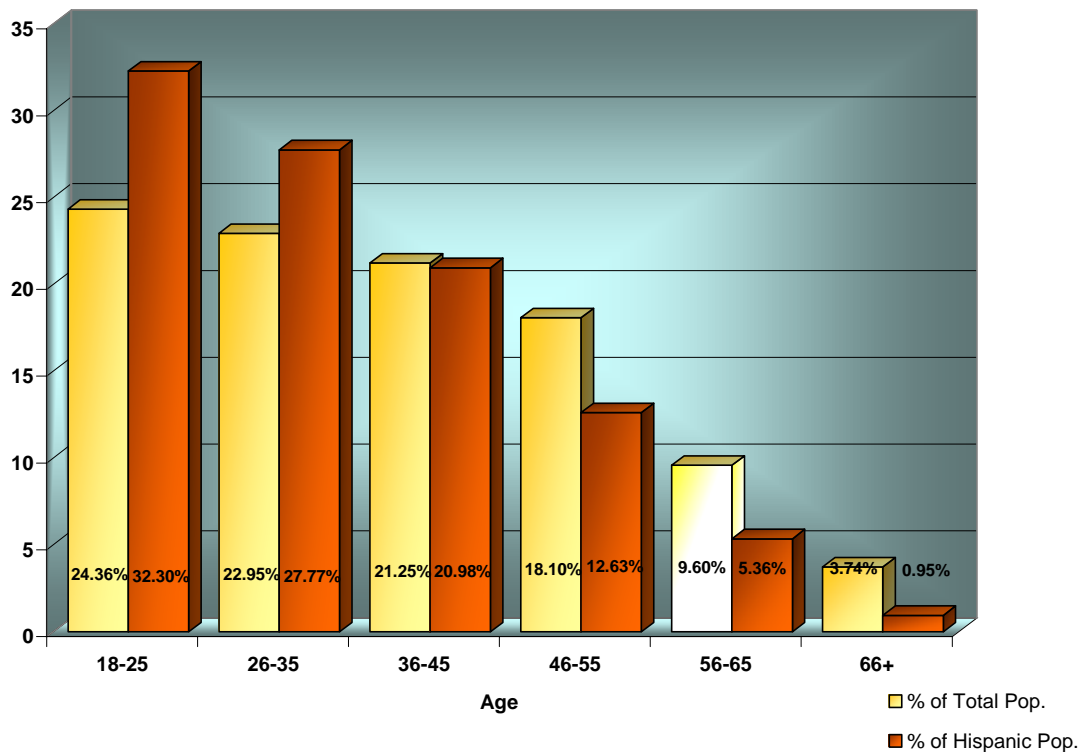


Figure 11: Age of Hispanic population vs. age of total population.

Figure 12 shows the annual household income reported by Hispanic women and women overall. The highest percentage of both Hispanics and the total female population fell in the two lowest income brackets. Within these two brackets, Hispanics were far more likely to earn less than \$25,000 annually per household, with almost 70% falling into that income range. Less than 15% of the Hispanic

sample earned more than \$50,000, supporting research from the Census that discusses the low earnings of this population (U.S. Census Bureau, 2003).

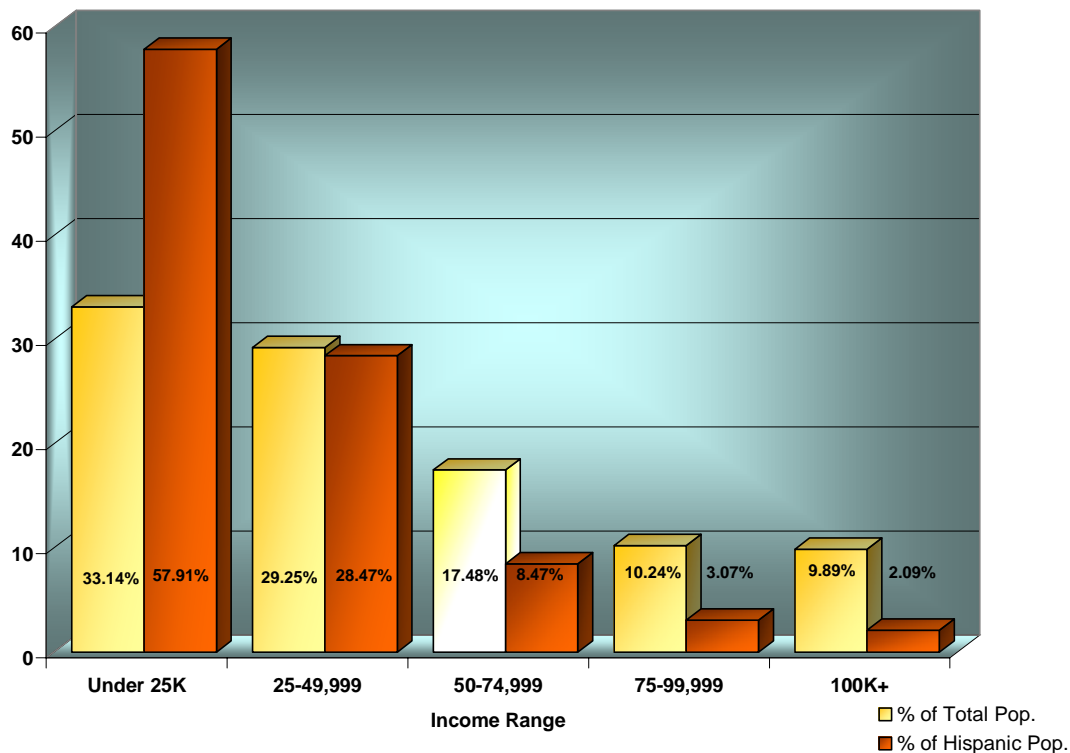


Figure 12: Hispanic annual income vs. total annual income.

The lower income levels reported by Hispanic women may be better understood after looking at the educational levels attained by Hispanics, shown in Figure 13. Overall, the Hispanic population was not as well educated as the total female population. The largest percentage of Hispanic women were only high school graduates, with the second largest percentage having finished some college or technical school. In addition, a far greater percentage (~18%) of Hispanic women than the total population had not completed high school. The largest percentage of

the overall population had some college or technical school with the second largest percentage being college graduates. This supports the information reported by the Census that Hispanics are on average less educated than the total population (U.S. Census Bureau, 2003).

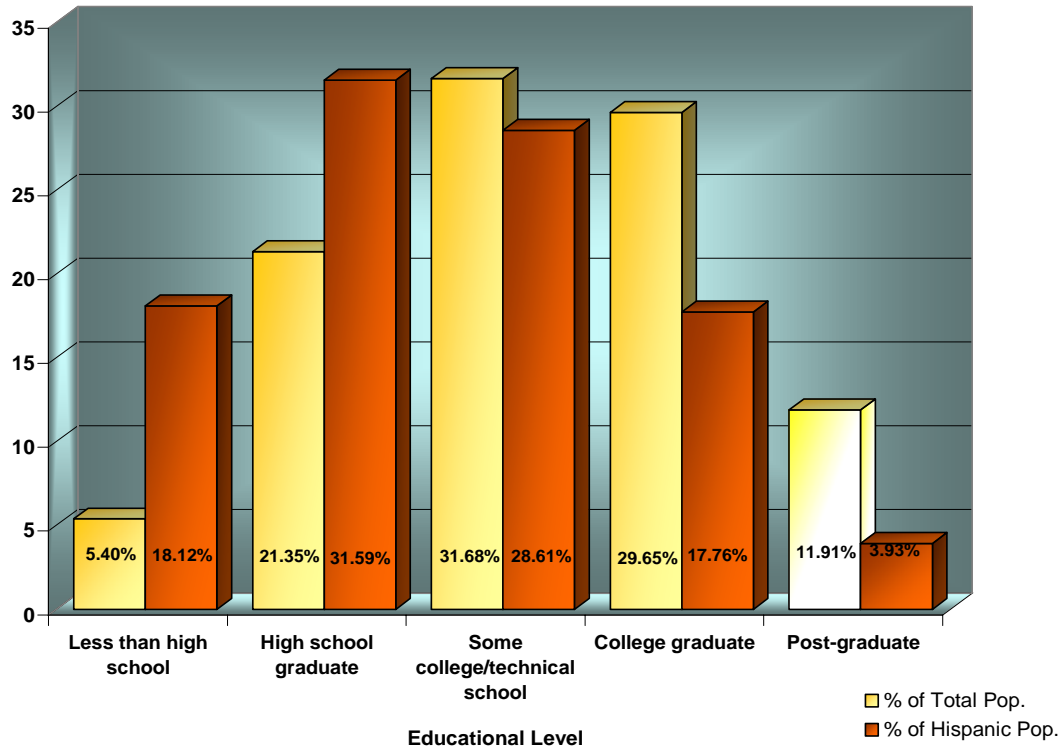


Figure 13: Hispanic educational attainment vs. total educational attainment.

The lower educational levels of the Hispanic population may help explain the results seen in Figure 14, which compares the employment status of Hispanics to the total female population. The largest percentage of Hispanic women were homemakers, while the largest percentage of the average population were in professional/managerial positions. Other interesting differences in profession were the small number of Hispanic retirees (most likely due to the young age of the

population) and the large percentage of this population in crafts, laborer, or farming jobs.

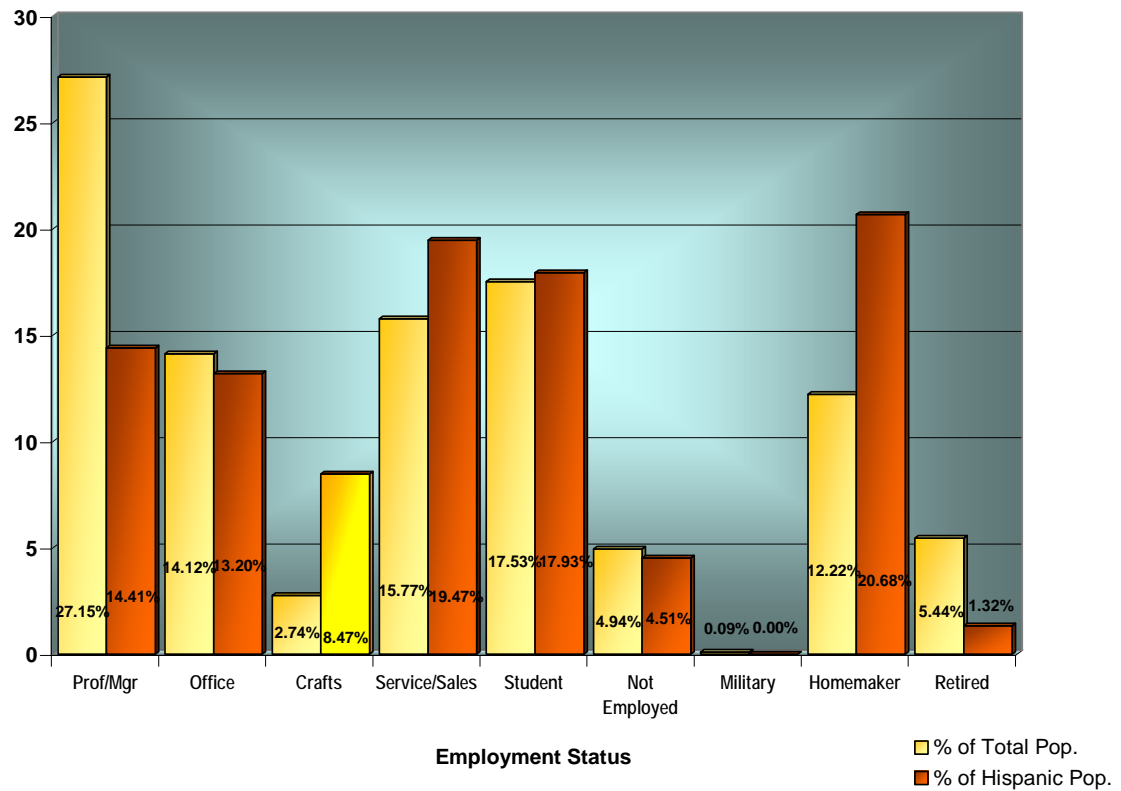


Figure 14: Hispanic employment status vs. total employment status.

As noted in the review of literature, the Hispanic population is geographically concentrated in specific areas of the U.S., most likely due to immigration (U.S. Census Bureau, 2003). This concentration is certainly illustrated by Figure 15. The largest portion of the Hispanic sample was scanned in the Western U.S., with almost 70% of the sample coming from this one region. The rest of the Hispanic women came from the South, with only 5% coming from the Northeast and Midwest. The fact that almost the entire sample came from these two regions was not surprising,

considering the large Hispanic populations in western and southern states such as California, Texas, and Florida.

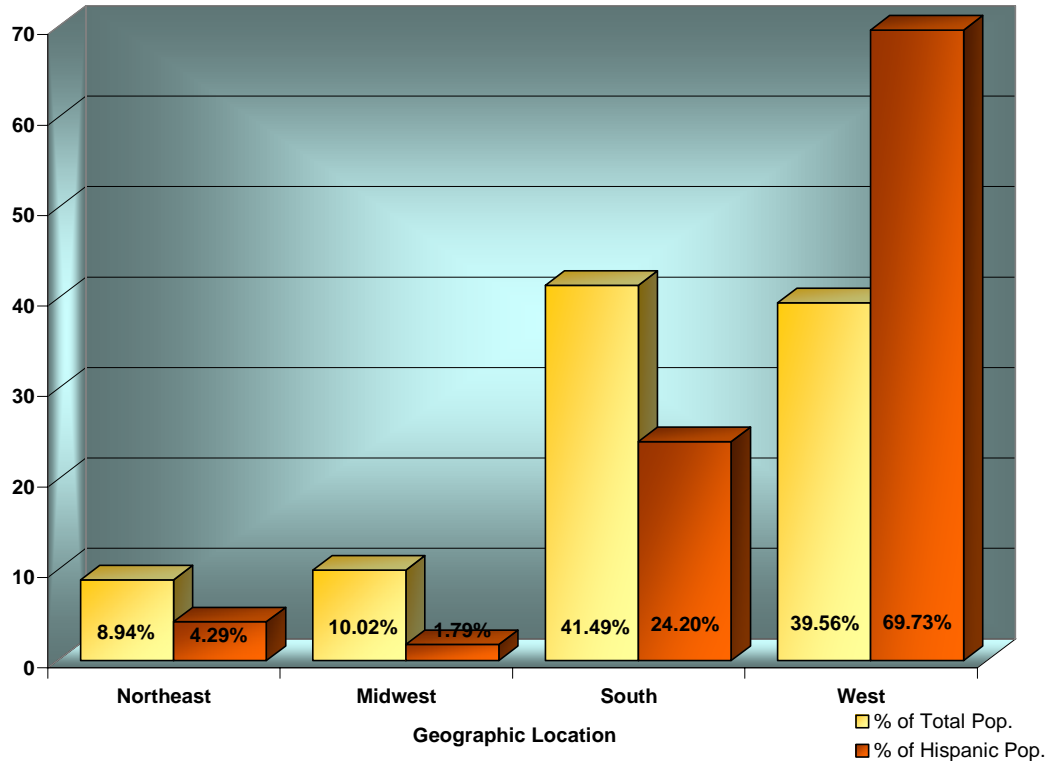


Figure 15: Hispanic geographic location scanned vs. total geographic location scanned.

In addition to demographic data collected in SizeUSA, of particular interest to apparel companies who sponsored the survey were the questions dealing with apparel shopping preferences. The information contained in the next two figures is very important for apparel companies in both the definition and understanding of target markets.

In the question dealing with clothing size, respondents could choose as many sizes as they wanted, meaning that people who wear several different sizes

depending on garments or brands could choose all of the sizes they wear. The chart in Figure 16 shows the percent of each of the populations who said they wore each of the sizes. As a result, the sums of the percentages for both populations were more than 100%, but these percentages can still be used to compare the sizes worn by both groups. The chart shows that the size chosen most often by Hispanic women was Medium, followed by Large, which was the same as the total population. A lower percentage of Hispanic women reported wearing Petite sizes and Tall sizes than the overall population.

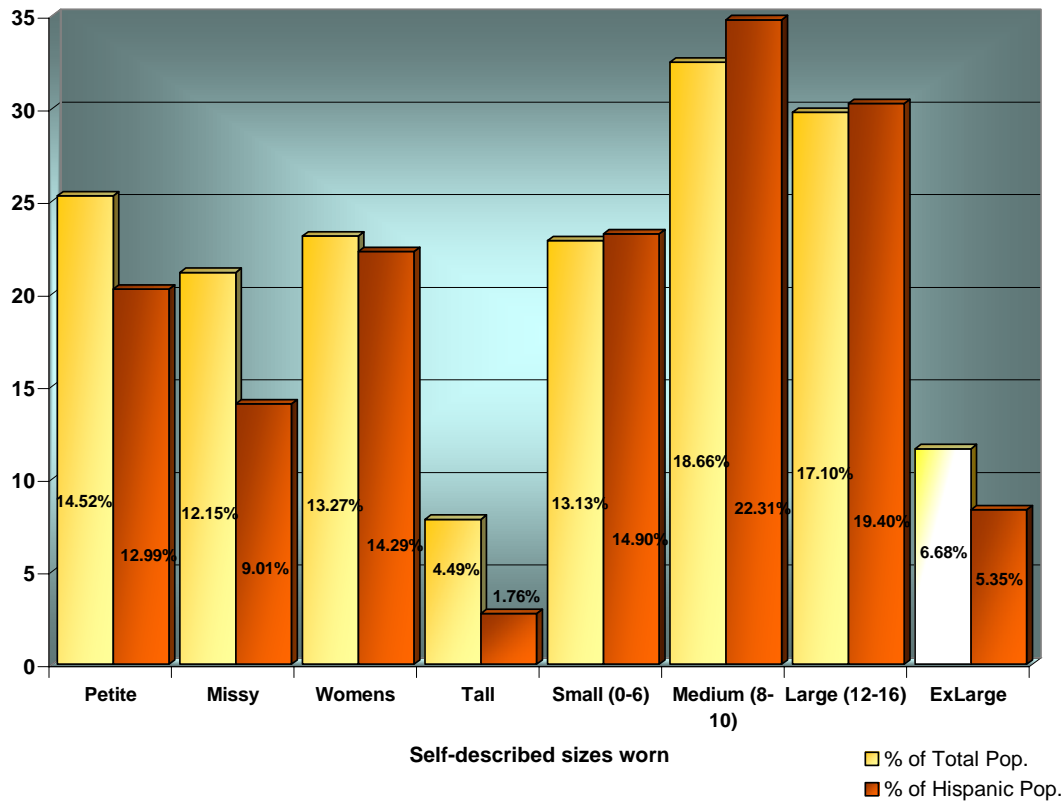


Figure 16: Apparel sizes worn by Hispanics vs. apparel sizes worn by total.

Much like the question regarding sizes worn, respondents were not limited to one choice when describing their shopping location preferences. As a result, the

percentages shown in Figure 17 represent the percent of each of the populations choosing each location. This chart shows that about 50% of Hispanic women shop for apparel at department stores, which is lower than the 70% of the average population that shop at department stores. Another 50% of Hispanic women shop at specialty stores for apparel. As far as specific stores are concerned, more than half of the entire sample of Hispanic women said they shopped at JC Penney, while other stores preferred by Hispanics were Target, Sears, and Kmart. This information would be very useful for stores trying to determine if there is a need for an apparel line targeted to Hispanics.

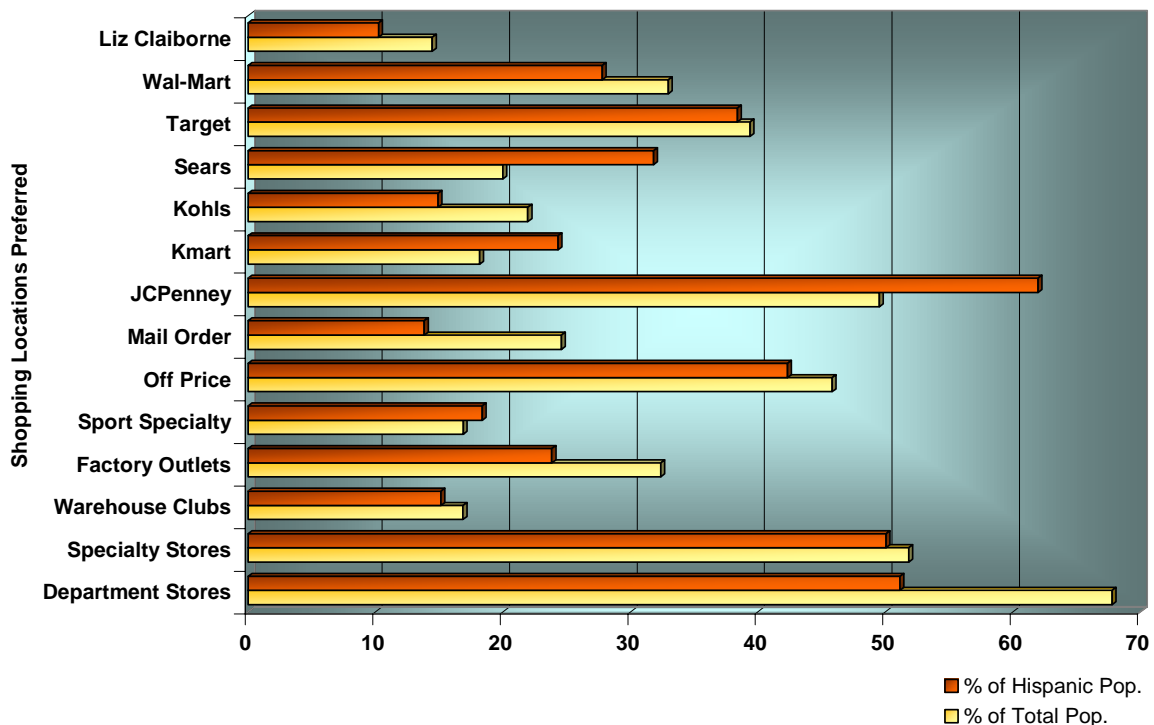


Figure 17: Hispanic shopping preferences vs. total shopping preferences.

Body Shape Analysis of U.S. Hispanic Women

This part of the paper presents the results of the body shape analysis performed with FFIT[®] for Apparel software, which helped to answer the first two research questions posed in this study. To restate, the first research question was: *How do the body shapes of Hispanic women in the U.S. compare to the body shapes of women from other ethnic groups in the U.S.?* The second research question was: *Do the body shapes of Hispanic women in the U.S. differ significantly based on age, income, or geographic location?*

An understanding of the body shapes and sizes that predominate in the Hispanic market, as well as how these body shapes are affected by such demographics as age, income, and geographic location is extremely helpful for apparel companies trying to determine if specialized sizing strategies are needed to target Hispanic women. Refer to Appendix A for a written description and illustration of each of the body shapes classified by FFIT[®] for Apparel.

Shape and Height Comparison among Ethnic Groups

Figure 18 shows the body shapes that predominate in each of the ethnic groups, as well as for the total population of women in SizeUSA. The Rectangle shape was the most predominant shape found in all four of the ethnic groups, with between 40% and 50% of each population falling into this category. However, while the second most popular shape for every ethnic group but the Hispanic group was the Spoon shape, the second most predominant shape for Hispanic women was the Inverted Triangle. Figure 18 also shows that roughly 80% of each of the ethnic

groups fell into three body shapes: Rectangle, Spoon, and Inverted Triangle.

Another interesting fact about body shapes of Hispanic women shown in this chart was that a greater percentage of Hispanics were classified as Top Hourglass shapes than any other ethnicity. When considered with the high predominance of Inverted Triangles in the Hispanic population, it seems that body shapes with relatively large bust measurements in comparison to waist and hip measurements was a common trend for Hispanic women.

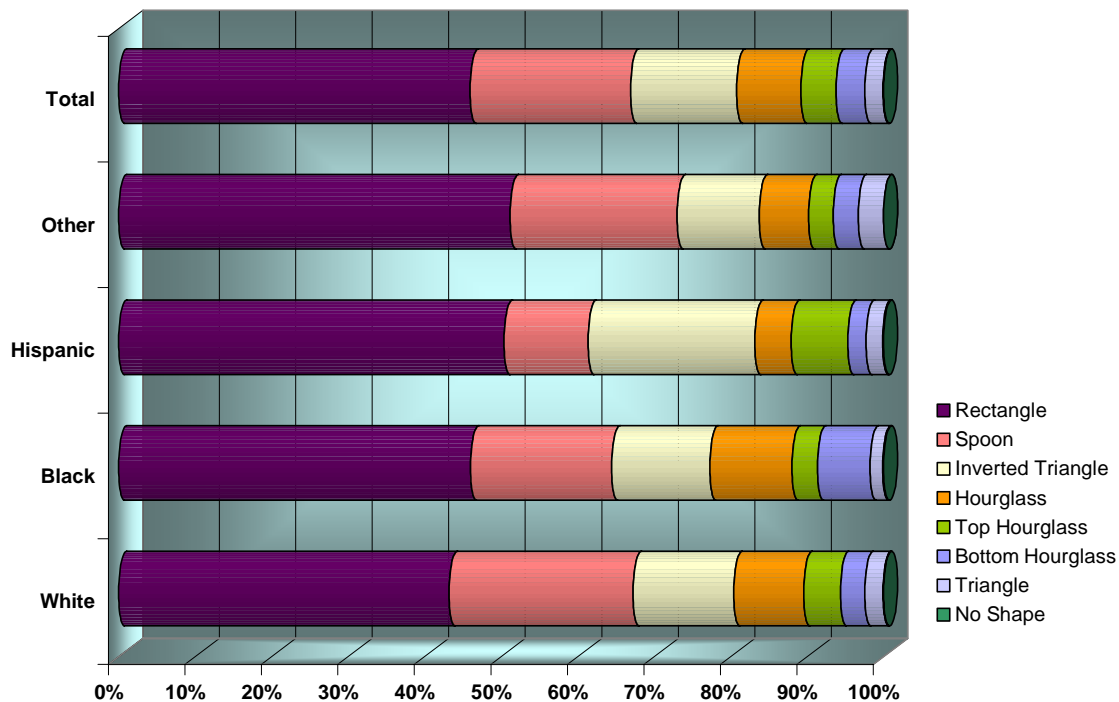


Figure 18: Percent shape by ethnic category.

Also important in a discussion of body shapes is an understanding of the height distribution of a target population. Figure 19 compares the percentages of Petite (5'2" and under), Regular (5'2.5" – 5'6.5"), and Tall (5'7" and over) women

found in each ethnic group and the total SizeUSA sample. Most important about this chart is that the Hispanic women had equal representation (roughly 48% each) in the Petite and Regular height categories, and less than 5% of the entire sample was in the Tall category. The percentage of Hispanic women in the Petite category was the highest of any ethnic group. Women in the Other ethnic group had the most similar height distribution to the Hispanic group, with a high percentage of Petites and low percentage of Talls. This was very different from the White and Black ethnic groups, of which roughly 60% of the groups were in the Regular height category. The remaining 40% of both of these groups were split fairly evenly between the Petite and Tall categories.

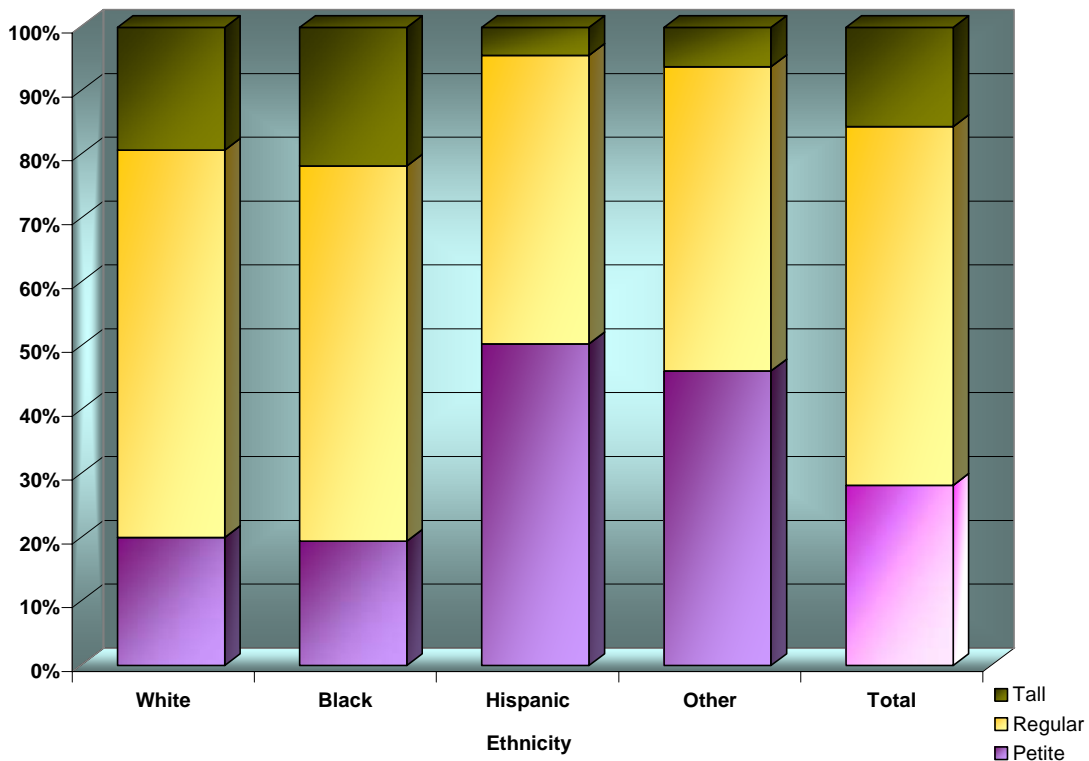


Figure 19: Percent height by ethnic category.

Effects of Age, Income, and Geographic Location on Body Shapes

To obtain a complete understanding of the body shapes of Hispanic women, demographics that may affect these shapes needed to be analyzed. Therefore, the effects of age, income, and geographic location on the body shapes of Hispanic women were analyzed separately to determine if any other factors affected their body shapes – any effects from these factors should be considered in the development of a sizing system for this ethnic group.

As Figure 20 shows, there seemed to be a trend across the age ranges – the younger age range was predominantly made up of Rectangles, but as Hispanic women aged, the percentage of Rectangles decreased. Meanwhile, the percentage of Inverted Triangle increased, implying that as Hispanic women aged, they moved out of the Rectangle shape and into the Inverted Triangle shape. However, an important issue to remember when looking at this graph was the very small sample sizes that existed for Hispanic women in the oldest two age ranges. While this could have magnified the trend previously discussed, the large sample sizes in the other age ranges do indicate movement out of the Rectangle category and into the Inverted Triangle category. However, the only way the trend can be verified is to have greater sample sizes in the large age ranges.

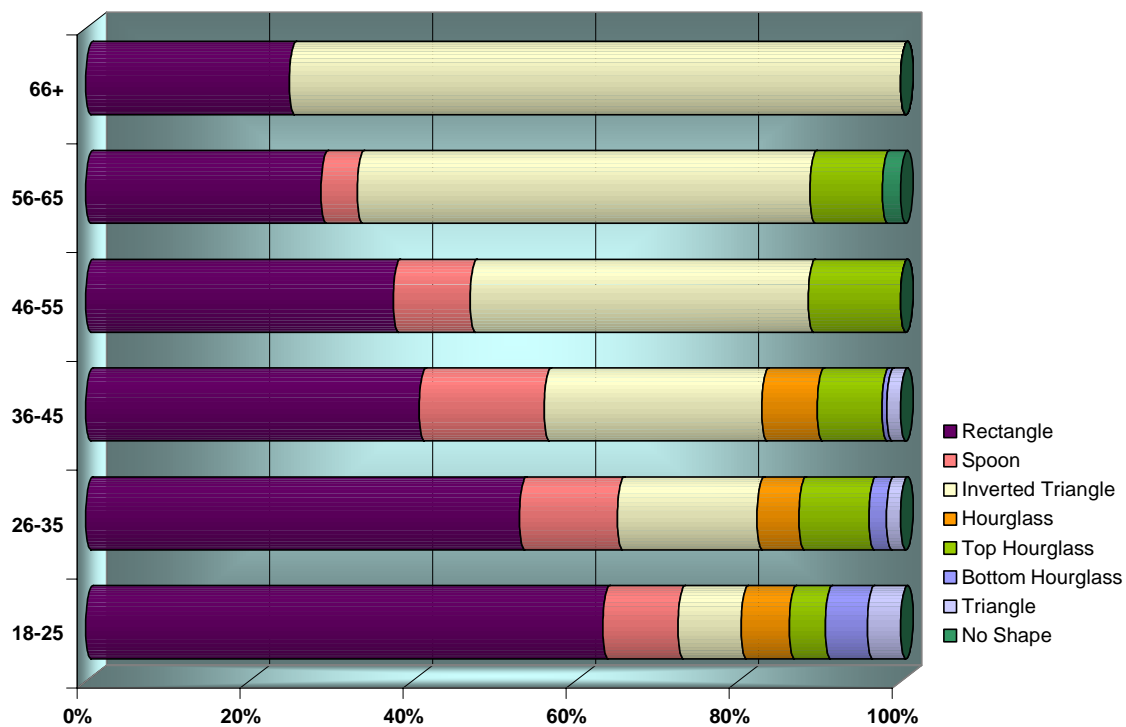


Figure 20: Hispanic shape across age ranges.

As shown by Figure 21, the most predominant shape in each income category was the Rectangle shape. There did not seem to be any noticeable trend across income levels. However, this could have had more to do with the fact that most of the sample fell into the two lowest income ranges, leaving very small sample sizes in the higher income levels.

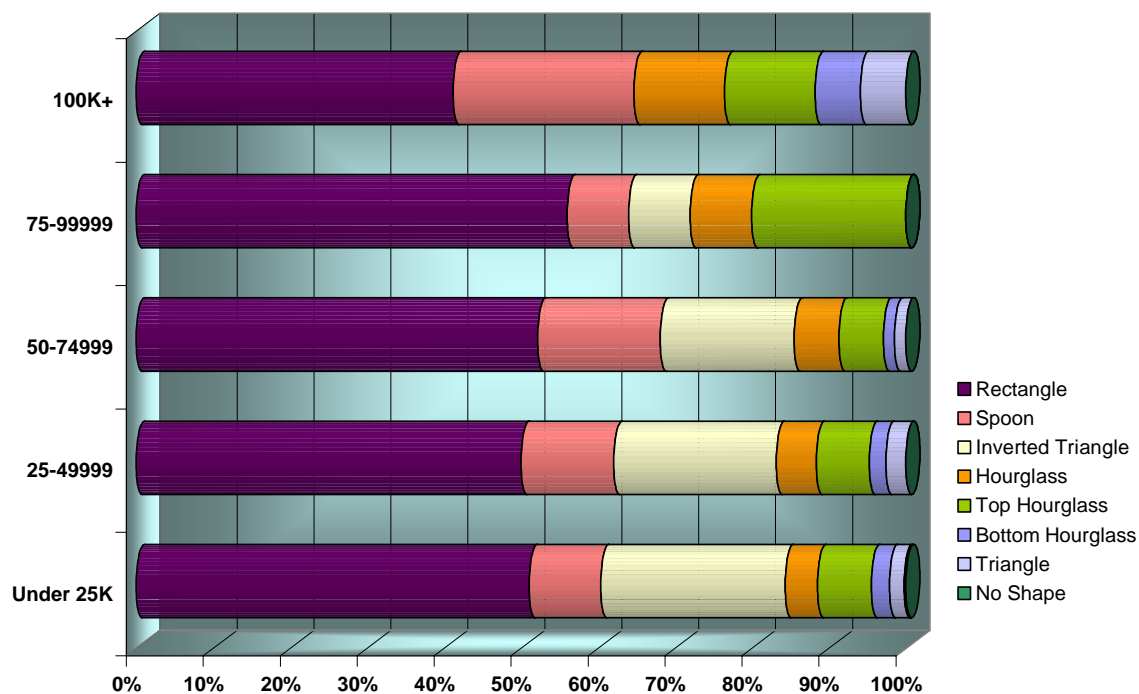


Figure 21: Hispanic shape across income levels.

The comparison of Hispanic body shapes in different geographic regions, shown in Figure 22, was plagued with similar problems of small sample sizes as were the comparisons based on age and income. Almost 95% of the Hispanic sample came from the West and South, leaving very small sample sizes in the Midwest and Northeast. While this rendered any comparisons between all four regions ineffective, comparisons of the two regions with large sample sizes were useful. The body shapes that predominated in the West and the South were very similar, with the Rectangle shape being the most predominant, and the Inverted Triangle being the second most predominant. The comparison between these two

regions did not indicate any effect of geographic location on the body shapes of Hispanic women.

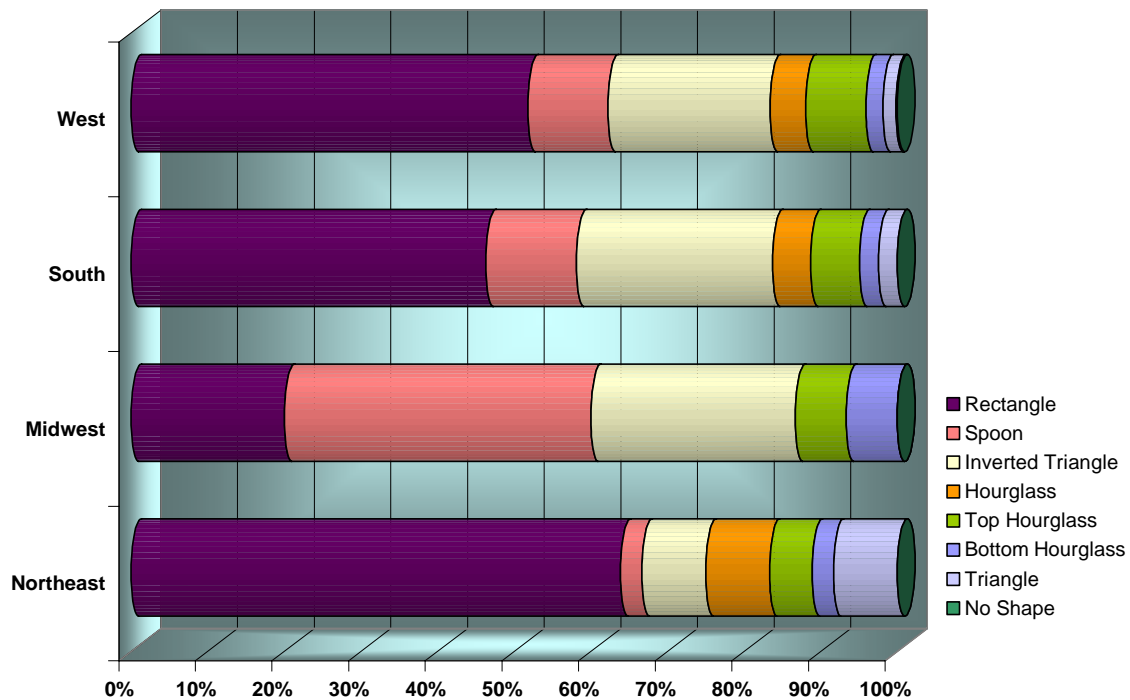


Figure 22: Hispanic shape by geographic location.

ASTM Sizing vs. Hispanic Body Shapes

To evaluate the effectiveness of current ASTM sizing standards in accommodating the body shapes of U.S. Hispanic women, body shapes that predominated in the Hispanic market were revisited and compared to the body shapes targeted by each of the current ASTM sizing standards used by the apparel industry today. The results presented in this section help to answer research question 3 posed in this study, which was: *How well do apparel sizing standards used by the industry today meet the needs of Hispanic women in the U.S.?*

Shapes Targeted by Current ASTM Sizing Standards

The sizing standards studied for this research were the Junior, Missy, and Over 55 family of standards. These standards, put forth by ASTM, are the currently accepted sizing standards for use by apparel companies. While most companies do not actually use the standards as they are written, they are the only standards officially issued for use in sizing.

The Junior standard (ASTM D 6829) targeted Hourglass through 100% of the sizes, as shown in Figure 23. This means that if apparel companies used this standard to produce a garment, consumers with the Hourglass shape would find the best fit this garment. Consumers with different body shapes who attempted to purchase a garment made to fit Hourglass shapes would not likely be satisfied with the fit of their apparel.

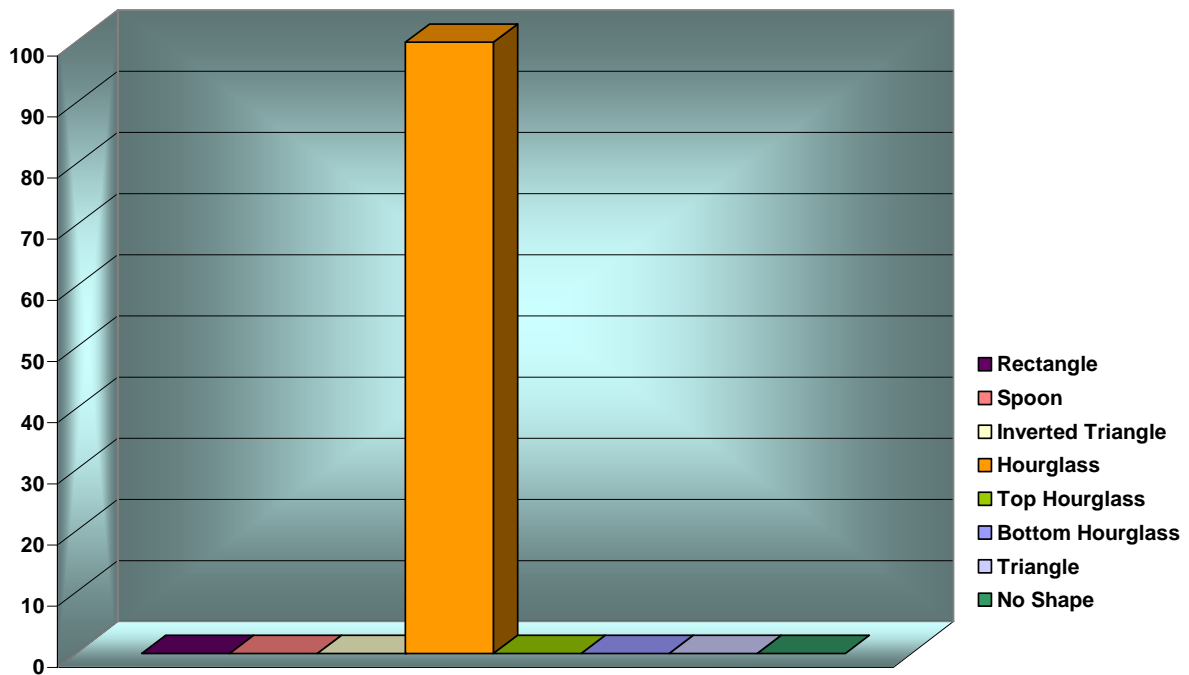


Figure 23: Shape targeted by current Junior standard (ASTM D 6829).

The evaluation of the Missy standard (ASTM D 5585) yielded similar results as the evaluation of the Junior standard, as illustrated by Figure 24. Once again, the Missy standard targeted the Hourglass shape throughout 100% of the size range. Like the Junior standard, apparel produced according to the Missy sizing standard would best fit women with Hourglass shapes, and would likely leave women with other body shapes with less than desirable fitting apparel.

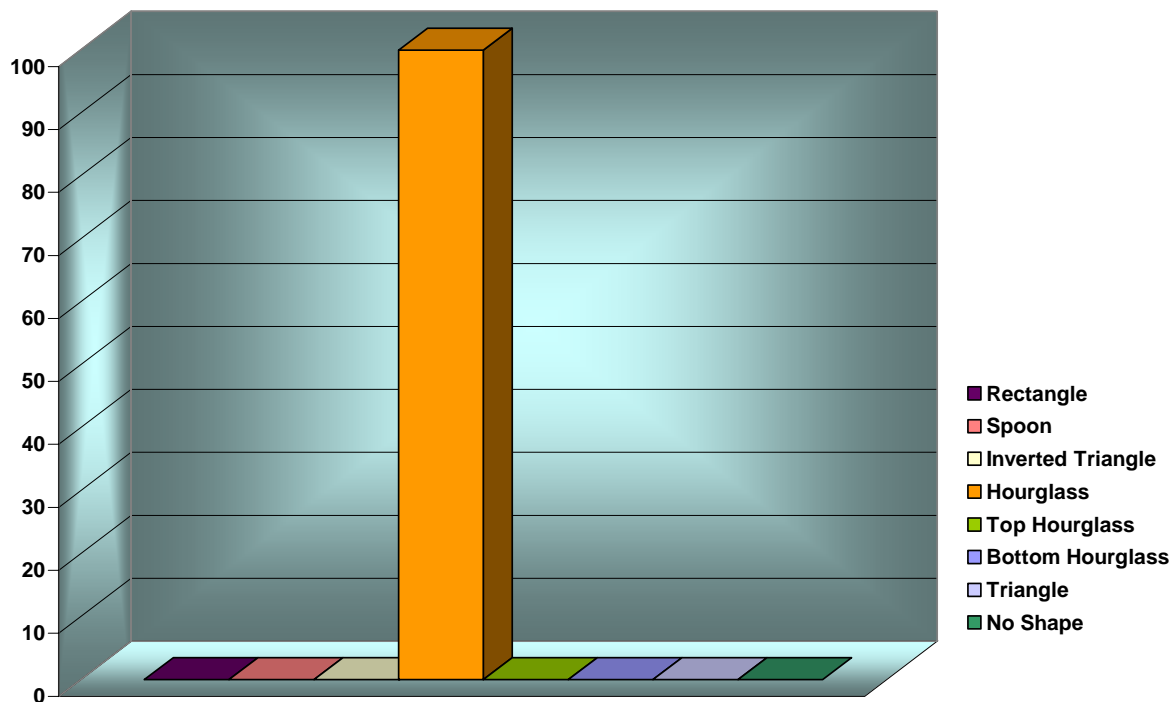


Figure 24: Shape targeted by current Missy standard (ASTM D 5585).

When processed through FFIT[®] for Apparel software, the Over 55 family of standards provided interesting results. While the Junior and Missy standards targeted one particular shape throughout the entire size range, all but one of the seven substandards within the Over 55 family of standards targeted two different shapes within their size ranges, as shown in Figure 25. Most of the standards targeted a combination of Spoon and Rectangle shapes, with some more heavily targeting Rectangles and others more heavily targeting Spoon shapes. The fact that these substandards targeted more than one shape means that depending on the

size chosen within the size range, the garment (produced using these standards) may better fit people of varying shapes.

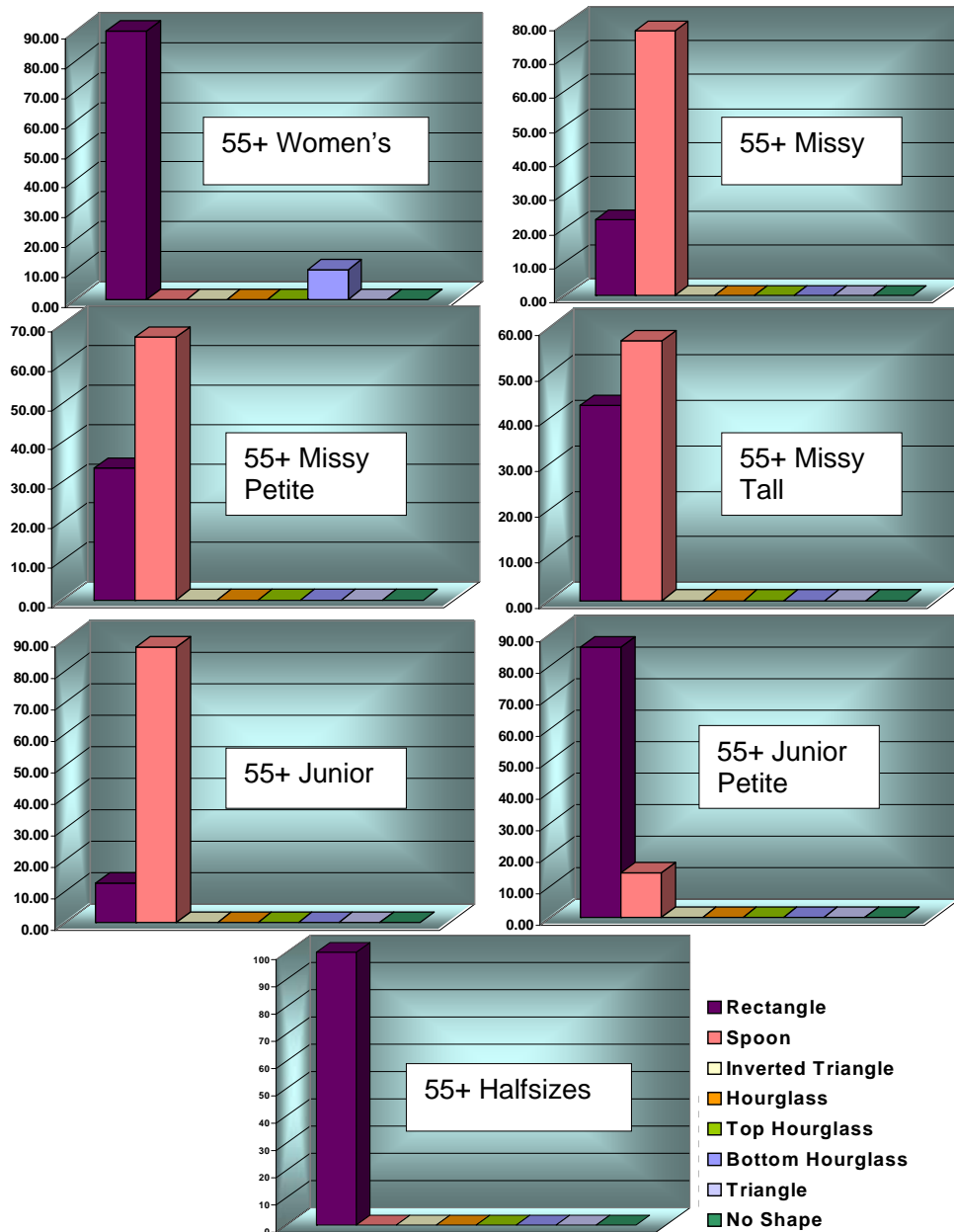


Figure 25: Shapes targeted by the current Over 55 family of standards (ASTM D 5586).

Another Look at Hispanic Body Shapes

To determine the ability of current sizing standards to satisfy the apparel fit needs of Hispanic women, it was helpful to revisit Figures 18 and 20, which showed the body shapes that predominated for Hispanic U.S. women, and how they varied by age. These charts showed that the most predominant shape in the Hispanic market was the Rectangle shape, followed by the Inverted Triangle, and then the Spoon shapes. In addition, as Hispanic women age, there seemed to be a trend of movement out of the Rectangle shape category and into the Inverted Triangle category.

Analysis of Body Measurements within the Rectangle Shape Category by Ethnicity

As shown in the previous section, current sizing standards used by the apparel industry are not serving the fit needs of Hispanic women in the U.S. However, Hispanics are not the only ethnicity not being served by these sizing standards. Figure 18 shows the body shapes that predominated in each of the ethnic groups, and a comparison of these shapes with the shapes being targeted by ASTM sizing standards illustrates the same inadequacies of the standards that were demonstrated for Hispanic women.

The ineffectiveness of the sizing standards at meeting the fit needs of all the ethnic groups resulted in an important question: Do individual sizing standards need to be created for each ethnic group, or could all of the ethnic groups be served

through the creation of one standard? This question cannot be answered without having a better understanding of exactly how body shapes and measurements of different ethnicities compare. The presence of significant and important differences between Hispanic women and women from other ethnic groups would support the creation of individual sizing standards for specific ethnicities.

To fully evaluate differences among ethnicities, six of the most important measurements used in the development of sizing standards were studied, and served as a starting point for understanding how ethnicities compare. The results of the comparisons between ethnic groups at the six body locations are presented in this section, and relate to research question 4 posed for this study, which was: *How do bust, waist, high hip, hip, upper arm, and thigh max measurements of Hispanic women in the Rectangle shape category compare to Rectangle-shaped women in the White, Black, and Other ethnic categories of SizeUSA?*

In making these comparisons, only subjects having the same body shapes were compared, due to the fundamental differences in body measurements that can result in people of different body shapes. For this study, the subjects from the Rectangle shape category were compared because this was the most predominant shape found in all of the ethnicities. This standardized the comparisons among ethnic groups, and allowed for a true determination of differences to be made.

Hypotheses

To test for significant differences among ethnic groups (at the specific body locations), the following hypotheses were used:

H₀: There is no significant effect of ethnicity on (bust, waist, high hip, hip, upper arm, and thigh max) measurements.

H_a: There is a significant effect of ethnicity on (bust, waist, high hip, hip, upper arm, and thigh max) measurements.

While the statistical tests performed in the comparison between ethnic groups tested for significant difference, the comparisons were also always done in the context of a real world situation. This meant that even if tests showed a significant difference between mean measurements of ethnic groups, the actual differences were also evaluated to determine if the differences were important.

Bust

Figure 26 compares the mean bust measurements for Rectangle-shaped women found in each of the ethnic groups as well as the total population of Rectangle-shaped women. This graph shows that the average bust measurements for Hispanic and White Rectangles were very close, only different by less than $\frac{1}{4}$ inch. The average for Black women was considerably larger than Hispanics, by about 2 inches, while the average for women in the Other category was smaller by a little more than 1 inch. The fact that over half of the sample of Rectangle-shaped women was in the White ethnic group meant that the mean bust measurement (as well as mean measurements at other locations studied later) calculated for this group was weighted much more heavily in the mean for the total population of Rectangles. As a result, the mean bust measurement found for Hispanic women was very close to the mean of the total population of Rectangles, with Hispanic

women having about 1/3 inch smaller bust measurement on average than the total population.

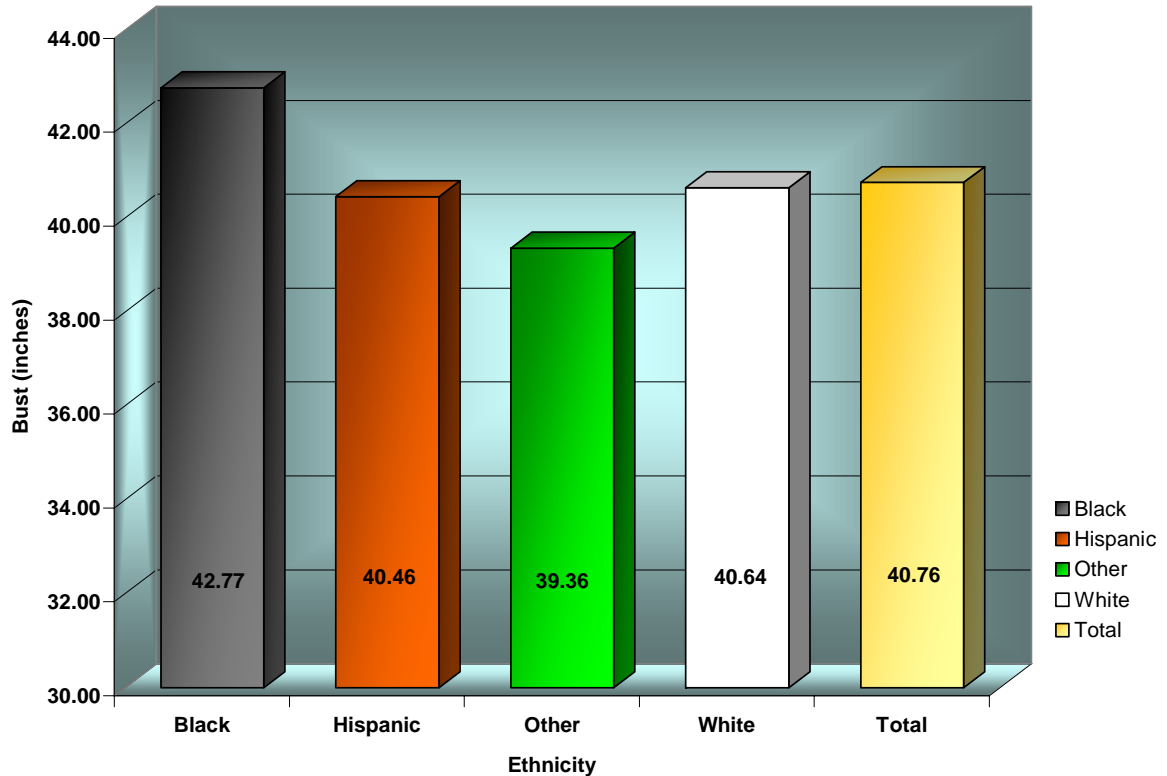


Figure 26: Graphical comparison of mean bust measurements among ethnic groups in the Rectangle shape category.

Also important in the comparison of bust measurements between ethnic groups was a comparison of other statistics besides means, shown in Table 10. For instance, a comparison of the range of bust measurements (maximum – minimum) indicated that Hispanic women were more closely concentrated, with a range of 22 inches between the largest and smallest extremes. This was the smallest range of measures found in any ethnic group, and even when the smallest and largest outliers were eliminated from the groups (in the calculation of 5th and 95th

percentiles), the results were the same. Ninety percent of Hispanic women had bust measurements within a span of just 12 inches, which was the smallest range of any ethnicity. This supports the result found when comparing variance as well. Less variance was found in the bust measurements of Hispanic women than any other ethnic group, with the most variance seen for Black women. This indicated that Hispanic women were more concentrated together around their mean bust measurement than any other ethnic group.

Table 10: Descriptive Statistics of Bust Measurements by Ethnic Group in the Rectangle Shape Category

| Ethnic Group | Mean (in) | Minimum (in) | Maximum (in) | Variance | Median (in) | 5th Percentile (in) | 95th Percentile (in) |
|---------------------|------------------|---------------------|---------------------|-----------------|--------------------|---------------------------------------|--|
| Black | 42.77 | 31.54 | 61.79 | 23.69 | 42.39 | 35.39 | 51.36 |
| Hispanic | 40.46 | 32.20 | 54.14 | 13.25 | 40.27 | 34.89 | 46.48 |
| Other | 39.36 | 30.27 | 53.88 | 16.05 | 39.03 | 33.47 | 47.14 |
| White | 40.64 | 31.52 | 57.78 | 15.97 | 40.20 | 34.80 | 47.65 |
| Total | 40.76 | 30.27 | 61.79 | 18.01 | 40.33 | 34.63 | 48.49 |

In the ANOVA test for significance of ethnicity on bust measurements across ethnic groups, a p-value of less than 0.0001 was calculated, as shown in Table 11. This was less than the alpha (significance) level of 0.05, indicating that ethnicity had a significant effect on bust measurements. Thus, the null hypothesis was rejected and the alternative hypothesis was accepted.

Table 11: Results of ANOVA test to determine Effect of Ethnicity on Bust Measurements

| Source | DF | Sum of Squares | F Ratio | Prob>F (p value) |
|-----------------|-----------|-----------------------|----------------|----------------------------|
| Ethnic Category | 3 | 3159.355 | 62.1602 | <.0001 |

Since ethnicity was found to have a significant effect on bust measurement, Tukey tests were done to determine which ethnic groups had significantly different bust measurements. Results in Table 12 show that Hispanic women and White women did not have significantly different bust measurements. However, Hispanic women had significantly smaller measurements than Black women, and significantly larger measurements than women in the Other ethnic group. Black women had significantly larger measurements than all other ethnicities, while women in the Other category had significantly smaller measurements than all other ethnicities, indicating that the relationship found between Hispanic women and women from these two ethnic groups was not unusual.

Table 12: Results of Tukey-Kramer HSD test to determine Ethnic Differences - Bust

| Level | | Mean |
|----------|---|-------|
| Black | A | 42.77 |
| White | B | 40.64 |
| Hispanic | B | 40.46 |
| Other | C | 39.36 |

Note: Levels NOT connected by the same letter are significantly different

Waist

Figure 27 compares the mean waist measurements found in each of the ethnic groups. Like the comparison of bust measurements, the average waist measurements of Hispanic women and White women in the Rectangle category were fairly close, only different by about ½ inch. Black women had an average waist

measurement that was more than 2 inches larger than Hispanic women, while women in the Other category were smaller by more than ½ inch. Overall, the average waist measurement for Hispanic women was slightly more than ½ inch smaller than the average for the total population of Rectangle-shaped women.

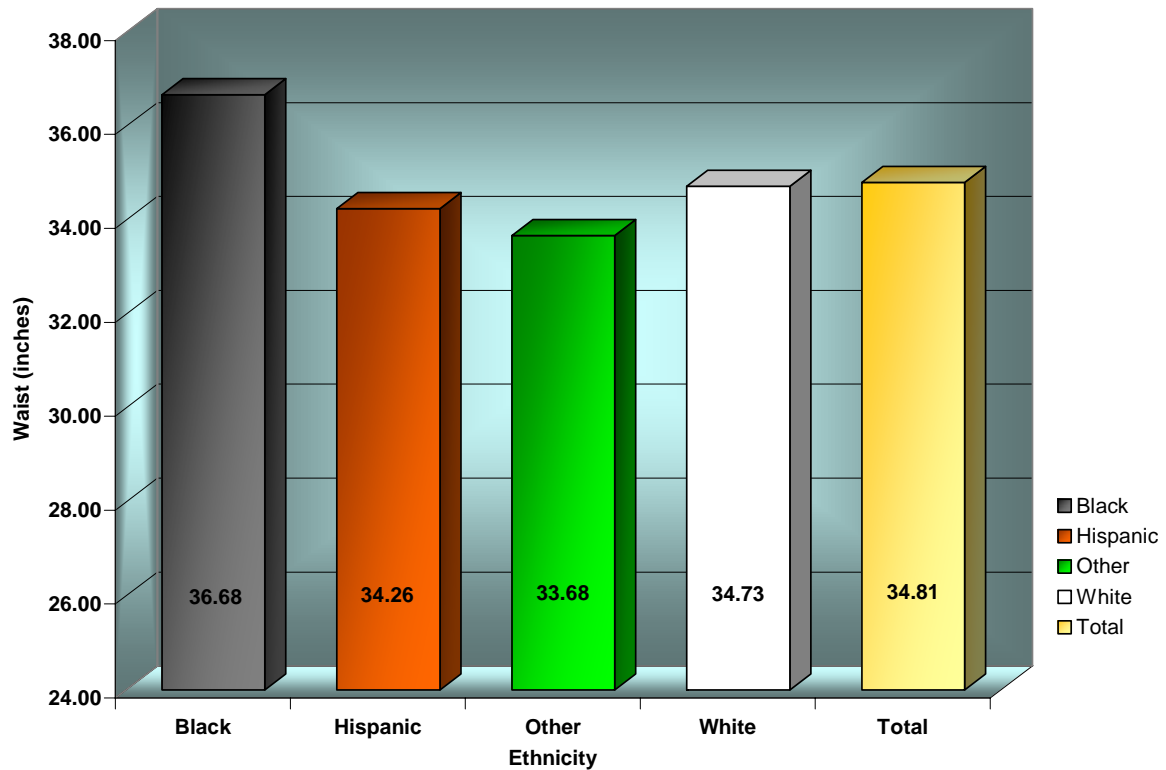


Figure 27: Graphical comparison of mean waist measurements among ethnic groups in the Rectangle shape category.

Table 13 presents some important descriptive statistics related to the waist measurements found in each ethnic group. A comparison of the range of measurements found in each ethnic group showed that the Hispanic group was much more concentrated than any ethnicity, with a 23 inch range found between the

smallest and largest values. In addition, the Hispanic group was less affected by extremely large or small outliers – 90% of Hispanic women had waist measurements within a 13 inch range, which was the smallest range found in any ethnic group. This concentration of measurements was supported by the variances calculated for each ethnic group. The variance of 15.81 found for Hispanic women was smaller than the variances found for any other group of women. Waist measurements of Black women were much more varied than the other ethnic groups from SizeUSA. Overall, the statistics in Table 13 showed that waist measurements for Hispanic women were more concentrated in a smaller range of values than any other ethnicity.

Table 13: Descriptive Statistics of Waist Measurements by Ethnic Group in the Rectangle Shape Category

| Ethnic Group | Mean (in) | Minimum (in) | Maximum (in) | Variance | Median (in) | 5th Percentile (in) | 95th Percentile (in) |
|---------------------|------------------|---------------------|---------------------|-----------------|--------------------|---------------------------------------|--|
| Black | 36.68 | 25.35 | 57.01 | 27.80 | 36.29 | 28.60 | 46.23 |
| Hispanic | 34.26 | 25.94 | 49.85 | 15.81 | 33.85 | 28.34 | 41.78 |
| Other | 33.68 | 25.16 | 53.79 | 18.02 | 33.06 | 27.80 | 41.94 |
| White | 34.73 | 25.02 | 53.14 | 19.53 | 34.26 | 28.52 | 42.93 |
| Total | 34.81 | 25.02 | 57.01 | 21.04 | 34.28 | 28.34 | 43.47 |

Results of the ANOVA test for effect of ethnicity on waist measurements are shown in Table 14. A p-value of less than 0.0001 indicated that ethnicity significantly affected the waist measurements recorded for the SizeUSA sample. Thus, the null hypothesis was rejected and the alternative hypothesis was accepted.

Table 14: Results of ANOVA test to determine Effect of Ethnicity on Waist Measurements

| Source | DF | Sum of Squares | F Ratio | Prob>F (p value) |
|-----------------|----|----------------|---------|------------------|
| Ethnic Category | 3 | 2606.579 | 43.0980 | <.0001 |

The conclusion of a significant effect of ethnicity on waist measurements necessitated the use of the Tukey test to determine which ethnic groups had significantly different waist measurements. Results of this test are shown in Table 15. Hispanic women did not have significantly different waist measurements than White women or women from the Other group. The only significant difference found for Hispanics was seen in the comparison with Black women, who had significantly larger mean waist measurements than Hispanic women. In fact, Black women had significantly larger measurements than any of the other ethnic groups compared.

Table 15: Results of Tukey-Kramer HSD test to determine Ethnic Differences - Waist

| Level | | Mean |
|----------|-----|-------|
| Black | A | 36.68 |
| White | B | 34.73 |
| Hispanic | B C | 34.26 |
| Other | C | 33.68 |

Note: Levels NOT connected by the same letter are significantly different

High Hip

A graphical comparison of mean high hip measurements found in the different ethnic groups defined by SizeUSA is found in Figure 28. Hispanic women had average high hip measurements closest to measurements found for women in the

Other category – only about ½ inch larger than the Other group. On average, Hispanic women were about 1 inch smaller through the high hip than White women, and over 2.5 inches smaller than Black women. A comparison with the total population of Rectangle-shaped women showed that Hispanic women were about 5/6 inch smaller.

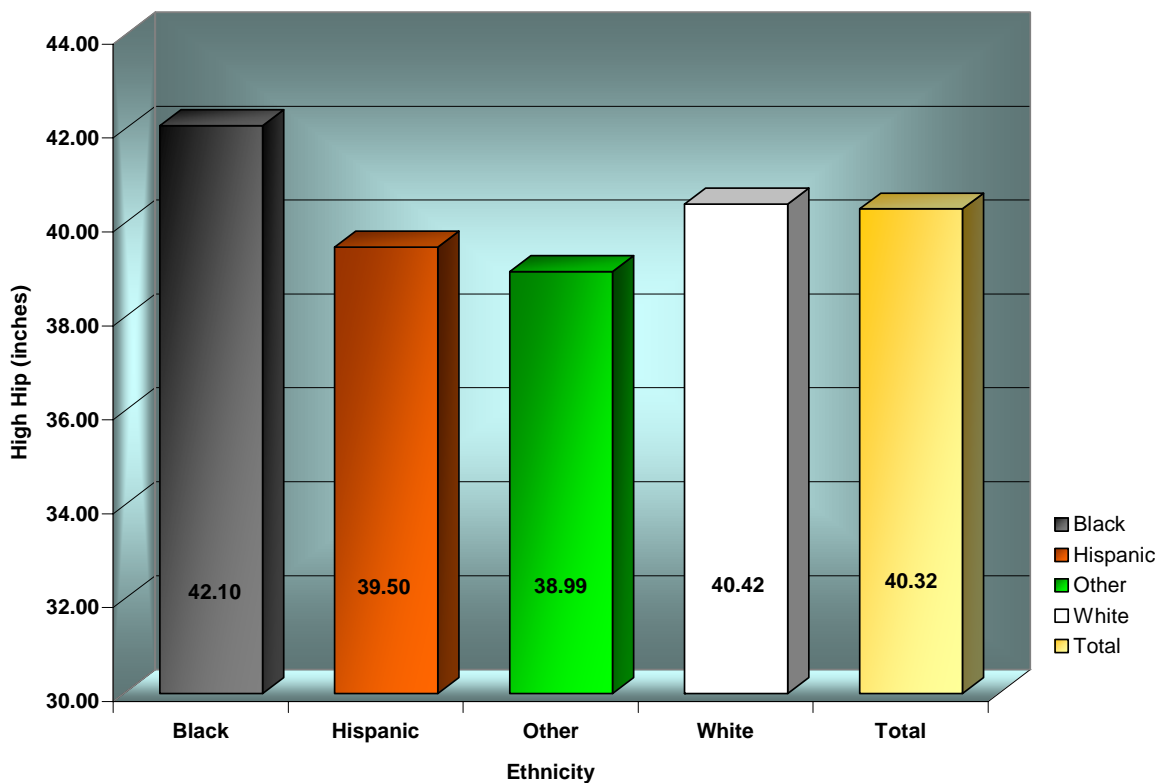


Figure 28: Graphical comparison of mean high hip measurements among ethnic groups in the Rectangle shape category.

Other important statistics in the comparison of high hip measurements across ethnicities are included in Table 16. Once again, the comparison of maximum-minimum values showed that high hip measurements for Hispanic women were

more concentrated within a smaller range of values than for any other ethnic group. Eliminating the extreme outliers provided the same results – 90% of Hispanic women had high hip measurements within a range of less than 16 inches (smallest of any group), indicating that not only did Hispanic women have fewer extreme outliers, but they were also grouped more closely together than other ethnic groups. The comparison of variances emphasized the concentration of Hispanic women, with smaller values being calculated for Hispanic Rectangles than for any other ethnicity. Measurements of Black women were the most varied, as well as most affected by extreme outliers. Overall, Table 16 shows that high hip measurements for Hispanic women were grouped more closely together with less variation than the other ethnic groups.

Table 16: Descriptive Statistics of High Hip Measurements by Ethnic Group in the Rectangle Shape Category

| Ethnic Group | Mean (in) | Minimum (in) | Maximum (in) | Variance | Median (in) | 5th Percentile (in) | 95th Percentile (in) |
|---------------------|------------------|---------------------|---------------------|-----------------|--------------------|---------------------------------------|--|
| Black | 42.10 | 29.16 | 64.60 | 34.79 | 41.83 | 33.06 | 52.04 |
| Hispanic | 39.50 | 29.38 | 59.33 | 21.22 | 39.33 | 32.45 | 48.24 |
| Other | 38.99 | 28.53 | 60.75 | 23.29 | 38.47 | 32.27 | 48.60 |
| White | 40.42 | 29.58 | 61.55 | 26.82 | 39.82 | 32.96 | 50.07 |
| Total | 40.32 | 28.53 | 64.60 | 27.71 | 39.77 | 32.61 | 50.16 |

Results of the ANOVA test to measure the effect of ethnicity on High Hip measurements are shown in Table 17. The p-value of less than 0.0001 indicated that ethnicity had a significant effect on high hip measurements of Rectangle-shaped

women. Thus, the null hypothesis was rejected and the alternative hypothesis was accepted.

Table 17: Results of ANOVA test to determine Effect of Ethnicity on High Hip Measurements

| Source | DF | Sum of Squares | F Ratio | Prob>F (p value) |
|-----------------|----|----------------|---------|------------------|
| Ethnic Category | 3 | 2840.011 | 35.3805 | <.0001 |

Table 18 shows the results of the Tukey test performed to determine which ethnic groups had significantly different mean high hip measurements. This table shows that Hispanic women and women in the Other ethnic category were not significantly different at the high hip location. However, Hispanic women had significantly smaller high hip measurements than White and Black women. In addition, Black and White women had significantly different high hip measurements than all of the other ethnic groups.

Table 18: Results of Tukey-Kramer HSD test to determine Ethnic Differences – High Hip

| Level | | Mean |
|----------|---|-------|
| Black | A | 42.10 |
| White | B | 40.42 |
| Hispanic | C | 39.50 |
| Other | C | 38.99 |

Note: Levels NOT connected by the same letter are significantly different

Hip

Figure 29 shows the mean hip measurements of Rectangle-shaped women in each of the ethnic groups as well as the total population of Rectangle-shaped

women. On average, Hispanic women had about $\frac{3}{4}$ inch smaller hip measurements than White women, nearly 3 inches smaller hips than Black women, and almost 1 inch larger hips than women in the Other category. This translated into only about a $\frac{3}{4}$ inch difference in the average hip measurements of Hispanic women and the total population of Rectangle-shaped women.

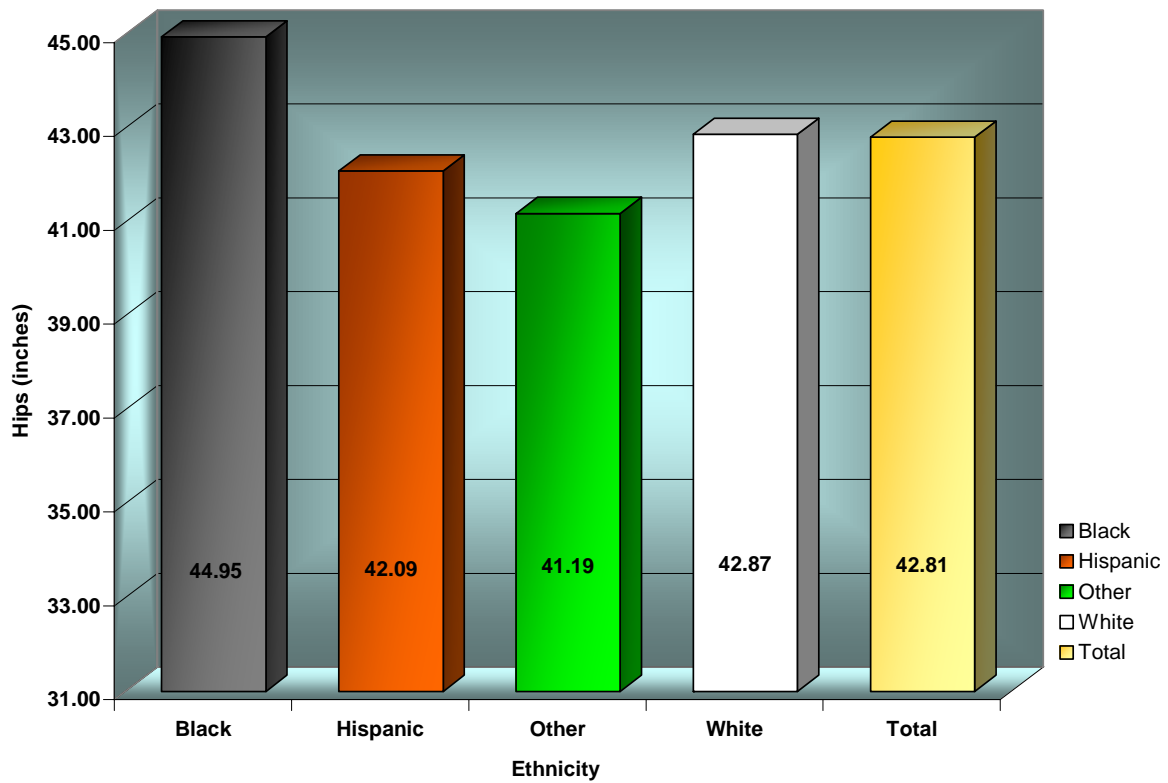


Figure 29: Graphical comparison of mean hip measurements among ethnic groups in the Rectangle shape category.

Table 19 details some other important descriptive statistics relating to the comparison of hip measurements across ethnic groups. Just as with the other measurements previously discussed, the hip measurements for Hispanic women

occupied a smaller range than any of the other ethnic groups. When extreme small and large values were eliminated, 90% of Hispanic women fit within a 13.5 inch range of values, the smallest range of any group. This closer concentration of measurements was supported by the variances calculated for each group. The variance of 17.28 for Hispanic measurements was the smallest value calculated for any group, while the variance in measurements of Black women was by far the highest, at 29.28. The information in Table 19 indicated that hip measurements for Hispanic women were more concentrated within a smaller range of values than any other ethnic group.

Table 19: Descriptive Statistics of Hip Measurements by Ethnic Group in the Rectangle Shape Category

| Ethnic Group | Mean (in) | Minimum (in) | Maximum (in) | Variance | Median (in) | 5th Percentile (in) | 95th Percentile (in) |
|---------------------|------------------|---------------------|---------------------|-----------------|--------------------|---------------------------------------|--|
| Black | 44.95 | 32.15 | 66.05 | 29.28 | 44.24 | 37.18 | 54.91 |
| Hispanic | 42.09 | 34.16 | 61.83 | 17.28 | 41.37 | 36.33 | 49.78 |
| Other | 41.19 | 33.11 | 64.43 | 20.21 | 40.49 | 35.59 | 50.78 |
| White | 42.87 | 32.63 | 65.91 | 22.97 | 41.93 | 36.62 | 52.04 |
| Total | 42.81 | 32.15 | 66.05 | 24.08 | 41.93 | 36.38 | 52.30 |

The ANOVA test performed to evaluate the effect of ethnicity on hip measurements gave similar results to those obtained when analyzing bust, waist, and high hip measurements. As shown in Table 20, the p-value of less than 0.0001 means that ethnicity did affect the hip measurements obtained for the Rectangle-shaped population of women. Thus, the null hypothesis was rejected and the alternative hypothesis was accepted.

Table 20: Results of ANOVA test to determine Effect of Ethnicity on Hip Measurements

| Source | DF | Sum of Squares | F Ratio | Prob>F (p value) |
|-----------------|----|----------------|---------|------------------|
| Ethnic Category | 3 | 3946.866 | 57.8445 | <.0001 |

Table 21 summarizes the results of the Tukey test performed to determine which ethnic groups had significant differences in their hip measurements. Most interesting about the results of this Tukey test was that the mean measurements of all of the groups were significantly different from one another. Of particular interest to this study was that Hispanic women had significantly larger hip measurements than women in the Other ethnic category. On the other hand, the hip measurements of Hispanics were significantly smaller than the measurements for Black and White women, with Black women recording the largest measurements of any group.

Table 21: Results of Tukey-Kramer HSD test to determine Ethnic Differences - Hip

| Level | | Mean |
|----------|---|-------|
| Black | A | 44.95 |
| White | B | 42.87 |
| Hispanic | C | 42.09 |
| Other | D | 41.19 |

Note: Levels NOT connected by the same letter are significantly different

Upper Arm

Figure 30 presents the graphical comparison of mean upper arm measurements of Rectangle-shaped women from the different ethnic groups and the total population of Rectangles. This graph shows that the mean upper arm

measurements of Hispanic women, White women, and Other women were very close. Hispanic women had less than $\frac{1}{4}$ inch smaller upper arms on average than White women, and less than $\frac{1}{5}$ inch larger upper arms than women in the Other ethnic group. However, Black women had considerably larger upper arm measurements than Hispanic women, with about a 1.5 inch difference between the means of the two groups. Overall, Hispanic women had about $\frac{1}{3}$ inch smaller upper arms than the total population of Rectangle-shaped women. However, this had more to do with the larger measurement of the Black population pulling up the average of the total group – the other ethnic groups (Hispanic, White, Other) recorded very close measurements to one another.

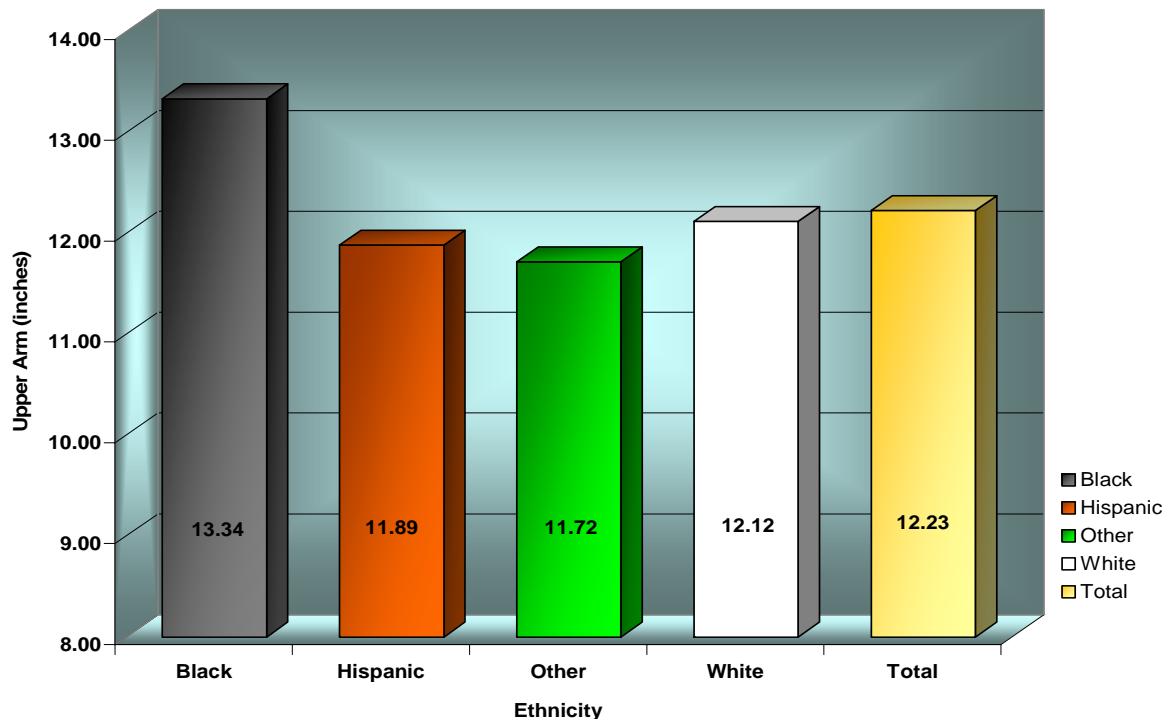


Figure 30: Graphical comparison of mean upper arm measurements among ethnic groups in the Rectangle shape category.

A more detailed chart of statistics describing the upper arm measurements of the distinct ethnic groups is included at Table 22. For the first time, the range (maximum-minimum) of upper arm measurements for Hispanic women was not the smallest; rather, women in the Other category fell into the smallest range of measurements. However, once the extreme outliers were eliminated, 90% of Hispanic women occupied a range of about 5¼ inches, which was the smallest range noted for any ethnic group. This indicated that the Other category was possibly more affected by outliers than the Hispanic group. A comparison of variances indicated that measurements for Hispanic women were less varied around their mean than any other group, while Black women were the most varied.

Table 22: Descriptive Statistics of Upper Arm Measurements by Ethnic Group in the Rectangle Shape Category

| Ethnic Group | Mean (in) | Minimum (in) | Maximum (in) | Variance | Median (in) | 5th Percentile (in) | 95th Percentile (in) |
|---------------------|------------------|---------------------|---------------------|-----------------|--------------------|---------------------------------------|--|
| Black | 13.34 | 8.68 | 21.05 | 5.04 | 13.25 | 9.87 | 17.24 |
| Hispanic | 11.89 | 8.48 | 18.70 | 2.67 | 11.71 | 9.52 | 14.80 |
| Other | 11.72 | 8.21 | 18.36 | 3.09 | 11.46 | 9.30 | 15.26 |
| White | 12.12 | 6.98 | 19.99 | 3.63 | 11.90 | 9.50 | 15.75 |
| Total | 12.23 | 6.98 | 21.05 | 3.92 | 11.93 | 9.53 | 15.93 |

Table 23 presents the results of the ANOVA test performed to evaluate the effect of ethnicity on upper arm measurements recorded for Rectangle-shaped SizeUSA subjects. The p-value of less than 0.0001 indicated that ethnicity had a significant effect on upper arm measurements of Rectangle-shaped women. Thus, the null hypothesis was rejected and the alternative hypothesis was accepted.

Table 23: Results of ANOVA test to determine Effect of Ethnicity on Upper Arm Measurements

| Source | DF | Sum of Squares | F Ratio | Prob>F (p value) |
|-----------------|----|----------------|---------|------------------|
| Ethnic Category | 3 | 828.916 | 75.9693 | <.0001 |

Based on the results of the ANOVA, Tukey tests were done to determine which ethnic groups had significant differences in upper arm measurements. The results of the Tukey test are summarized in Table 24. This table shows that Hispanics did not have significantly different mean upper arm measurements from White women or women in the Other ethnic category. However, Hispanic upper arm measurements were significantly smaller than measurements for Black women.

Table 24: Results of Tukey-Kramer HSD test to determine Ethnic Differences – Upper Arm

| Level | | Mean |
|----------|-----|-------|
| Black | A | 13.34 |
| White | B | 12.12 |
| Hispanic | B C | 11.89 |
| Other | C | 11.72 |

Note: Levels NOT connected by the same letter are significantly different

Thigh Max

Figure 31 shows the comparison of the mean thigh max measurements of the Rectangle-shaped women from the four ethnic groups that were part of SizeUSA, as well as the mean measurement of the total population of Rectangle-shaped women. This graph shows that the mean thigh max measurement of Hispanic women was very close to that of White women (less than 1/5 inch difference between the two),

as well as women in the Other category (only ½ inch difference). However, the mean thigh max measurement for Black women was more than 2.5 inches bigger than the average for Hispanic women. Overall, Rectangle-shaped Hispanic women were less than ½ inch smaller than the total population of Rectangles.

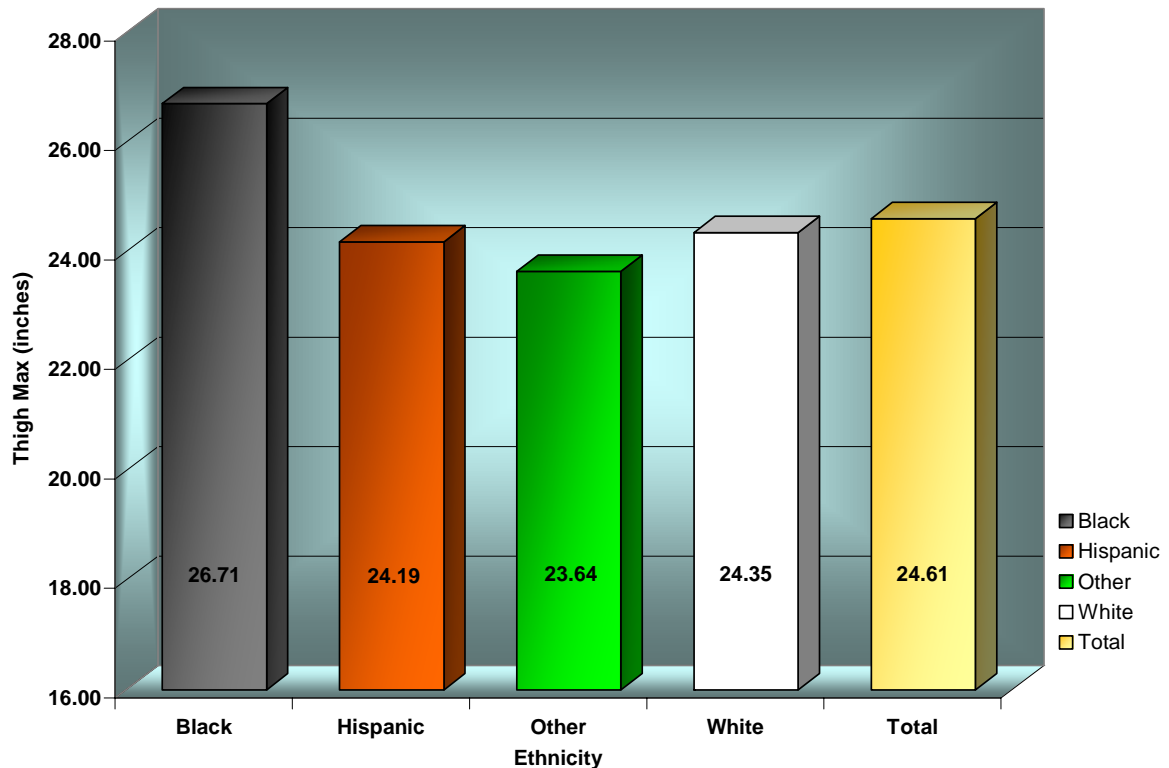


Figure 31: Graphical comparison of mean thigh max measurements among ethnic groups in the Rectangle shape category.

More detailed descriptive statistics related to thigh max measurements are included in Table 25. The comparison of minimum and maximum values showed that the Other category had a smaller range of values than the remaining ethnic groups. However, once the smallest and largest extreme values were eliminated,

the Hispanic group had the smallest range of values – 90% of Hispanic women fell within an 8¼ inch span of measurements. This was the smallest range (when looking at the middle 90% of each group) found for any ethnicity. This indicated that the Other category was possibly more affected by outliers than the Hispanic group. The close concentration of measurements for Hispanic women was supported by the calculation of the variances of the measurements. The variance of 6.29 found for the Hispanic group was the smallest of any ethnic group, while the measurements of Rectangle-shaped Black women were the most varied of any group.

Table 25: Descriptive Statistics of Thigh Max Measurements by Ethnic Group in the Rectangle Shape Category

| Ethnic Group | Mean (in) | Minimum (in) | Maximum (in) | Variance | Median (in) | 5th Percentile (in) | 95th Percentile (in) |
|---------------------|------------------|---------------------|---------------------|-----------------|--------------------|---------------------------------------|--|
| Black | 26.71 | 17.48 | 39.04 | 12.76 | 26.26 | 21.43 | 33.31 |
| Hispanic | 24.19 | 19.32 | 37.86 | 6.29 | 23.79 | 20.75 | 28.99 |
| Other | 23.64 | 18.30 | 36.02 | 7.70 | 23.14 | 20.01 | 29.07 |
| White | 24.35 | 17.07 | 36.33 | 7.42 | 23.93 | 20.69 | 29.30 |
| Total | 24.61 | 17.07 | 39.04 | 9.24 | 24.09 | 20.65 | 30.49 |

Results of the ANOVA test for effect of ethnicity on thigh max measurements are shown in Table 26. A p-value of less than 0.0001 indicated that ethnicity significantly affected the thigh max measurements recorded for the SizeUSA sample. Thus, the null hypothesis was rejected and the alternative hypothesis was accepted.

Table 26: Results of ANOVA test to determine Effect of Ethnicity on Thigh Max Measurements

| Source | DF | Sum of Squares | F Ratio | Prob>F (p-value) |
|-----------------|----|----------------|----------|------------------|
| Ethnic Category | 3 | 2902.389 | 117.3657 | <.0001 |

Table 27 provides the results of the Tukey test that was performed to discover which ethnic groups had significantly different thigh max measurements. According to this test, there was no significant difference between the thigh max measurements of the Hispanic group and the White group. However, the women from the Other ethnic category had significantly smaller thigh max measurements than Hispanic women, while Black women had significantly larger thigh max measurements than Hispanic women.

Table 27: Results of Tukey-Kramer HSD test to determine Ethnic Differences – Thigh Max

| Level | | Mean |
|----------|---|-------|
| Black | A | 26.71 |
| White | B | 24.35 |
| Hispanic | B | 24.19 |
| Other | C | 23.64 |

Note: Levels NOT connected by the same letter are significantly different

Summary of Comparisons

In comparing the measurements of Rectangle-shaped women from the Hispanic group to Rectangle-shaped women from the other ethnic categories at the six body locations used in this study, several overarching trends were apparent. For example, Hispanic women's body measurements (at all six body locations

compared) were less varied around their means than any other ethnic group. This meant that Hispanic women's measurements were more closely concentrated within a smaller range of values than other ethnic groups' measurements.

In addition, ethnicity significantly affected the body measurements at each of the six locations studied. Specifically, there was no significant difference between Hispanic women and White women at four of the body locations tested (bust, waist, upper arm, and thigh max). Hispanic women had significantly smaller measurements than White women at the other two body locations (high hip and hip). When comparing Hispanic women's measurements to women in the Other category, there was no significant difference at three of the body locations (waist, high hip, and upper arm); the Other ethnic group recorded significantly smaller measurements than Hispanic women at the other three body locations (bust, hip, and thigh max). Black women were significantly larger than Hispanic women at each of the six body locations.

Even though ethnicity was found to have a significant effect on each of the six measurements, the comparison of the means of each of the measurements helped to determine if this effect was important. For instance, the largest difference found between Hispanic mean measurements and White mean measurements (at any of the six body locations) was less than 1 inch. Due to the large sample of White women within the total population, Hispanic mean measurements were also fairly close to average measurements for the total population.

Development of the Rectangle Sizing Standard

Because of the relatively small differences in measurements between the total population of Rectangle-shaped women and Hispanic Rectangles, the decision was made to create a standard to accommodate the total population of Rectangles. Even though there is no such thing as an “average” Rectangle-shaped women (she is White, Black, Hispanic, or Other), all of the subjects in the Rectangle shape category were compiled and focused on together to create a standard for all Rectangle-shaped women. This replaced the idea of creating an entirely new standard solely for Hispanic women. Instead, the goal was to create a standard for Rectangle-shaped women that would hopefully fit Rectangle-shaped women of all ethnic groups. One standard that meets the fit needs of all Rectangle-shaped women (with no regard to ethnicity) would be far more attractive for apparel companies than separate standards for each ethnic group.

The development of the standard for Rectangle-shaped women related to the fifth research question posed for this study, which was: *How should a sizing standard for the most predominant shape category in the U.S. population (the Rectangle shape) be created?* All of the steps involved in the development of the standard are presented in this section, with the final result being a Rectangle sizing standard that was made to accommodate the proportions and sizes of Rectangle-shaped women.

Choice of Principal Component

As discussed in the methodology, a combination of principal component analysis, regression, and proportionate sizing was used to develop the Rectangle sizing standard. The first step was to choose the one measurement that was the best predictor measurement for the other measurements. This predictor variable is known as the principal component, as it is the measurement used as the basis for development of the standard. In choosing the principal component, only the three measurements of bust, waist, and hip were evaluated to determine their effectiveness at predicting the other measurements in the standard.

To choose the principal component, R^2 values (calculated as part of regression analysis) associated with how well bust, waist, and hip measurements predicted the other measurements of the standard were compared. R^2 values indicated how well the predictor measurement was predicting the other measurements, with values closer to 1 indicating better prediction. A summary of the R^2 values related to the bust, waist, and hip measurements is included as Table 28. As shown in this table, the waist was the best predictor of bust, high hip, and hip. The hips were the best predictor of the waist, upper arm, and thigh max, but the bust was not the best predictor of any of the measurements. Thus, the bust was eliminated as the principal component, and the choice was left between the waist and hips. When looking at the total of the R^2 values for the waist and hip, it seemed that the hip was the best overall predictor measurement. However, the waist was chosen as the principal component for the following reasons:

1. Even though the sizing standard created for this study only contained six measurements, any official sizing standard proposed for actual use by the industry would contain far more measurements. The six included for this study only served as a starting point and the first step in development of the sizing standard. Thus, the bust, waist, and hip measurements' abilities to predict the other measurements that would be included in an official sizing standard were also analyzed (even though not included as part of this study). When all of the R^2 values for all of the measurements were included, the waist was the best predictor variable. Because all of these measurements would be necessary for an official standard, the waist was chosen as the principal component.
2. The waist measure is very important both in the creation of apparel tops and bottoms. A standard created using the bust as the principal component would be best applicable to tops, while a standard created using the hips as the principal component would be best applicable to bottoms. Thus, the decision was made to use the waist as the principal component in the hopes that it would be equally appropriate for use in tops and bottoms.
3. In the creation of apparel, the critical fit measurements are often thought to be bust, waist, hips, and possibly high hip. Slight misfit in measures such as upper arm and thigh max may not be as problematic as misfit in the areas of bust, waist, hip, and high hip. Summing the R^2 values calculated for these

measurements (using each of the three predictor variables) showed that the waist was the better predictor of these critical fit areas.

Table 28: Comparison of R^2 values used to choose Principal Component

| Waist | | Hips | | Bust | |
|--------------|--------------|--------------|--------------|--------------|-------------|
| Bust | 0.878 | Bust | 0.858 | Waist | 0.878 |
| High Hip | 0.934 | Waist | 0.887 | High Hip | 0.852 |
| Hips | 0.887 | High Hip | 0.909 | Hips | 0.858 |
| Upper Arm | 0.756 | Upper Arm | 0.769 | Upper Arm | 0.761 |
| Thigh Max | 0.776 | Thigh Max | 0.869 | Thigh Max | 0.811 |
| Total | 4.231 | Total | 4.292 | Total | 4.16 |

Note: This chart compares R^2 values for the six measurements included in the standard for this study; an official sizing standard would include approximately 20 more measurements.

Development of Size Ranges

Once the waist was chosen as the principal component, the next step was to create the sizes that were included in the standard. One of the most important considerations for this part was the number of sizes to be included in the standard, as too few sizes would not provide acceptable fit for a wide range of the population, while too many sizes would be cumbersome to most apparel companies. Appendix E shows the current ASTM Missy Standard (D 5585), including the sizes and measurements that make up this standard. Only the six measurements included in the standard created for this study are shown in Appendix E, to simplify comparisons between the current ASTM standard and the proposed standard. The Missy standard contains 10 sizes (2-20) covering a waist range of 24 – 36.5 inches. Sizes 2-10 are separated into 1 inch size intervals, sizes 12-16 are separated into 1.5 inch

intervals, and 18-20 are separated into 2 inch intervals (when looking at the waist measurement).

Similar strategy was used in the development of size ranges for the Rectangle sizing standard. First, mean, median, 5th and 95th percentile values of the waist measurement (of the total population of Rectangles) were considered as a starting point for the range of values to be covered by the standard. Referring back to Table 13, the 5th percentile of the waist measurement was about 28 inches, while the 95th percentile was about 44 inches. The mean was 34.81 inches, while the median was 34.28. Because all of these values relate to the “average” population of Rectangles (and no one person is “average”), they only served as a guide in the decision of number of sizes and widths of size intervals. The range of sizes created for the proposed standard is included in Table 29. The 16 sizes included in the standard covered a range of waist measurements from 27 – 47 inches. The large number of sizes not only maximized the percentage of the population who could fit into the standard (according to their waist measurement), but also provided enough sizes for companies to select the range appropriate for their target markets. The creation of actual intervals was modeled after the intervals used in the current Missy standard, with the smaller sizes being separated into 1 inch intervals and then gradually moving into 2 inch intervals for the largest sizes. This type of incremental change between sizes resembled the proportionate sizing methods discussed in the review of literature.

Because sizes are not generally presented as a range of measurements (and instead as one measurement corresponding to a specific size), the middle of each of the size ranges of the proposed standard was chosen as the waist measurement that corresponded to the specific sizes 1-16. The specific waist measurement corresponding to each size in the standard is found in column 3 in Table 29. However, even though standards are typically presented as one particular measurement (for each body location), companies and consumers should always remember the size intervals around these measurements, as most people do not actually have the specific measurement included in the standard and instead fall somewhere in the range of sizes.

Table 29: Initial Size Intervals Created for Rectangle Sizing Standard (by Waist)

| Size | Waist Interval (inches) | Actual Waist Measure for Standard (inches) |
|------|-------------------------|--|
| 1 | 27 – 27.99 | 27.5 |
| 2 | 28 – 28.99 | 28.5 |
| 3 | 29 – 29.99 | 29.5 |
| 4 | 30 – 30.99 | 30.5 |
| 5 | 31 – 31.99 | 31.5 |
| 6 | 32 – 32.99 | 32.5 |
| 7 | 33 – 33.99 | 33.5 |
| 8 | 34 – 34.99 | 34.5 |
| 9 | 35 – 35.99 | 35.5 |
| 10 | 36 – 36.99 | 36.5 |
| 11 | 37 – 37.99 | 37.5 |
| 12 | 38 – 39.49 | 38.75 |
| 13 | 39.5 – 40.99 | 40.25 |
| 14 | 41 – 42.99 | 42 |
| 15 | 43 – 44.99 | 44 |
| 16 | 45 – 46.99 | 46 |

Completion of Sizing Standard

Once the size ranges were established and the waist measurements corresponding to each of the sizes included in the standard were finalized, the rest of the measurements included in the Rectangle sizing standard were calculated.

Regression Prediction: In the regression analysis used to evaluate the relationship between the predictor variable (waist) and the dependent variables

(bust, high hip, hip, upper arm, and thigh max), regression equations were also calculated - in addition to the R^2 values previously used to choose the principal component. The predictor variable can be plugged into each of the respective regression equations to predict the remaining measurements for the standard. The regression equations related to each of the measurements for the sizing standard are included in Table 30. The waist measurement corresponding to each size in the standard was plugged into each of these regression equations in order to predict the six measurements for the full range of sizes 1-16 in the standard. The resulting standard is included in Table 31.

Table 30: Equations used to predict measurements for Rectangle Sizing Standard

| Waist | Defined by researcher |
|-----------|-------------------------------------|
| Bust | $10.5795 + (0.8669 * \text{Waist})$ |
| High Hip | $1.7195 + (1.1089 * \text{Waist})$ |
| Hips | $7.7437 + (1.0075 * \text{Waist})$ |
| Upper Arm | $-0.8332 + (0.3752 * \text{Waist})$ |
| Thigh Max | $4.2975 + (0.5836 * \text{Waist})$ |

Table 31: Sizing Standard Created after Regression Prediction

| Size | Bust | Waist | High Hip | Hip | Upper Arm | Thigh Max |
|-------------|-------------|--------------|-----------------|------------|------------------|------------------|
| 1 | 34.42 | 27.5 | 32.21 | 35.45 | 9.48 | 20.35 |
| 2 | 35.29 | 28.5 | 33.32 | 36.46 | 9.86 | 20.93 |
| 3 | 36.15 | 29.5 | 34.43 | 37.47 | 10.23 | 21.51 |
| 4 | 37.02 | 30.5 | 35.54 | 38.47 | 10.61 | 22.10 |
| 5 | 37.89 | 31.5 | 36.65 | 39.48 | 10.98 | 22.68 |
| 6 | 38.75 | 32.5 | 37.76 | 40.49 | 11.36 | 23.26 |
| 7 | 39.62 | 33.5 | 38.87 | 41.50 | 11.74 | 23.85 |
| 8 | 40.49 | 34.5 | 39.98 | 42.50 | 12.11 | 24.43 |
| 9 | 41.35 | 35.5 | 41.08 | 43.51 | 12.49 | 25.02 |
| 10 | 42.22 | 36.5 | 42.19 | 44.52 | 12.86 | 25.60 |
| 11 | 43.09 | 37.5 | 43.30 | 45.53 | 13.24 | 26.18 |
| 12 | 44.17 | 38.75 | 44.69 | 46.78 | 13.71 | 26.91 |
| 13 | 45.47 | 40.25 | 46.35 | 48.30 | 14.27 | 27.79 |
| 14 | 46.99 | 42 | 48.29 | 50.06 | 14.92 | 28.81 |
| 15 | 48.72 | 44 | 50.51 | 52.07 | 15.67 | 29.98 |
| 16 | 50.46 | 46 | 52.73 | 54.09 | 16.43 | 31.14 |

Revision through Rounding: The standard created through regression prediction and included in Table 31 would not likely be widely accepted for use by most apparel companies, for one main reason. The measurements included in the standard are too precise, with values such as 44.17, 27.79, and 50.06. These values would likely be confusing to consumers trying to pick out their size within the standard. Very few people actually measure themselves and know their measurements so precisely.

Thus, the sizing standard created through regression prediction was slightly altered, by rounding the bust, high hip, and hip measurements to the nearest $\frac{1}{4}$ inch and by rounding the upper arm and thigh max measurements to the nearest $\frac{1}{8}$ inch. The final standard is presented in Table 32, showing that the only difference

between the two standards was that the measurements in the final standard were rounded to more “common” measurements.

As mentioned in the methodology, the first approach used to complete the sizing standard was to model the grade rules between sizes (at all of the measurements) according to common grade rules. However, the resulting standard was much too different from the measurements predicted through regression to provide appropriate fit. The first completed standard altered according to grade rules is in Appendix F. Due to the inaccuracy of the measurements in this standard, the standard was instead simply rounded as discussed in the previous paragraph.

Table 32: Final Sizing Standard proposed for Rectangle-shaped women (after rounding)

| Size | Bust | Waist | High Hip | Hip | Upper Arm | Thigh Max |
|------|-------|-------|----------|-------|-----------|-----------|
| 1 | 34.5 | 27.5 | 32.25 | 35.5 | 9.5 | 20.375 |
| 2 | 35.25 | 28.5 | 33.25 | 36.5 | 9.875 | 20.875 |
| 3 | 36.25 | 29.5 | 34.5 | 37.5 | 10.25 | 21.5 |
| 4 | 37 | 30.5 | 35.5 | 38.5 | 10.625 | 22.125 |
| 5 | 38 | 31.5 | 36.75 | 39.5 | 11 | 22.625 |
| 6 | 38.75 | 32.5 | 37.75 | 40.5 | 11.375 | 23.25 |
| 7 | 39.5 | 33.5 | 38.75 | 41.5 | 11.75 | 23.875 |
| 8 | 40.5 | 34.5 | 40 | 42.5 | 12.125 | 24.375 |
| 9 | 41.25 | 35.5 | 41 | 43.5 | 12.5 | 25 |
| 10 | 42.25 | 36.5 | 42.25 | 44.5 | 12.875 | 25.625 |
| 11 | 43 | 37.5 | 43.25 | 45.5 | 13.25 | 26.125 |
| 12 | 44.25 | 38.75 | 44.75 | 46.75 | 13.75 | 26.875 |
| 13 | 45.5 | 40.25 | 46.25 | 48.25 | 14.25 | 27.75 |
| 14 | 47 | 42 | 48.25 | 50 | 14.875 | 28.75 |
| 15 | 48.75 | 44 | 50.5 | 52 | 15.625 | 30 |
| 16 | 50.5 | 46 | 52.75 | 54 | 16.375 | 31.125 |

Analysis of Proposed Rectangle Sizing Standard

Once the Rectangle sizing standard was created, its ability to meet the fit needs of Rectangle-shaped Hispanic women (as well as the total population of Rectangles) was analyzed. This analysis related to the final research question posed in this study which was: *How well does the sizing standard created for the Rectangle-shaped U.S. population of women meet the needs of Hispanic women in the Rectangle shape category?*

Distribution of Rectangle Populations within Proposed Standard

The first step in analyzing the proposed Rectangle sizing standard was to create histograms showing the distribution of the population within the sizes in the standard. Figure 32 shows the distribution of the total population of Rectangle-shaped women within the 16 sizes of the Rectangle sizing standard, according to their waist measurements. The numbers underneath each bar in the histogram represented the upper end of each of the size intervals. The first and last bars (“<27” and “More”) in the histogram indicated the amount of the population not covered by the sizes in the standard because they were either too small or too large to fit into the sizes. The graph in Figure 32 shows that less than 100 people in the total population of Rectangle-shaped women (2901 women total) were not covered by the sizes in the standard. In addition, the distribution of the rest of the population followed a fairly normal curve, with most of the population falling into the middle sizes and less falling into the smaller and larger sizes within the standard.

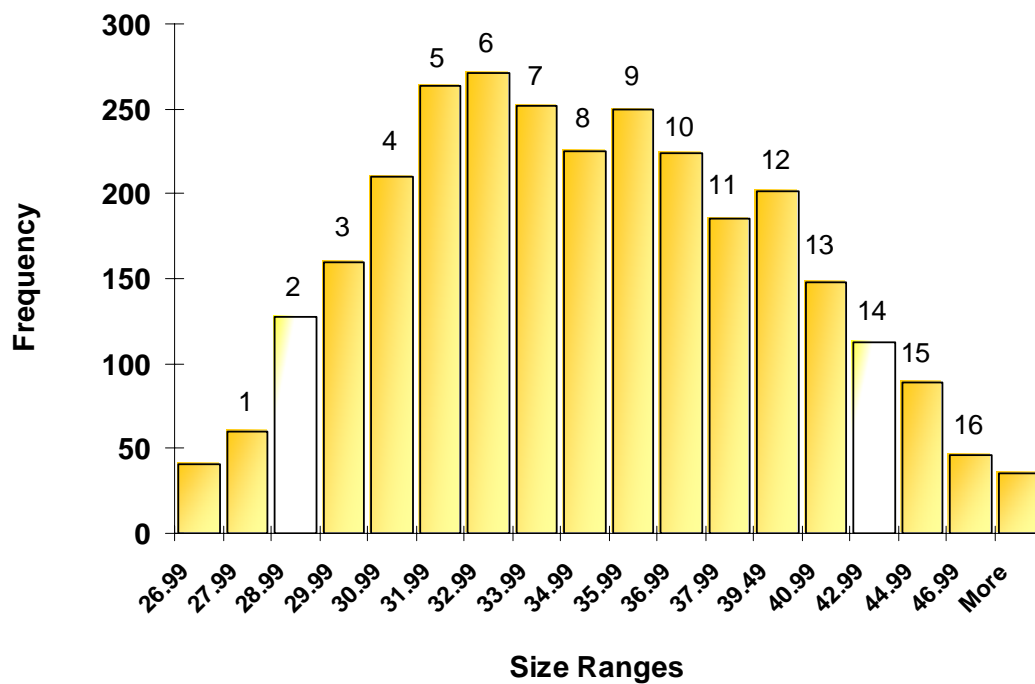


Figure 32: Histogram showing distribution of waist measurements of total population of women in Rectangle sizing standard.

Figure 33 shows the distribution of Rectangle-shaped Hispanic women within the Rectangle sizing standard, according to their waist measurements. This graph shows that less than 10 people out of the entire sample of Rectangle-shaped Hispanics (423 total women) were not covered by the sizing standard. However, unlike the semblance of a normal curve seen for the distribution of the total population, the distribution of the rest of the Hispanic population did not appear to follow a normal curve. Rather than a gradual increase in concentration from the smaller sizes to the middle sizes, and then a gradual decrease in concentration in

the larger sizes, the transition through sizes for the Hispanic population was considerably less smooth. Instead, the Hispanic population was mostly concentrated in the smaller and middle sizes within the standard. In addition, rather than a smooth decline in concentration from the middle to largest sizes, the transition between sizes 12 and 13 seemed to experience a sudden drop – the result was a very small percentage of the population falling into the four largest sizes.

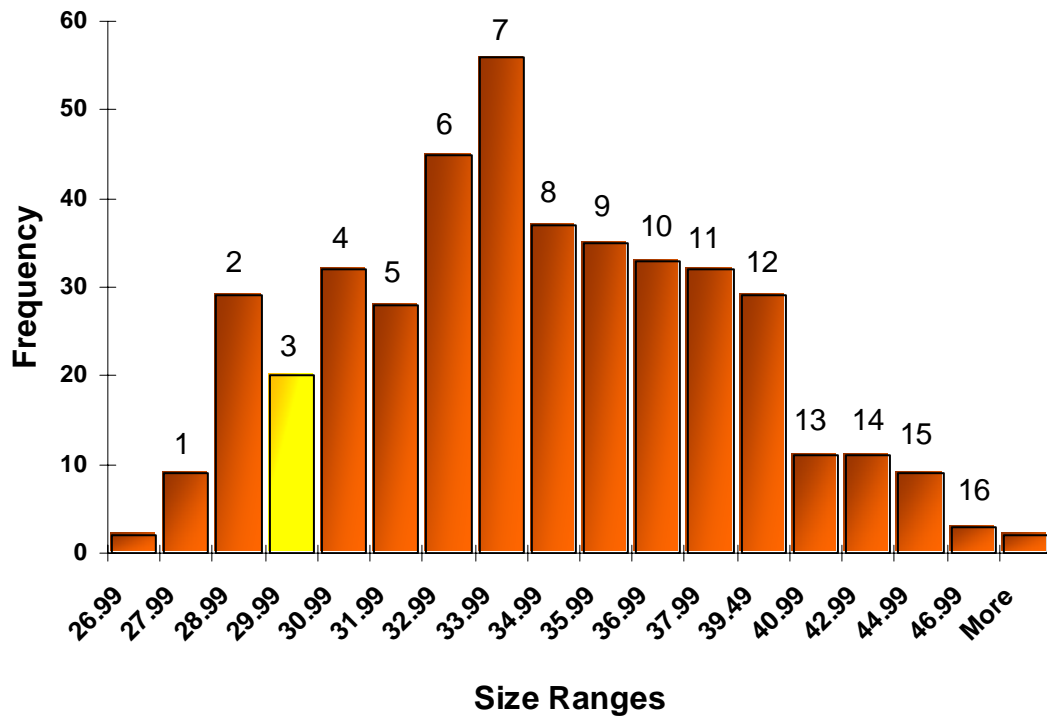


Figure 33: Histogram showing distribution of waist measurements of Hispanic women in Rectangle sizing standard

Proposed Standard & Current ASTM Sizing vs. Overall Rectangle & Hispanic Rectangle Populations

The analysis of the distribution of Rectangle-shaped women within the Rectangle sizing standard gave an indication of how well the population was covered, according to their waist measurements. It did not, however, show how well the standard fit the population in terms of the other measurements included in the standard. To evaluate the distribution of the population at the other body locations, scatterplots showing the relationship between the bust (then high hip, hip, upper arm, and thigh max) measurements and the waist measurements were created. Plotted on these graphs were the total population of Rectangle-shaped women, Hispanic Rectangle-shaped women, the proposed Rectangle sizing standard, and the current ASTM Missy standard (ASTM D 5585). Analysis of these graphs showed not only how close the proposed standard and current standard fit the two populations, but also indicated the concentration or range of sizes needed to accommodate these populations. Presentation of the scatterplots related to the other measurements included in the standard follows.

Bust by Waist: Figure 34 shows the relationship between bust and waist measurements for the total population of Rectangles and Hispanic Rectangles. A comparison of these two groups on the graph shows that Hispanic women were less varied and more concentrated in the smaller size ranges than the total population of women. Hispanic women also had less extreme outliers than the total population of women. Comparison of ASTM D 5585 and the proposed Rectangle standard against these two groups also provided interesting results. The proposed standard

was better at fitting a larger group of people than the current ASTM standard. For instance, the smallest size in the ASTM standard was smaller than any subjects in either of the two groups. Overall, all of the sizes in the ASTM standard were too small, only running through the edge of the populations on the graph. The proposed standard ran through a larger percentage of the population, and fit the larger sized people in the populations better than the ASTM sizing standard (which were almost totally ignored by the current standard).

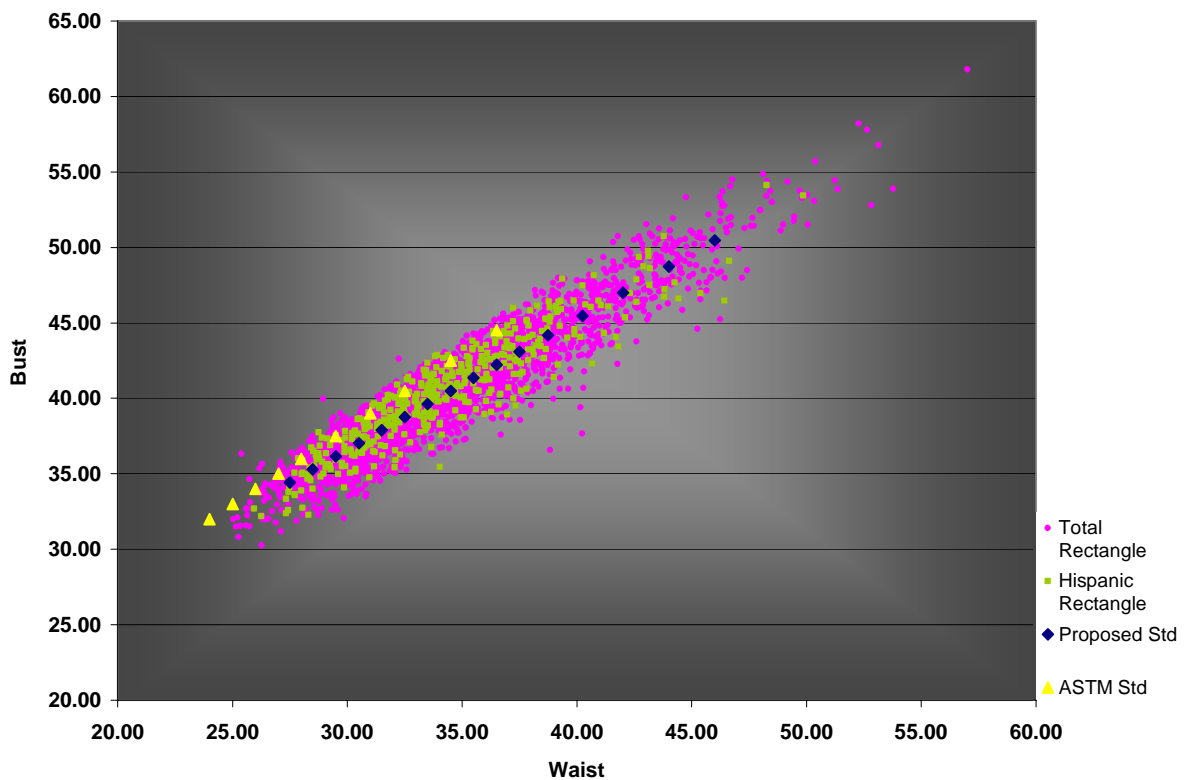


Figure 34: Evaluation of ASTM D 5585 and proposed Rectangle standard against Rectangle populations – Bust by Waist.

High Hip by Waist: Figure 35 shows the relationship between high hip and waist measurements for the total population of Rectangles and Hispanic Rectangles.

Once again, the Hispanic population was much more concentrated (and less varied) in the smaller range of measurements than the total population. The Hispanic population also had less extreme outliers than the total population. In addition, sizes in the ASTM standard were simply too small for the populations, with the first 5 sizes in the standard being outside any of the subjects in either of the two groups. The proposed Rectangle standard performed much better than the current standard, running through the middle of the Rectangle population. The proposed standard also provided sizes to fit larger-sized women who were almost entirely ignored by ASTM D 5585.

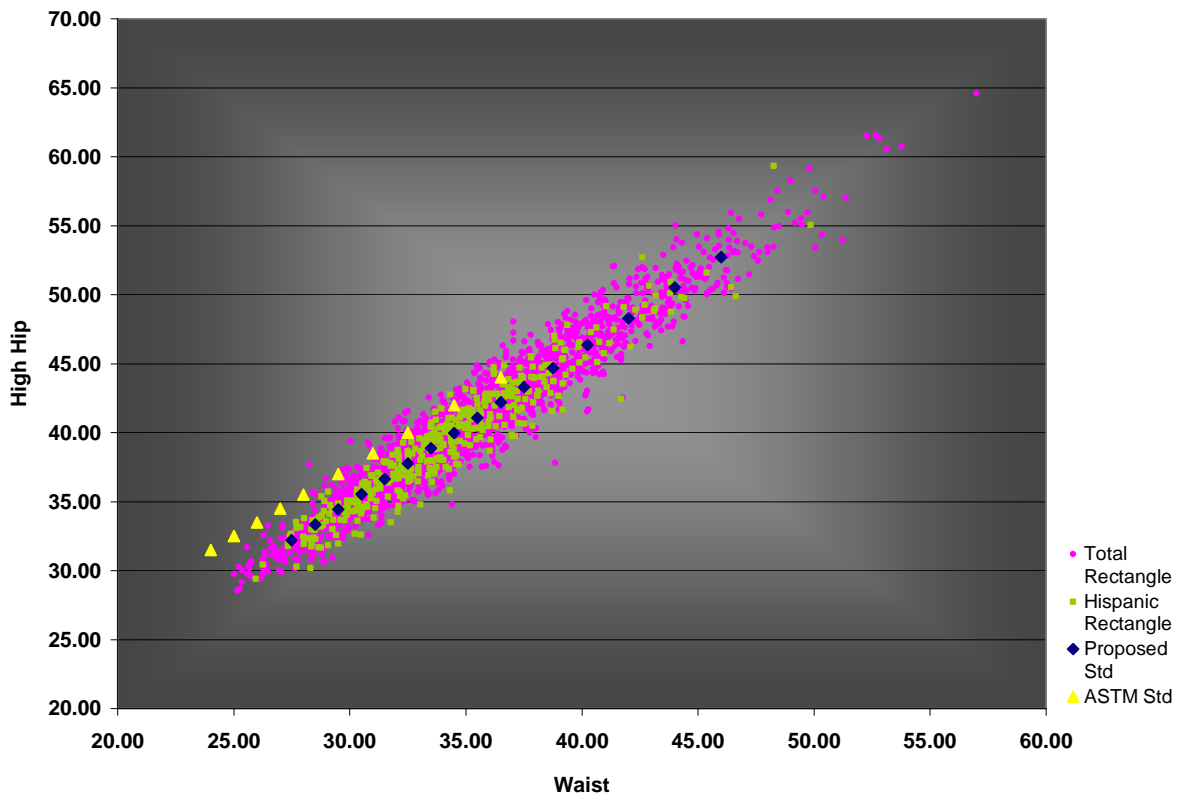


Figure 35: Evaluation of ASTM D 5585 and proposed Rectangle standard against Rectangle populations – High Hip by Waist.

Hip by Waist: Figure 36 illustrates the relationship between the hip measurements and waist measurements of the total population of Rectangle-shaped women and Rectangle-shaped Hispanics. As with the other measurements, the Hispanic population was more concentrated within a smaller range of sizes than the total population of Rectangles. Hispanics were also less affected by extreme outliers than the total population. In addition, ASTM D 5585 did not provide appropriate fit for the two groups, with most of the sizes being too small for the majority of the populations. In fact, the Hispanic population was almost entirely ignored by the current sizing standard. The proposed sizing standard did a much better job of fitting more of the population (especially the Hispanic population) than the ASTM standard. Throughout the size range of the proposed standard, the line appeared to run through the middle of the populations, indicating a good fit for the majority of the population. The only problem apparent with the proposed standard involved the 3 largest sizes in the standard, which were not as close to the larger-sized subjects in the groups as they should be. Poorer prediction of the larger sizes was likely the result of the higher variance in measurements seen in the larger sizes than the smaller sizes – regression was better at predicting the smaller sizes in the standard than the larger sizes.

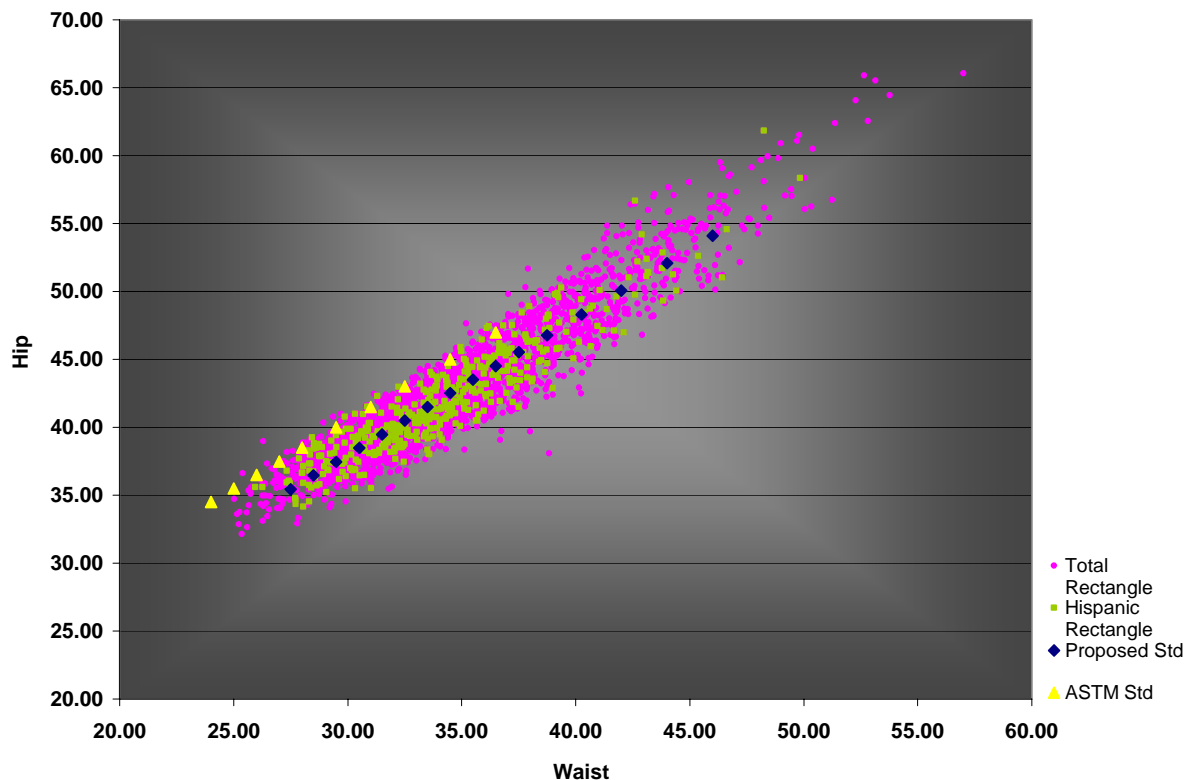


Figure 36: Evaluation of ASTM D 5585 and proposed Rectangle standard against Rectangle populations – Hip by Waist.

Upper Arm by Waist: Figure 37 shows the relationship between upper arm and waist measurements of the total population of Rectangle-shaped women and Hispanic Rectangles. The most obvious point regarding this relationship was that upper arm measurements and waist measurements were not as closely related as the previous measurements studied, with the points on the scatterplot not following as much of a linear trend as the previous measurements. Referring back to Table 28, the R^2 value describing the strength of the relationship between measurements was the lowest for the upper arm vs. waist relationship than for any other measurement.

While the relationship between measurements was not as strong, the comparison of the populations on the scatterplot yielded similar results found in the previous comparisons. Once again, the Hispanic population was more closely concentrated within the smaller range of sizes than the total population of Rectangle-shaped women. The Hispanic population was also less varied than the total population, and less affected by the extreme outliers that were noticed in the total population. In addition, the proposed Rectangle sizing standard was much more effective at fitting a larger portion of the population than ASTM D 5585. The smallest 5 ASTM sizes were beyond any of the subjects in either of the groups. In addition, the incremental change between sizes of the ASTM sizing standard was entirely wrong, not growing in the same direction of change as the populations. However, the sizes in the proposed standard followed the same slope as the populations themselves, growing in the proper direction to accommodate the growth in the populations' measurements. The proposed standard ran through the middle of the Rectangle population, providing much better fit for the population than ASTM D 5585.

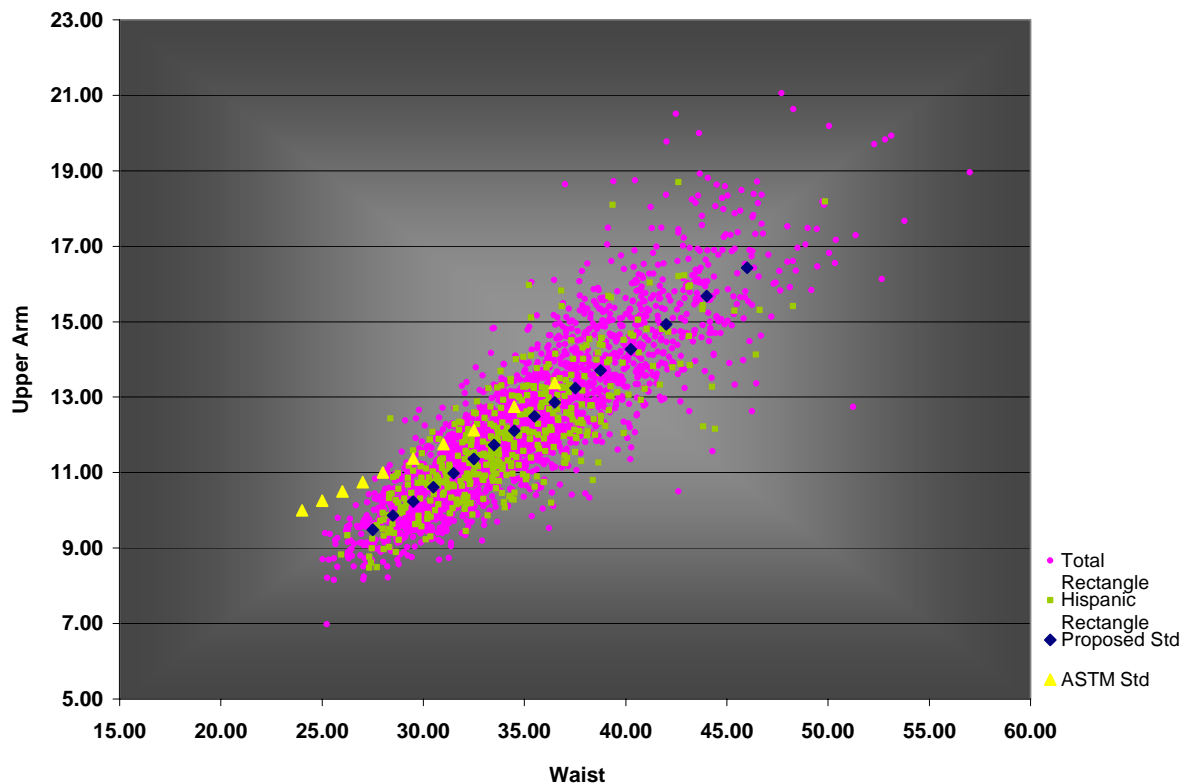


Figure 37: Evaluation of ASTM D 5585 and proposed Rectangle standard against Rectangle populations – Upper Arm by Waist.

Thigh Max by Waist: Figure 38 illustrates the relationship between the thigh max measurements and waist measurements for the total population of Rectangle-shaped women and Hispanic Rectangles. As with the previous measurements discussed, Hispanic women tended to be less varied and more concentrated in a smaller range of sizes than the total population of women. In addition, there were less outliers in the Hispanic population than the total population. When comparing the proposed standard to the ASTM sizing standard, the proposed standard was much better at fitting a larger portion of Rectangle-shaped women than ASTM D 5585. The first two sizes in the ASTM standard were beyond any actual subjects in

the populations, while the rest of the sizes in the standard were located too far near the edge of the scatterplot to fit barely any of the populations. In fact, the Hispanic population was almost entirely ignored by the current sizing standard. The proposed sizing standard was much better at fitting a larger portion of the Hispanic population and the total population. The points representing the sizes of the proposed standard ran through the middle of the two groups, indicating better fit for the majority of the populations. The only problem apparent with the proposed standard involved the larger 3 sizes in the standard, which did not seem to run through the center of the measurements. However, this was due to the wider variation seen in the larger measurements and the resulting difficulty in predicting the larger sizes.

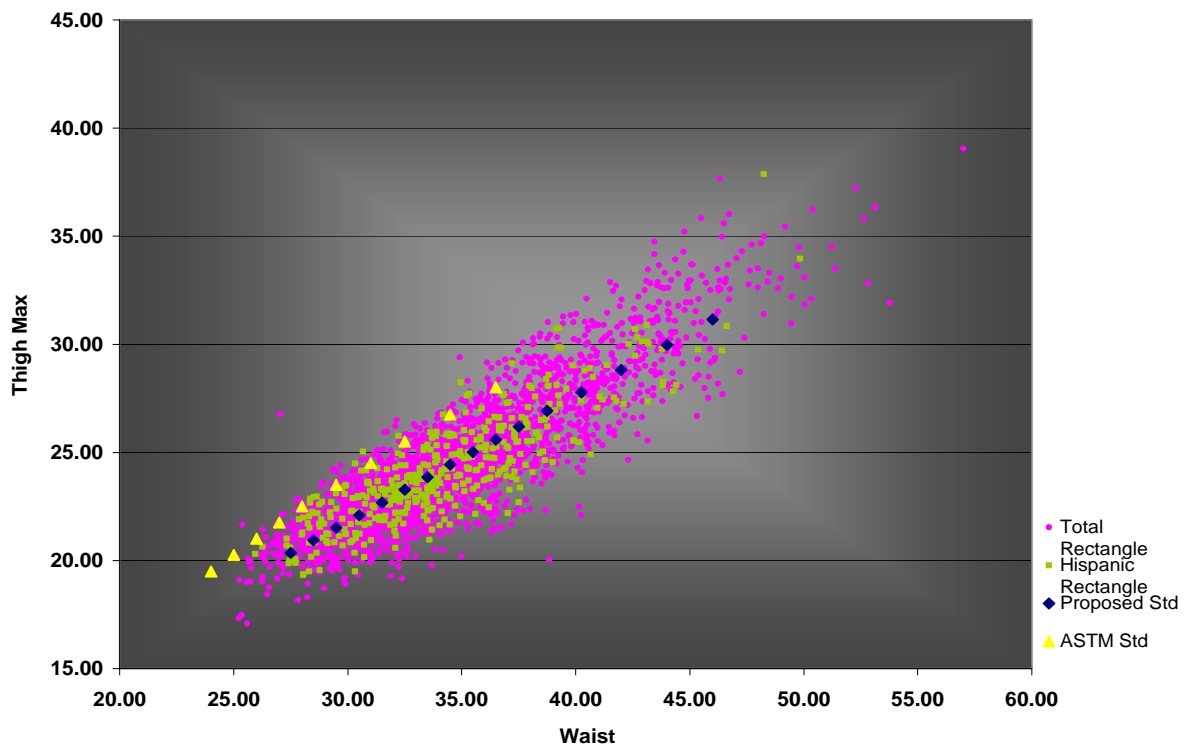


Figure 38: Evaluation of ASTM D 5585 and proposed Rectangle standard against Rectangle populations – Thigh Max by Waist.

Summary of Results

This study involved a series of sequential steps with the ultimate goal of determining if and how a sizing standard specifically for Hispanic women should be created. In the comparison of body shapes across ethnic groups (Hispanic, Black, White, and Other), the Rectangle shape was the most prevalent among all ethnicities. However, the shape occurring second most for Hispanic women was the Inverted Triangle, while the second most prevalent shape for all of the other ethnic groups was the Spoon shape. This was reversed for the shapes in third place, with the Spoon being the third most predominant for Hispanics, and Inverted Triangle being third most predominant for the other groups.

This study also found that the body shapes that characterized the Hispanic population in the SizeUSA sample are not being served by the three ASTM sizing standards currently used by the apparel industry. The Junior and Missy standards both targeted Hourglass shapes throughout the entire range of sizes, while Hispanic women had fewer women in the Hourglass shape category than any other ethnicity. The standard that performed the best at accommodating the body shapes of Hispanic women was the Over 55 family of standards, because some of its substandards actually targeted Rectangle and Spoon shapes. However, when considering the youthfulness of the majority of the Hispanic population, use of the Over 55 standard would not be appropriate. Thus, none of the current ASTM sizing standards fit the body shapes that predominate for Hispanic women.

However, instead of trying to create an entirely new standard solely for Hispanic women, the decision was made to try to develop a new standard targeted for all Rectangle-shaped women (regardless of ethnicity). ASTM sizing standards do not provide satisfactory fit for the body shapes that predominate in *any* of the ethnic groups. Thus, because the most predominant shape for all ethnicities was the Rectangle shape, the focus of this study shifted to the creation of a standard aimed at the Rectangle shape.

Before developing the standard, ANOVA tests showed that ethnicity significantly affected the body measurements found in the Rectangle-shaped population of women at six body locations (bust, waist, hip, high hip, upper arm, and thigh max). These six measurements were selected as a starting point for this study, due to the complexity of creating an actual sizing standard with all of the measurements needed to cover the entire body. Next, Tukey-Kramer HSD tests indicated that ethnic groups had significantly different measurements, and determined how these differences might be defined. Overall, Hispanic women had significantly smaller measurements than Black women at all of the six body locations. In comparisons with the other two ethnic groups, Hispanic women were significantly larger than women in the Other category at bust, hip, and thigh max locations (and had no significant difference at the remaining three locations), while they were significantly smaller than White women high hip and hip locations (and had no significant difference at the other four locations). Even though significant differences were noted at some of the body locations, the comparison of mean

measurements at the six body locations showed that actual differences between Hispanic women and White women especially were very small. Because White women made up over half of all of the Rectangle-shaped women, mean measurements of Hispanic women were very close to measurements of “average” Rectangle-shaped women. Even though there is no such thing as an “average” person, with everyone belonging to some ethnic category, the decision was made to create one sizing standard aimed at the entire population of Rectangle-shaped women. If this one standard could provide better and acceptable fit for Hispanic women (as well as women in the other ethnic groups), it would simplify options available to companies in the apparel industry. One standard for each shape category would certainly be preferred over separate standards for each of the ethnic groups, and for each of the shapes.

The Rectangle sizing standard was then created using the waist as the principal component. Regression equations were used to calculate the remaining five measurements included in the standard. The resulting standard included 16 sizes, covering a range of waist measurements from 27 – 47 inches.

When the proposed Rectangle sizing standard’s effectiveness at meeting the fit needs of the total population of Rectangles and Hispanic Rectangles was analyzed, excellent results were found. At each of the body locations included in the standard, the proposed standard provided better fit for a larger portion of the population than the current Missy sizing standard. The most important result found in the comparison between populations (Hispanic Rectangles vs. total Rectangles)

was that Hispanic women were more concentrated within the smaller size ranges than the total population of Rectangles at every body location included in the standard.

CHAPTER FIVE: DISCUSSION, CONCLUSIONS & FUTURE RESEARCH

Brief Review of Study

The apparel fit problem is a major concern for the apparel industry, with the majority of people dissatisfied with the fit of their apparel. Most people have no idea of their true size, and instead wear a variety of sizes depending on brands or styles. This is primarily due to the lack of standardization of sizing in the industry. ASTM sizing standards have been created to serve as a guide for apparel companies, but most companies' sizing strategies don't resemble these standards, for several reasons. For instance, many companies participate in the practice of vanity sizing, where apparel is sized smaller than actual standards suggest, because companies have found that women will purchase smaller sized clothing for psychological reasons. In addition, current sizing standards are based on anthropometric data from 1939, so even if companies used them, they would not provide satisfactory fit of apparel for the diverse U.S. population of today. For these reasons, apparel fit is a major problem facing the industry.

Due to the scale of this problem, many companies are spending time and energy trying to improve apparel fit for their consumers. In this way, they are hoping to create a competitive advantage and capitalize on it. Creating a competitive advantage is critical in the mature apparel industry.

Another way that companies can create a competitive advantage is to supply products to niche markets, which are narrowly defined target markets. The Hispanic market provides a great opportunity for a niche market, one defined by ethnicity. The Hispanic market is one of great growth in size and purchasing power. Also, certain aspects of the Hispanic market make it unique and especially attractive for niche marketing strategies, such as the youthfulness of the population, its large households, and high geographic concentration in a few areas.

However, many companies are at a loss trying to target this group – most have used a variety of style, design, and marketing or advertising changes. However, companies have been hesitant to use sizing and fit strategies to target Hispanics, most likely due to a lack of understanding about their body shapes and sizes. The reason for the lack of understanding has been the absence of any anthropometric data for this group. The last anthropometric study completed in the U.S. was a biased one from 1939 – the study did not account for the ethnic diversity of the U.S. in 1939, much less 2005. Thus, the apparel industry has simply been ill-equipped to solve the apparel fit problem, especially for (but not limited to) their Hispanic consumers.

However, body scanning has revolutionized the apparel industry, providing the resources needed to complete SizeUSA, the National Sizing Survey. Body scanning allows for the collection of a large number of measurements very quickly, resulting in more accurate and repeatable anthropometric data than hand measuring could ever supply. SizeUSA, completed in 2003, was the first anthropometric sizing

study performed since 1939, and was the first ever representative sizing study completed on the U.S. population. The release of the data in 2004 has given the apparel industry the resources it needs to obtain a better understanding of the shapes and sizes of the current U.S. population. Not only did the national sizing survey obtain anthropometric data, but a variety of demographic and psychographic information was also obtained that allows for the segmentation of the sample into distinct groups for further study.

The purpose of this study was to use SizeUSA data to obtain a better understanding of the body shapes and sizes of Hispanic women in the U.S., and how they compare to women of other ethnicities. The better understanding of body shapes and sizes was used to develop a method to target Hispanic women with a sizing strategy that was more appropriate for this market than what is currently available for use by the apparel industry.

This study was limited by the following factors: First, the Hispanic sample (and the other ethnic groups in the SizeUSA sample) was representative of the Hispanic population in the U.S. only to the extent that SizeUSA was representative. Using a previously validated study, NHANES, SizeUSA organizers obtained a representative sample of the current U.S. population, enabling any analysis of the Hispanic sample to be generalized to the Hispanic population in the U.S. Next, subjects were classified as Hispanic through self-identification. However, SizeUSA questionnaires only distinguished between Mexican-Hispanic and Non-Mexican Hispanic. While large differences can be seen between Hispanics of other cultures

(from Cuba, Puerto Rico, etc.), SizeUSA did not allow for subcultures to be studied, beyond Mexican or Non-Mexican. In addition, the sizing standard created for this study was limited to Rectangle-shaped women (for reasons discussed later). The standard also was limited to six girth measurements. Because length, height, and other girth measurements were not included, it cannot be considered a complete standard. However, it does provide a starting point and a model for the development of a complete standard.

Framing this research were six questions:

1. How do the body shapes of Hispanic women in the U.S. compare to the body shapes of women from other ethnic groups in the U.S.?
2. Do the body shapes of Hispanic women in the U.S. differ significantly based on age, income, or geographic location?
3. How well do apparel sizing standards used by the industry today meet the needs of Hispanic women in the U.S.?
4. How do bust, waist, high hip, hip, upper arm, and thigh max measurements of Hispanic women in the Rectangle shape category compare to Rectangle-shaped women in the White, Black, and Other ethnic categories of SizeUSA?
5. How should a sizing standard for the most predominant shape category in the U.S. population (the Rectangle shape) be created?
6. How well does the sizing standard created for the Rectangle-shaped U.S. population of women meet the needs of Hispanic women in the Rectangle shape category?

Discussion of Results

To answer these questions, several approaches were used. First, FFIT[®] for Apparel software used body scanning input from the SizeUSA subjects to classify each person in the sample as one of nine body shapes: Rectangle, Inverted Triangle, Spoon, Bottom Hourglass, Top Hourglass, Hourglass, Triangle, Diamond, or Oval. The body shapes that predominated in the Hispanic sample of women were compared to the body shapes predominating in the total population and each ethnic group. Results showed that the most predominant shape found in all of the ethnic groups was the Rectangle shape, with close to 50% of each ethnic group belonging to this category.

While this is powerful information, giving apparel companies the ability to satisfy half of the population by focusing on one shape, companies should not simply target this one shape. A focus on only the Rectangle shape would result in the other half of the population being dissatisfied with apparel that doesn't fit their body shapes. Therefore, it was important to understand the second and third most predominant body shapes in the ethnic groups from the SizeUSA sample. While the second most predominant shape for White, Black, and women in the Other category (and as a result also the average population) was the Spoon shape, the second most predominant shape for Hispanic women was Inverted Triangle. This was reversed for the third most predominant shape in each of the ethnicities.

Overall, results showed that 80% of each ethnic group belonged in three shape categories: Rectangle, Spoon, and Inverted Triangle. The order of

predominance of each shape was only different for Hispanic women. This is important information for apparel companies – simply knowing that 80% of a target ethnic group can be covered by targeting three body shapes is huge. However, if targeting Hispanic women, the areas of concentration should be on Rectangle first, then Inverted Triangle, then Spoon. The concentration for other ethnicities would be Rectangle first, Spoon second, and Inverted Triangle third. This was an important difference noted for U.S. Hispanic women.

Also revealed in the analysis of body shapes and sizes was that a greater percentage of Hispanics (48%) than any other ethnicity fell into the Petite height category. Very few (less than 5%) were classified as Tall. The high percentage of Petites in the Hispanic population could help explain the large number of Inverted Triangles found in the Hispanic population. In a previous study completed at NC State's College of Textiles, analysis of body shapes that predominated in different height ranges showed that the Inverted Triangle shape was more predominant in the Petite height category than any other height category. Thus, the high predominance of Petite women and Inverted Triangle shapes in the Hispanic population makes sense, when considered together.

In the comparison between the body shapes that predominated for Hispanic women to the body shapes that are currently being targeted by ASTM Junior, Missy, and Over 55 standards, results were alarming. Junior and Missy standards targeted the Hourglass shape through 100% of the sizes, but a lower percentage of Hispanics were in the Hourglass shape (~5%) than any other ethnic group. The Over 55 family

of standards appeared to be better, targeting Rectangle and Spoon shapes, but the body changes that these standards were created to accommodate (such as increasing waistline, sloping shoulders etc.) do not seem appropriate for the young Hispanic population.

The results showing that Hispanic women's body shapes were not being accommodated by current sizing standards provided the justification needed to create a new sizing standard for this population. However, this was not a problem Hispanic women experienced in isolation. None of the other ethnic groups were being served by current sizing standards, leading researchers to believe that no one is being served – this helps explain the widespread apparel fit problem. The fact that none of the groups' body shapes were being accommodated by current sizing standard lead to an interesting question – Are the body shapes and sizes of Hispanic women different enough from the other ethnicities to warrant an individual sizing system, or should efforts be targeted at creating one standard to improve apparel fit for all ethnic groups?

To help solve this question, several statistical tests were used to determine if measurements (at certain body locations) of different ethnic groups were significantly different. The measurements studied for this research were the girth measurements of bust, waist, high hip, hip, upper arm, and thigh max. These six measurements served as a starting point for better understanding any differences that existed among ethnic groups. When comparing the measurements of the different ethnic groups, only women from the Rectangle shape category were

included. The choice was made to focus on one particular shape category because of inherent differences in measurements that can exist for people of the same size, but different body proportions. Focusing on only the Rectangle-shaped women not only made sense because this was the most predominant shape in all ethnicities, but also because it provided a sense of standardization and allowed for true differences between the measurements of different ethnicities to be ascertained. ANOVA tests showed that ethnicity significantly affected all six measurements.

Tukey tests performed after the ANOVA tests showed which ethnic groups had significant differences at the six body locations. Hispanic women were significantly smaller than Black women at each of the six locations. When comparing Hispanics to women in the Other ethnic category, Hispanic women had significantly larger bust, hip, and thigh max measurements. No significant difference was found at the other three body locations (waist, high hip, and upper arm) between Hispanics and women in the Other category. When comparing Hispanic women to White women, Hispanic women had significantly smaller high hip and hip measurements than White women. No significant difference was found between Hispanic and White women at the other four body locations (bust, waist, upper arm, thigh max).

Due to the large number of White women making up the sample of Rectangle-shaped women, the fact that no significant difference was found between White and Hispanic women at four of the six body locations tested was very important – this meant that Hispanic women's measurements were not very different

from the “average” Rectangle-shaped woman. Even though there is no “average” person, with all women belonging to one ethnic group or another, the fact that Hispanic women’s measurements were so close to the majority of Rectangle-shaped women was very important. In addition, even at the locations where significant differences were noted between Hispanic and White women and Hispanic and Other women, the actual differences were very small, with the largest difference in mean measurements at any location being 1.10 inches. The most significant differences were seen between Hispanic women and Black women, with differences at certain body locations ranging as high as 3 inches. However, Hispanics were not the only ethnic group with significant differences from Black women. Black women were significantly larger than all ethnic groups at each of the six body locations.

Because of the relatively small differences between Hispanic Rectangle-shaped women and the majority of the Rectangle population of women, the decision was made to create a standard for the entire Rectangle-shaped population, rather than an individual standard for Hispanic women. Its effectiveness at meeting the needs of Hispanic Rectangles would then be evaluated.

One might question the need for performing ANOVA tests and Tukey tests if their results were simply overlooked to create one sizing standard for all Rectangle shapes regardless of ethnicity. However, most apparel companies would not prefer to use four different standards to target each of the nine body shapes – if appropriate fit could be accomplished with a Rectangle standard targeted at the whole Rectangle population, it would be much preferred to many different standards.

ANOVA tests and Tukey tests allowed for a better understanding of where significant differences occurred, so if the standard needed to be tweaked, companies would know which measurements should be altered, and in which direction. For instance, companies targeting Hispanics might decrease high hip and hip measurements where they were significantly smaller than the majority of the population. On the other hand, Black women may need to have increases at all the body measurements, because they were significantly larger at each of the six body locations than any other ethnicity.

In developing the Rectangle sizing standard, special care was given to the number of sizes in the standard, as well as the intervals between size ranges. Too many sizes would be cumbersome for apparel companies to implement and result in more skus than would be economically efficient. Too few sizes would either ignore part of the populations or could only be achieved with wide size ranges only appropriate for loosely fitted garments – certainly not tailored products.

To create the standard, regression was used to choose the best predictor measurement of the other five measurements in the standard, with the final choice being the waist measurement as the principal component. The waist measurement was the best predictor of all measurements needed for a sizing standard (even ones not studied for this research) and it was more applicable to both tops and bottoms than a standard based on bust or hips would be. The waist also predicted the critical fit areas of hips, bust, and high hip better than the other choices of bust and hip.

Waist measurements were then plugged into regression equations to predict the bust, hip, high hip, upper arm, and thigh max measurements across all sizes in the proposed standard. The result was 16 sizes spanning a waist range of 27-47 inches, with grades between the smaller sizes being smaller and gradually increasing to larger incremental changes in the larger sizes. This grading (at the waist measurement) was modeled after the Missy sizing standard and current practices used in the apparel industry. The rest of the measurements included in the standard did not display the same type of even grading used to define the waist measurements. After regression was used to predict the measurements, bust, high hip, and hip measurements were rounded to the nearest $\frac{1}{4}$ inch, and upper arm and thigh max measurements were rounded to the nearest $\frac{1}{8}$ inch. Rounding was done so that the measurements in the final standard would be more “common” and practical for consumer use. Thus, the final standard proposed through this study was slightly different from the first standard predicted through regression. However, it is important to note that after rounding, grading between sizes (at most of the body locations) in the proposed standard does not resemble current grading practices used by the apparel industry. While the industry is used to even, consistent grade rules between sizes, analysis of SizeUSA data has shown that this consistency is not appropriate for most women in today’s U.S. population. Uneven grading between sizes provided the most appropriate measurements to fit both Rectangle-shaped Hispanics and the total population of Rectangle-shaped women.

The analysis of the proposed Rectangle sizing standard's effectiveness at meeting the body shapes of Hispanic Rectangle-shaped women showed that the proposed standard was quite successful. To evaluate its effectiveness, scatterplots showing the relationship between the measurements (bust vs. waist, high hip vs. waist, etc.) making up the standard for Hispanic Rectangles and the total population of Rectangles were created. Also plotted on these graphs were the measurements relating to the proposed Rectangle standard and the current ASTM Missy standard (probably the most referenced standard of the current ASTM standards). Analysis of these scatterplots showed how well the current Missy standard and the proposed Rectangle standard accommodated the measurements of the total population of Rectangle-shaped women and more specifically, Hispanic Rectangle-shaped women.

At each of the body locations studied, the Hispanic population of Rectangle-shaped women was shown to be less varied, and more concentrated within the smaller size ranges of the proposed standard than the total population of Rectangles. In addition, while the proposed standard did not ideally meet everyone at every location, the proposed standard performed better (for a larger percentage of the population) than the ASTM standard at every measurement. ASTM standard sizes were simply too small for the majority of the populations. Areas that needed improvement in the proposed standard were the upper arm and thigh max, which were not as strongly predicted by waist measurements as the other measurements in the standard.

Conclusions and Implications

In conclusion, the implications of this study are widespread and beneficial for the apparel industry, especially companies trying to target Hispanic women. For instance, companies targeting Hispanic women should focus on Rectangle, Inverted Triangle, and Spoon body shapes, in this order, which was unique to the Hispanic ethnic group. The Rectangle shape should be the primary focus, with 50% of the population being classified in this shape category. Also, special emphasis should be given to providing garments appropriate for petite women, since about half of Hispanic women in the SizeUSA sample fell into this height category (which was the highest percentage of petites in any ethnicity). For instance, companies could offer pants with shorter inseams, shirts with shorter sleeves, or garments cut in silhouettes most flattering for petites.

In addition, the Rectangle sizing standard created in this study performed much better than the current Missy sizing standard at accommodating the needs of the Rectangle-shaped Hispanic women. However, in order to attain the best fit for Hispanics, companies utilizing the Rectangle standard to try to target the Hispanic market can use the results of the Tukey tests to reduce the high hip and hip measurements in the standard. This would likely improve overall fit for Rectangle-shaped Hispanics, who were significantly smaller in these body locations than the majority of the Rectangle-shaped population.

Furthermore, when using the Rectangle sizing standard, companies targeting Hispanics would be most effective by concentrating on the smaller sizes in the

standard, as the population seemed to be centered around these sizes. The smaller variance seen in the Hispanic population (as opposed to the total population) also indicated that fewer sizes might be needed to satisfy a larger portion of the population.

While improved fit can be achieved for Rectangle-shaped women through the implementation and use of the Rectangle sizing standard proposed in this study, this will not happen without the commitment of apparel companies to change. The uneven grading between sizes at many of the body locations is quite unusual for companies used to consistent, even grade rules. Before computerized pattern making and grading, grading between sizes was performed manually. As a result, the industry often used even grades between sizes (with a possible break and increase in grades in the larger sizes) to facilitate manual grading. However, the type of uneven grading suggested in the Rectangle sizing standard should be easy to use in computer grading, and the benefits of improved fit attained with this standard would surely outweigh the costs.

For true success of the type of sizing standard revision proposed in this study to be realized, apparel companies must also be committed to consumer education. Current sizing strategies used by the industry have left consumers very confused over sizing – most consumers have no idea of their “true” size, much less their measurements. If the Rectangle sizing standard (or any other shape-based sizing standard created in the future) is implemented by the industry, companies must spend time and resources educating consumers about the shapes and sizing

information upon which these standards are based. Without knowledge of the body proportions and measurements that define these shapes, consumers will not know what shape they are, or what size they fall into. Consumers can be best educated through a commitment to better labeling practices and instructions available in retail outlets and on actual garments.

In conclusion, this study gives companies the information needed to target their efforts and maximize their benefits with the smallest number of sizes possible. This not only will help companies improve customer satisfaction with the fit of apparel but also maximize efficiency and profits.

Future Research

This study has highlighted many areas of future research. For instance, specific revisions of the upper arm and thigh max measurements in the Rectangle sizing standard could improve the overall effectiveness of the standard. These two measurements were not as strongly predicted by the waist measurement as the other measurements in the standard. Future research should investigate either better predictor measurements for these locations, or revisions to the proposed standard that might improve overall fit. Further changes of the standard would be to add length and height measurements, to accommodate Petite and Tall women, as well as add additional girth measurements to develop a complete standard.

The successful performance of the Rectangle sizing standard (not only for Hispanics, but for the total population of Rectangles as well) suggests that shape-

based sizing standard modifications could improve the fit of apparel. Thus, future work could be done to create sizing standards for the other shape categories, such as Inverted Triangle and Spoon. This would give apparel companies a “bank” of standards to work with and choose from, allowing them to select the appropriate standards to fit the body shapes of their target populations.

In addition to the development of sizing standards, the actual use of the standards in the creation of garments should be analyzed. For instance, the Rectangle sizing standard created as part of this study could be used to create garments for Rectangle-shaped women. The fit of the actual garments on Hispanic women would give an indication of the effectiveness of the standard at improving apparel fit for this market, especially if garments made with current standards were also tested on Hispanic women for comparison’s sake.

The significant differences noted for Black women throughout all of the tests performed in this study indicate that future study of this market would be very useful for companies interested in targeting this group. Similar methodology used in this study could be applied to analysis of this market (as well as any other target market) to determine the best way to satisfy the apparel fit needs of varying groups of people. In sum, endless possibilities abound for future research using the methodology created in this study.

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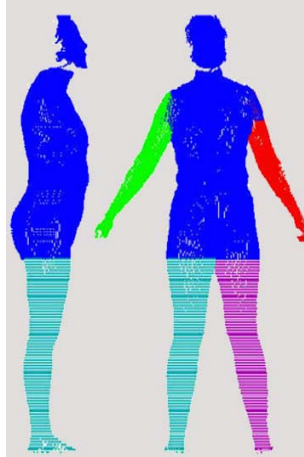
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Appendices

Appendix A: FFIT[®] for Apparel Body Shape Classifications

Rectangle: Little to no waist definition; balanced under arm and hips



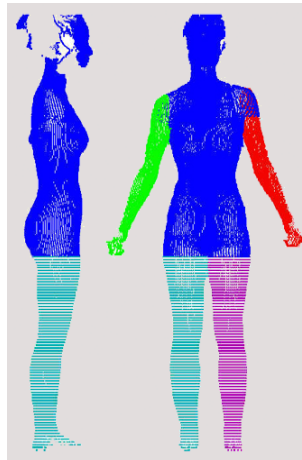
Spoon: Bust is small in proportion to waist; waist is well-defined; hips are large in proportion to waist



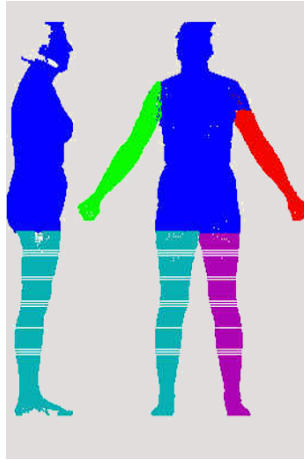
Inverted Triangle: Upper body is larger than lower body



Hourglass: Bust and hips are balanced; waist is well-defined



Top Hourglass: Bust is larger than hips; waist is well-defined



Bottom Hourglass: Hips are larger than bust; waist is well-defined



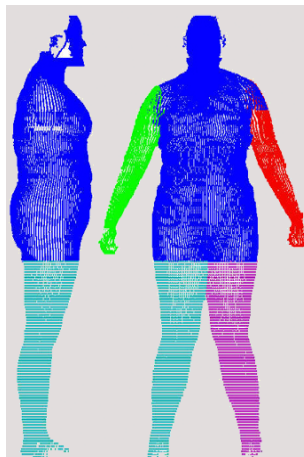
Triangle: Lower body is larger than upper body



Diamond: Full figure with waistline dominating shape of high full stomach



Oval: Full figure with curved midsection



Source: (Simmons, 2002)

Appendix B: SizeUSA Questionnaire

US National Sizing Survey

Please answer **all** the following questions. This data will be matched with the body scan data. This information will not be connected to any other information including your name, address, phone or e-mail address.

Please fill circles completely like this: ● Not like this: ◐ ◑

1. What is your **age** in years?

- ☐ 18-25 ☐ 26-35 ☐ 36-45
☐ 46-55 ☐ 56-65 ☐ 66+

2. What is your **gender**?

- ☐ Male
☐ Female

3. What is your **primary ethnic group**?

- ☐ Non-Hispanic White ☐ Non-Mexican Hispanic ☐ Asian
☐ Non-Hispanic Black ☐ Mexican Hispanic ☐ Other

4. What is your 5-digit zip code?
income

__▼ __▼ __▼ __▼ __▼

- - - - -

☐ ☐ ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐

5. What is your **annual household**

in US dollars?

- ☐ Under \$25,000
☐ \$25,000 - \$49,999
☐ \$50,000 - \$74,999
☐ \$75,000 - \$99,999
☐ \$100,000 or more

6. What is your **current marital** status?

- ☐ Married ☐ Single ☐ Widowed
☐ Single, living with partner
☐ Divorced or separated

7. For my **age and body structure**, I am probably ...

- ☐ Quite a bit overweight ☐ A little overweight

◀ About the right weight ▶ Underweight

8. Which of the following sentences describes your **lifestyle** best?

- ☐ I live a very active, physical lifestyle ☐ I'm about as active as most other people
 ◀ I'm a little less active than other people ▶ I'm much less active than other people

9. What is the **last grade of school** you have completed?

- ☐ Less than high school ☐ High school graduate
 ◀ Some college or tech school ▶ College graduate ▲ Post-graduate

10. Which of the following best describes your **current employment status**?

- Professional or managerial ? Service or sales related
 Military Office/clerical Student Homemaker
☐ Craftsman/laborer/farm ● Not currently employed for pay ✕ Retired

11. Considering all the types of clothing you wear, which of the following words best describe the size you usually wear? **Select all that apply.**

Women

Men

- ☐ Petite ☐ Small (0-6) ☐ Small ☐ Medium
 ▼ Missy ◀ Medium (8-10) ◀ Large ▶ X-Large
 ▲ Women's ▶ Large (12-16) ▲ XXL or XXXLarge ▼ Big/Tall
 ▲ Tall ▼ Extra large (18+)

12. Please mark all of the following **brands or stores** in which you have purchased **clothing for yourself** in the past **12 months**.

- ☐ Department Stores (Belk, Dillard's, Macy's, etc.) ✕ JCPenney
☐ Specialty Stores (GAP, Old Navy, Eddie Bauer, etc.) ✕ Kmart
 ◀ Warehouse Clubs (SAM's, BJ's, Costco, etc.) Kohl's
 ▶ Factory or Company Outlet Stores ? Sears
 ▲ Sport Specialty Stores (Sports Authority, Foot Locker, etc.) Target
 ▼ Off Price Stores (TJ Maxx, Marshall's, Ross, etc.) Wal-Mart
 ◀ Mail Order Catalog, TV, or Internet ✕ Liz Claiborne

13. Mark below **all the types of clothing** you usually wear at least once a week when in season.

- | | | |
|------------------------------|---------------|-----------------------------------|
| ✓ Knit outerwear t-shirts | 🚲 Sweatshirts | ① Knit polo shirts or golf shirts |
| 🧶 Sweaters or vests | ♥ Jeans | ✈ Woven sport shirts or blouses |
| □ Dresses or skirts | 👔 Neckties | ✂ Suits, Sport coats, or blazers |
| ✦ Casual pants or slacks | ? Dress shirt | ● Sheer hosiery or pantyhose |
| 🧥 Outerwear jackets or coats | | 👟 Athletic or crew type socks |
| 👟 Running shoes or sneakers | | 👢 Work shoes or boots |

By submitting this questionnaire I give my permission for Textile/Clothing Technology Corporation, [TC]², to use this survey and my anonymous measurement data in sizing research and to provide manufacturers and retailers with aggregate, generic size information to improve garment fit, and to improve the design of size-related consumer products.

- ☒ I **accept** this agreement
 ☐ I **decline** this agreement

Thank you for your answers. Please give this form to the attendant who will record your height and weight.

[illegible]

Appendix C: SizeUSA Demographics – Females and Males

| Scan Location | Subjects Scanned | Scan Location | Subjects Scanned |
|-----------------------|------------------|--------------------------|------------------|
| 13% 1. Cary, NC | 1338 | 7% 7. Los Angeles, CA | 685 |
| 11% 2. Columbia, MO | 1105 | 4% 8. San Francisco, CA | 396 |
| 17% 3. Dallas, TX | 1750 | 5% 9. Portland, OR | 499 |
| 1% 4. Miami, FL | 99 | 6% 10. Lawrence, MA | 557 |
| 4% 5. New York, NY | 447 | 1% 11. Winston-Salem, NC | 132 |
| 7% 6. Chattanooga, TN | 667 | 10% 12. Buford, GA | 1002 |
| | | 13% 13. Glendale, CA | 1324 |
| | | Total: | 10,001 |

Ethnicity:

| | |
|-----|--------------------|
| 51% | Non-Hispanic White |
| 18% | Non-Hispanic Black |
| 8% | Hispanic |
| 8% | Other |

Age:

| | |
|-----|-------|
| 25% | 18-25 |
| 22% | 26-35 |
| 22% | 36-45 |
| 18% | 46-55 |
| 9% | 56-65 |
| 4% | 66+ |

Income:

| | |
|-----|---------------------|
| 36% | Under \$25,000 |
| 26% | \$25,000 - \$49,999 |
| 16% | \$50,000 – \$74,999 |
| 9% | \$75,000 - \$99,999 |
| 9% | \$100,000 or more |

Lifestyle:

| | |
|-----|---------------------------|
| 29% | Very Active |
| 47% | About as active as others |
| 19% | A little less active |
| 5% | Much less active |

Marital Status:

| | |
|-----|-----------------------------|
| 42% | Married |
| 37% | Single |
| 2% | Widowed |
| 6% | Single, living with partner |
| 8% | Divorced or separated |

Educational Level:

| | |
|-----|----------------------------------|
| 6% | Less than high school |
| 24% | High school graduate |
| 31% | Some college or technical school |
| 27% | College graduate |
| 12% | Post-graduate |

Weight Perception

| | |
|-----|------------------------|
| 17% | Quite a bit overweight |
| 35% | A little overweight |
| 43% | About the right weight |
| 5% | Underweight |

Current Employment:

| | | | |
|-----|--------------------------|-----|--------------------------------|
| 29% | Professional/managerial | 19% | Student |
| 11% | Office/Clerical | 1% | Military |
| 8% | Craftsman/laborer/farm | 9% | Homemaker |
| 17% | Service or sales related | 8% | Not currently employed for pay |
| 6% | Retired | | |

Clothing Sizes –Women:

| | | |
|-----|--------|-------------|
| 25% | Petite | Small (0-6) |
|-----|--------|-------------|

Clothing Sizes - Men:

| | | | |
|----|-------|-----|-----------------|
| 5% | Small | 11% | XXL – or larger |
|----|-------|-----|-----------------|

| | | | |
|-------------|-------------------|-----------------|-------------|
| 21% Missy | Medium (8-10) | 30% Medium | 4% Big/Tall |
| 23% Women's | Large (12-16) | 38% Large | |
| 8% Tall | Extra Large (18+) | 27% Extra Large | |

Stores:

| | | |
|-----------------------|--------------|----------------------------|
| 61% Department Stores | 47% JCPenney | 22% Sport Specialty Stores |
| 49% Specialty Stores | 19% Kmart | 39% Off Price Stores |
| 17% Warehouse Clubs | 18% Kohl's | 21% Mail Order Catalogs |
| 31% Factory Outlets | 21% Sears | 33% Wal-Mart |
| 10% Liz Claiborne | 35% Target | |

Clothing Types:

| | |
|---------------------------------|------------------------------------|
| 54% Knit outerwear t-shirts | 27% Dress Shirts |
| 48% Sweaters or vests | 27% Knit Polo shirts |
| 67% Dresses or skirts (females) | 26% Woven sports shirts or blouses |
| 73% Casual pants or slacks | 25% Suits, sport coats, blazers |
| 56% Outerwear jackets or coats | 26% Sheer Hosiery |
| 71% Running shoes or sneakers | 53% Athletic socks |
| 45% Sweatshirts | 31% Work Shoes |
| 79% Jeans | 25% Neckties (males) |

Source: ([TC]², 2004b)

Appendix D: Definition of Measurements taken in SizeUSA

| | |
|------------------|---|
| Bust | Measure the bust circumference horizontally around the body under the arms, across the nipples, and parallel to the floor. |
| Waist | Circumference measured around the body at the waist level following the pant waist. |
| High Hip | Measure the high hip circumference of the body at high-hip level, approximately 3 inches below the waist level and parallel to the floor. |
| Hip | Maximum circumference of the body measured between the waist and crotch, parallel to the floor. |
| Upper Arm | Measure the maximum arm circumference between the shoulder point and the elbow. |
| Thigh Max | Measure the circumference of the upper leg 1 inch below the crotch. |

Source: ([TC]², 2004b)

Appendix E: ASTM D 5585 (Missy Standard): Selected Measurements

| Size | Bust | Waist | High Hip | Hip | Upper Arm | Thigh Max |
|------|------|-------|----------|------|-----------|-----------|
| 2 | 32 | 24 | 31.5 | 34.5 | 10 | 19.5 |
| 4 | 33 | 25 | 32.5 | 35.5 | 10.25 | 20.25 |
| 6 | 34 | 26 | 33.5 | 36.5 | 10.5 | 21 |
| 8 | 35 | 27 | 34.5 | 37.5 | 10.75 | 21.75 |
| 10 | 36 | 28 | 35.5 | 38.5 | 11 | 22.5 |
| 12 | 37.5 | 29.5 | 37 | 40 | 11.375 | 23.5 |
| 14 | 39 | 31 | 38.5 | 41.5 | 11.75 | 24.5 |
| 16 | 40.5 | 32.5 | 40 | 43 | 12.125 | 25.5 |
| 18 | 42.5 | 34.5 | 42 | 45 | 12.75 | 26.75 |
| 20 | 44.5 | 36.5 | 44 | 47 | 13.375 | 28 |

Source: (ASTM, 1995a)

Appendix F: Original standard completed according to common grade rules

| Size | Bust | Waist | High Hip | Hip | Upper Arm | Thigh Max |
|------|-------|-------|----------|-------|-----------|-----------|
| 1 | 34.5 | 27.5 | 32 | 35.5 | 9.5 | 20.5 |
| 2 | 35.5 | 28.5 | 33 | 36.5 | 9.875 | 21 |
| 3 | 36.5 | 29.5 | 34 | 37.5 | 10.25 | 21.5 |
| 4 | 37.5 | 30.5 | 35 | 38.5 | 10.625 | 22 |
| 5 | 38.5 | 31.5 | 36 | 39.5 | 11 | 22.5 |
| 6 | 39.5 | 32.5 | 38 | 40.5 | 11.375 | 23.125 |
| 7 | 40.5 | 33.5 | 38 | 41.5 | 11.75 | 23.75 |
| 8 | 41.5 | 34.5 | 39 | 42.5 | 12.125 | 24.375 |
| 9 | 42.5 | 35.5 | 40 | 43.5 | 12.5 | 25 |
| 10 | 43.5 | 36.5 | 41 | 44.5 | 12.875 | 25.625 |
| 11 | 44.5 | 37.5 | 42 | 45.5 | 13.25 | 26.25 |
| 12 | 45.75 | 38.75 | 43.25 | 46.75 | 13.75 | 27 |
| 13 | 47.25 | 40.25 | 44.75 | 48.25 | 14.25 | 27.75 |
| 14 | 49 | 42 | 46.5 | 50 | 15 | 28.75 |
| 15 | 51 | 44 | 48.5 | 52 | 15.75 | 30 |
| 16 | 53 | 46 | 50.5 | 54 | 16.5 | 31.25 |