

ABSTRACT

ROSS, TAIHESIA ALTOVISE. Sizing and Fit of Men's Underwear. (Under the direction of Pamela Banks-Lee)

The purpose of the research was to determine if ASTM Standards used for producing men's underwear satisfy the measurements of males in the U.S. Additionally, this research determined whether or not males in the U.S. are satisfied with the fit of underwear made available to them. The results provided insight into a relatively untapped area of research, men's apparel sizing and men's fit satisfaction. This study employed the use of two data sources: the Size USA National Study and an administered online Men's Fit Survey. A considerable amount of the data was statistically analyzed using SAS and JMP statistics programs.

The research aimed to substantiate findings cited in the literature regarding inadequate size standards and consumer's dissatisfaction with the fit of ready to wear clothing produced from these standards. This study further evaluated the effect of ethnic group and age group on a subject's ability to meet ASTM Standards. "Proposed" classifications were recommended in an effort to enable a larger percentage of U.S. males to meet size designations (small to 2x-large). In addition, the responses from the Men's Fit Survey were used to assess fit satisfaction of underwear in key locations.

This study found that at a 95% confidence level, ethnicity and age of male subjects are significant factors that influence measurements used to produce underwear. In comparing the body measurements of 3,691 male, Size USA

subjects to ASTM Standards, results showed that only 3% met size specifications for underpants and 1% met size specifications for undershirts. Using the “Proposed” classifications 75% would meet specifications for underpants and 81% would meet specifications for undershirts. In addition, this study found that of the 205 respondents that were surveyed, at least 70% were dissatisfied with the fit of their underpants while 59% were dissatisfied with the fit of undershirts.

Sizing and Fit of Men's Underwear

by

Taihesia Altovise Ross

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DEDICATION

To God my Father, Jesus Christ my brother, and the blessed Holy Spirit my guide. Much Luv-Always!

To Bernadette Cummings and Robert Ross, how blessed I am to have you both as my parents!

BIOGRAPHY

Taihesia Altovise Ross was born on August 19, 1981 in Newark, New Jersey to Robert Ross and Bernadette Cummings. Both of her parents were born and raised in Guyana, South America. Taihesia lived in Orange, New Jersey until age 7 and then moved to Newark, Delaware and graduated from Christiana High School in June, 1999.

Taihesia graduated Magna Cum Laude with a Bachelor of Science Degree in Textile and Apparel Management in May 2003. Taihesia began in the Master of Science program in August 2003, pursuing her degree in Textile and Apparel Technology/Management with a minor in Statistics.

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Mom, my sweetheart; your stern and unchanging love will always be my joy. Thank you for all the sacrifices, which you didn't have to make, but made in order to give your children the best. I pray that one day I will be able to give you even half of what you've given to me. Daddy, I love you. I thank you for not only opening windows and doors of opportunity but also supporting me while I go through them. I am blessed to call you daddy. To Michael and Janice, thank you for being the best big brother and big sister a little sister could ever have; your encouragement kept me headed towards my future. Thanks to all my nephews: Kwann, Michael Jr., Adrian, Jyaire, Dominic, Kiimare, Kierre, JaiKai, and Ahmad and my niece Aerionna for keeping a smile on my face even though you all were hundreds of miles away. Last but not least, a special thanks to Ferguson James III (aka Gus), who was an awesome blessing in my life [4/2003-4/2005].

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The will of God is never exactly what you expect it to be. It may seem to be much worse, but in the end it's going to be a lot better and a lot bigger.
-Elisabeth Elliot

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1. INTRODUCTION

1.1 Introduction

The US population continues to grow not only larger and taller, but also more ethnically and culturally diverse. As a result, the apparel industry faces the overwhelming task of responding to these changes by providing satisfactory fitted clothing to consumers. In an age where focus is on customer satisfaction, dissatisfaction with fit of apparel is a serious problem. These problems have proven to be both costly and frustrating to apparel manufacturers as they often result in returned merchandise and lost sales. The higher costs incurred by retailers are then passed on to consumers. In addition to markups, consumers experience the cost and frustration of fit dissatisfaction resulting in brand dissatisfaction and time wasted in the fitting room. (DesMarteau, 2000)

A Kurt Salmon Associates-KSA (1999) study indicated that 50 percent of women and 62 percent of men could not find a good fit in apparel (DesMarteau, 2000). An additional KSA survey conducted in 2003 found that 60 percent of consumers overall had difficulty finding clothes that fit well (Campbell, 2004). This increasing phenomenon has led to greater exploration into the discrepancies with current sizing standards used by the apparel industry.

Men's clothing was first mass produce, ready-to-wear garments, starting in the early 1800's (Ahren's, 2000). This industry was established long before the women's apparel industry began. U.S. size systems are generally based on data obtained in the late 1940's, however, since that time; the focus on sizing has been

mainly associated with women (Ashdown, 1991). Although men's size standards, which are based, on actual body measurements have proven to be more accurate than those set for women, dissatisfaction of fit in men's clothing is still an issue. The changing build of the average male body lends cause for more research efforts focused on sizing and fit satisfaction of men's apparel (Tamburrino, Apr, 1992 & Cardyn, 2003).

Several approaches have been attempted by those associated with the apparel industry to address the problems of size inadequacies and fit dissatisfaction. Initiatives by some manufacturers have focused on creating a better profile of their target market. These profiles were established by determining the physical characteristics of customers, in an effort to provide satisfactory fit (Cardyn, 2003 & LaBat & Delong, 1987). Also new anthropometric studies have been done through the use of body scanning technologies (Hill, 2003; Cardyn, 2003 & Ahrens, 2000). These have been established as the groundwork for the development of new sizing standards for the US population and abroad.

The premise of this research is that fit satisfaction of men's underwear is dependent on providing appropriate and updated measurement standards for the changing body proportions of the male population. Although studies specifically addressing the fit satisfaction of men's underwear are not prevalent in the literature, a variety of studies related to sizing and fit satisfaction are available for use in this research.

1.2 Objectives of the Study

This study focuses on understanding the male consumer's satisfaction/dissatisfaction with the fit of men's underwear. The study employs the use of key measurements from the Size USA National Study. Measurements of importance are those used in producing sizes for men's underwear (underpants and undershirts). Key components of this research involve relating the Size USA National Study's body measurements, ASTM sizing standards, and consumer satisfaction/dissatisfaction with men's underwear. The research is designed to accomplish the following:

- 1)** To determine the difference, if any, in body measurements of males in the U.S. based on age and ethnicity.
- 2)** To determine if body measurements of males in the U.S are satisfied by the ASTM Sizing Standards.
- 3)** To create "Proposed" size classifications by altering the ASTM Sizing Standard to provide a more satisfactory fit to male consumers.
- 4)** To determine if males in the US are satisfied with the fit of their undergarments.

II. REVIEW OF LITERATURE

The issues that will be discussed in this chapter are directed at providing a greater understanding in the areas of sizing and fit satisfaction. Included in the beginning of this section is the definition of terms, which provides useful explanations needed throughout this study. The pertinent subjects that will be included in the rest of this section are a background in the development of sizing standards and why these standards have become inadequate, the relationship between sizing and patterning, the difficulties faced in determining satisfactory fit, and how satisfactory fit relates to the men's underwear industry.

2.1 Definition of Terms

The definition of terms are cited from ASTM D 5219-02, Standard Terminology Relating to Body Dimensions for Apparel Sizing and ASTM D 6240-98, Standard Tables of Body Measurements for Men Sizes Thirty-Four to Sixty (34-60) Regular, otherwise it is noted.

- 1) **Across shoulder**, n-the horizontal distance across the back from the top of one shoulder joint to the top of the other shoulder joint, taken with arms down. (See Figure 1.5)
- 2) **Anthropometric measurement**, the dimensions of various segments of the body. (Ranieri, 1985)
- 3) **Armscye**, n-the opening in a garment for the attachment of a fitted sleeve. This is a tailor's term for armhole.

- 4) **Armscye girth**, n- the circumference taken from the shoulder joint through the front break-point, the armpit, the back break-point and the starting point, taken with the arms down. (See Figure 1.3)
- 5) **Body dimension**, n – a body measurement that can be used to build a sizing system or to select an appropriately sized garment.
- 6) **Body measurements**, n- a standardized distance between two specific points on the human anatomy. The measurements are generally based on standardized values from statistical studies of large populations.
- 7) **Body weight**, n- the weight as measured on a calibrated scale taken with the subject in undergarments.
- 8) **Chest/bust girth**, n- the horizontal circumference around the body, taken under the arms and across the fullest part of the chest/bust apex including the lower portion of the shoulder blades. (See Figure 1.4)
- 9) **Crotch**, n- the body area adjacent to the vertex of the included angle between the legs. (See Figure 1.1)
- 10) **Crotch length (total)**, n- the distance from the waist level at the center front, through the crotch and to the waist level at the center back, avoiding constriction at the crotch. (Figure 1.8)
- 11) **Height**, n- the vertical distance from the crown of the head to the floor, taken with subject standing without shoes (See Figure 1.7)
- 12) **Hip**, n- the laterally projecting region formed by the lateral parts of the pelvis and the upper part of the femur together with the flesh covering them, (See Figure 1.1)

- 13) **Hip girth**, n- the maximum horizontal circumference around the body at hip height. (See Figure 1.3)
- 14) **Hip height**, n- the vertical distance from the hip girth level to the floor along the side of the body, taken with subject standing without shoes. (See Figure 1.6)
- 15) **Neck base girth**, n- the circumference of the neck, taken over the cervicale at the back and the top of the collarbone at the front. (See Figure 1.3)
- 16) **Shoulder joint**, n- the juncture of the collarbone and the shoulder blade.
 - a) The outer end of the collarbone or clavicle pivots against the acromion which in turn pivots against the humerus or upper arm bone in the arm. These bones form the shoulder girdle. (See Figure 1.2)
- 17) **Sizing system**, n- a method of designating garment sizes.
- 18) **Shoulder girth**, n- the horizontal circumference around the shoulders, taken at the front break-point level with the arms down. (See Figure 1.3)
- 19) **Thigh girth**, n- the maximum horizontal circumference of the upper leg, taken close to the crotch. (See Figure 1.3)
- 20) **Waist**, n- the part of the body at the location between the lowest rib and hip identified by bending the body to the side. (See Figure 1.1)
- 21) **Waist girth**, n- the minimum horizontal circumference around the body at waist height. (See Figure 1.3)
- 22) **Waist height**, n- the distance from the waist level to the hip girth level along the side of the body (contour) then vertically to the floor, taken with subject standing and without shoes. (See Figure 1.7)

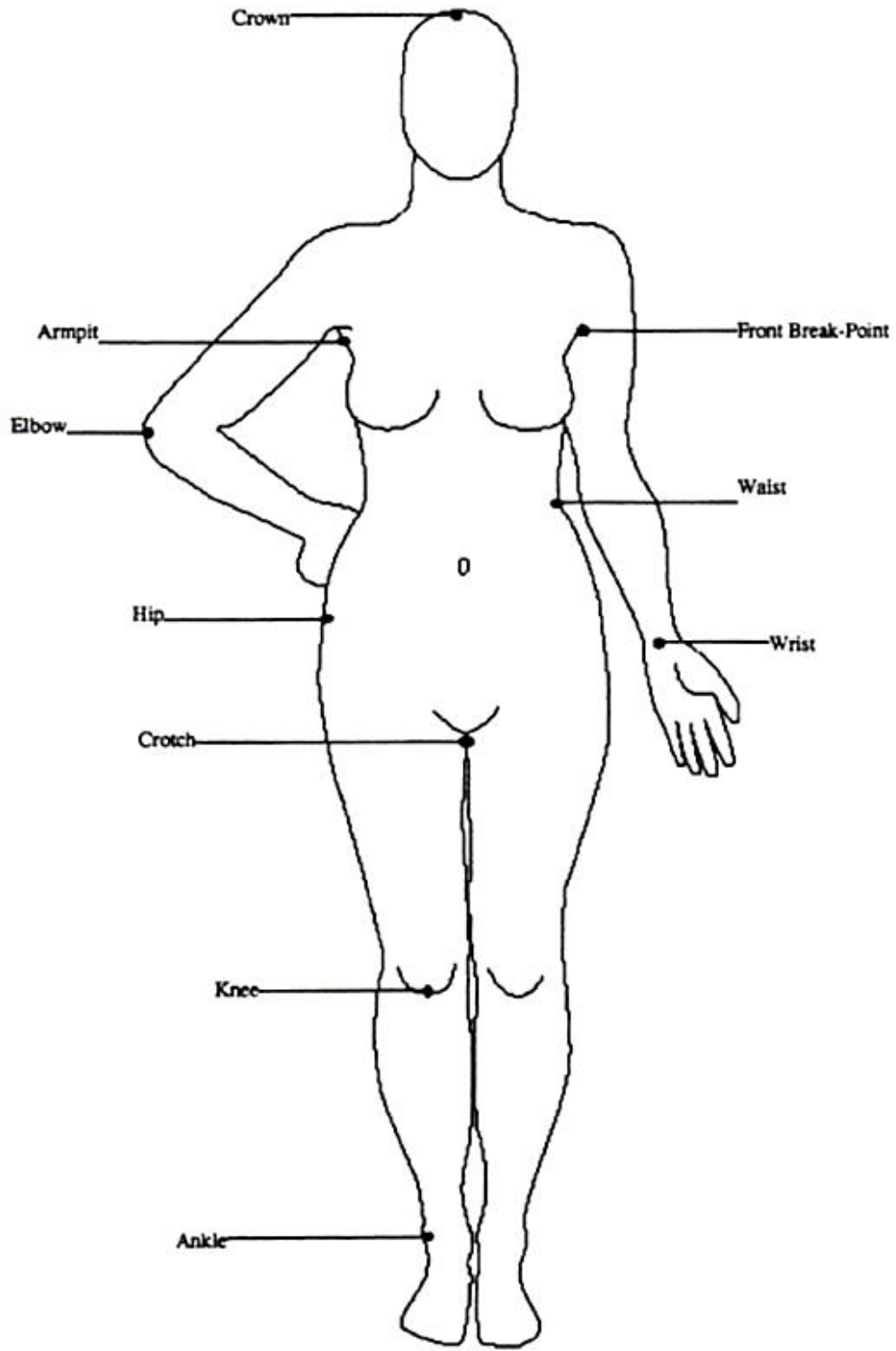


Figure 1.1

Source: ASTM D 5219-02

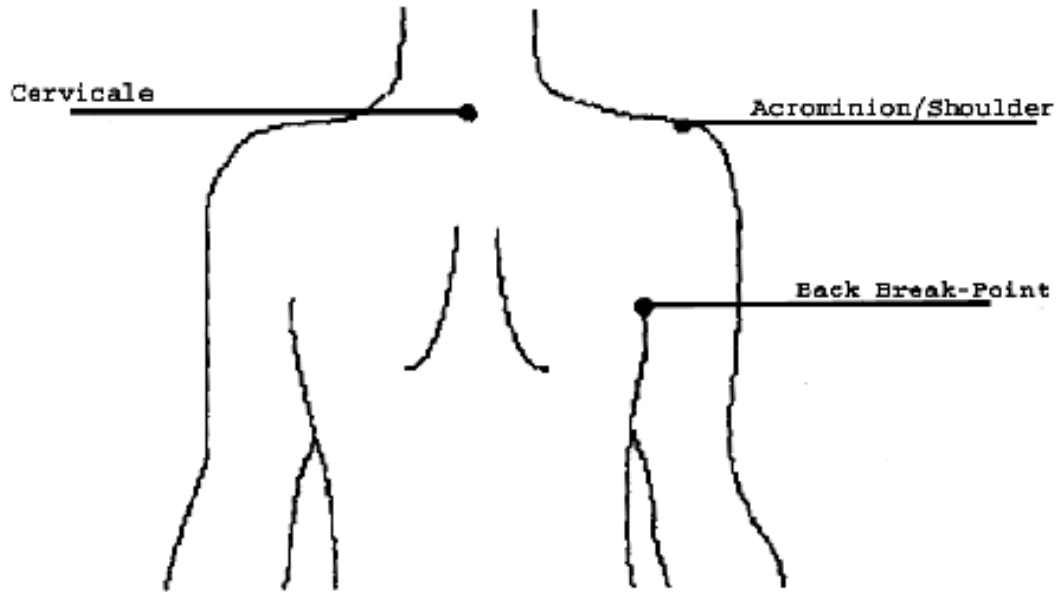


Figure 1.2

Source: ASTM D 5219-02

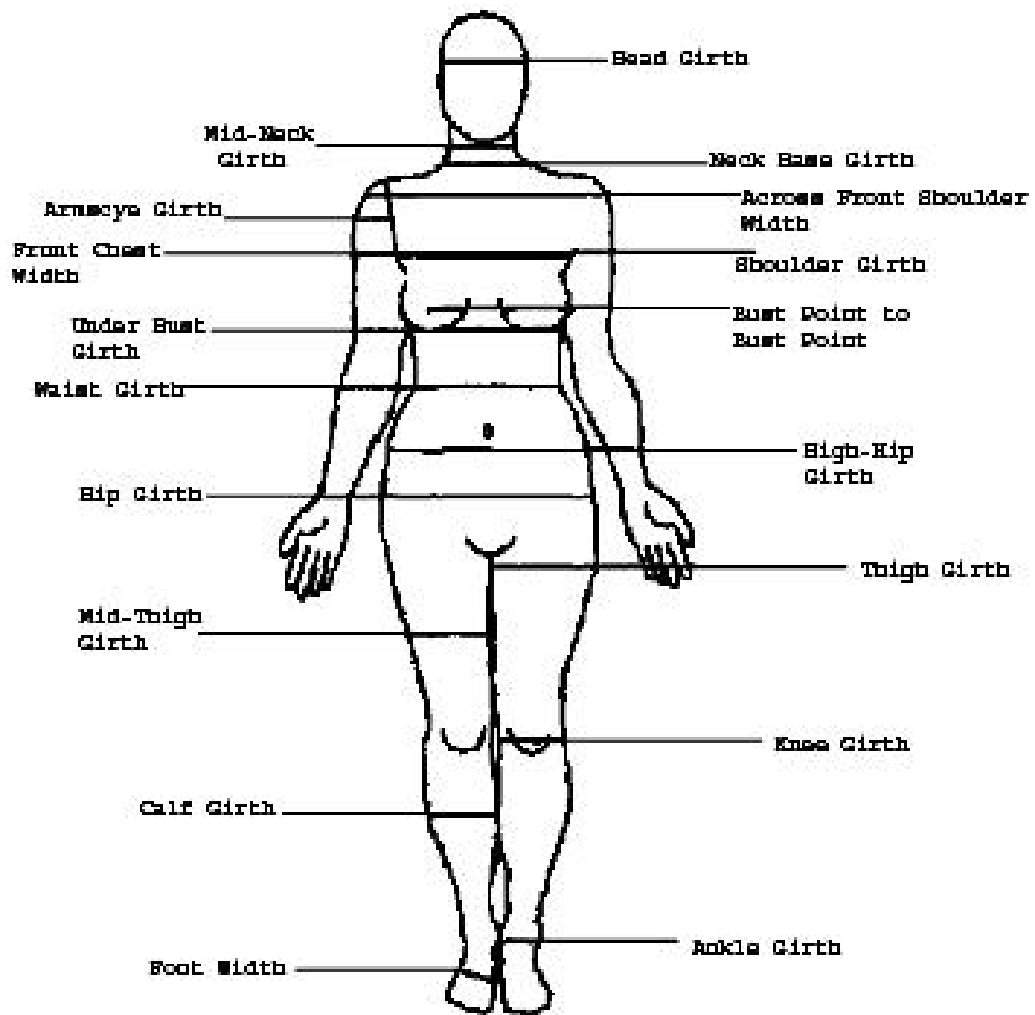


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Source: ASTM D 5219-02

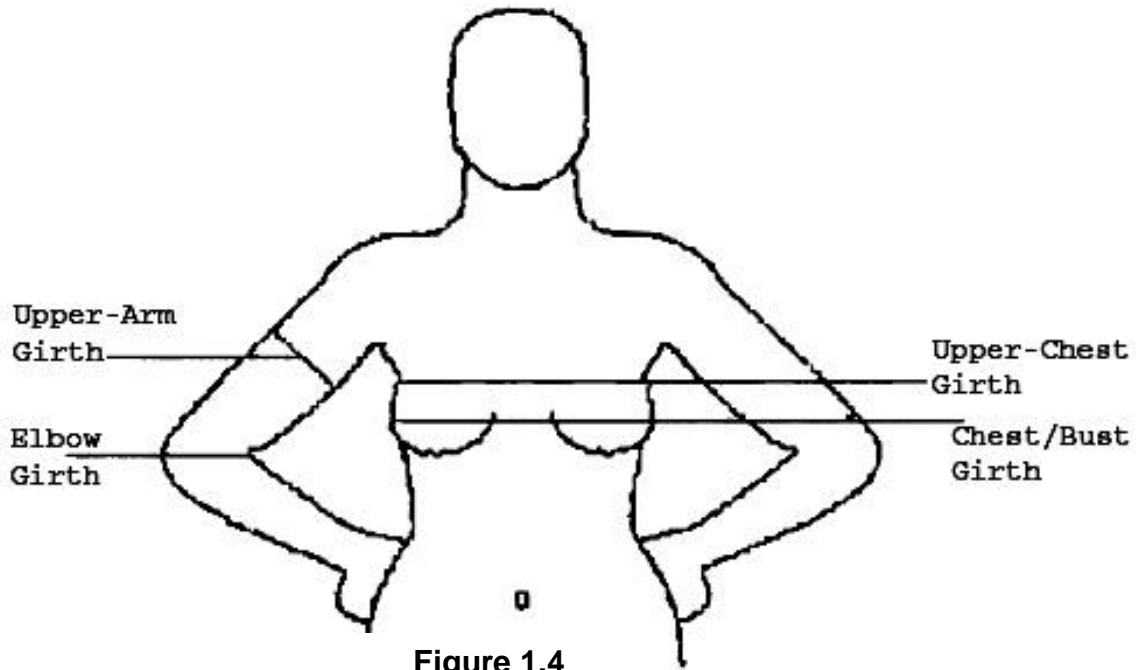


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Source: ASTM D 5219-02

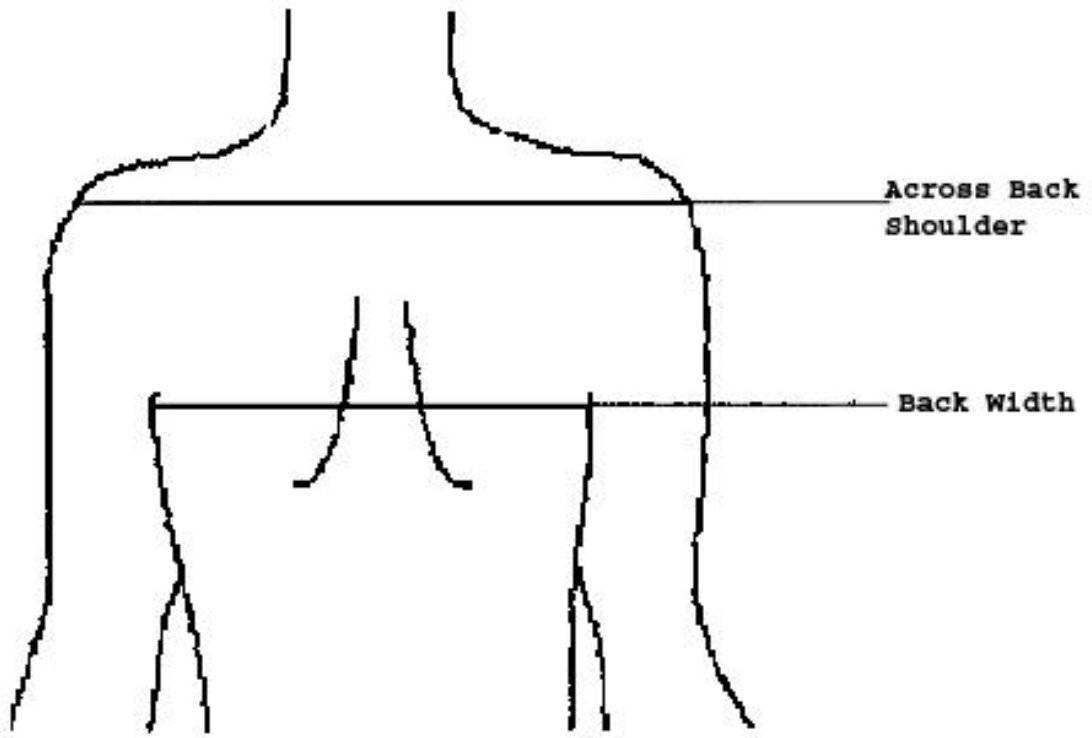


Figure 1.5

Source: ASTM D 5219-02

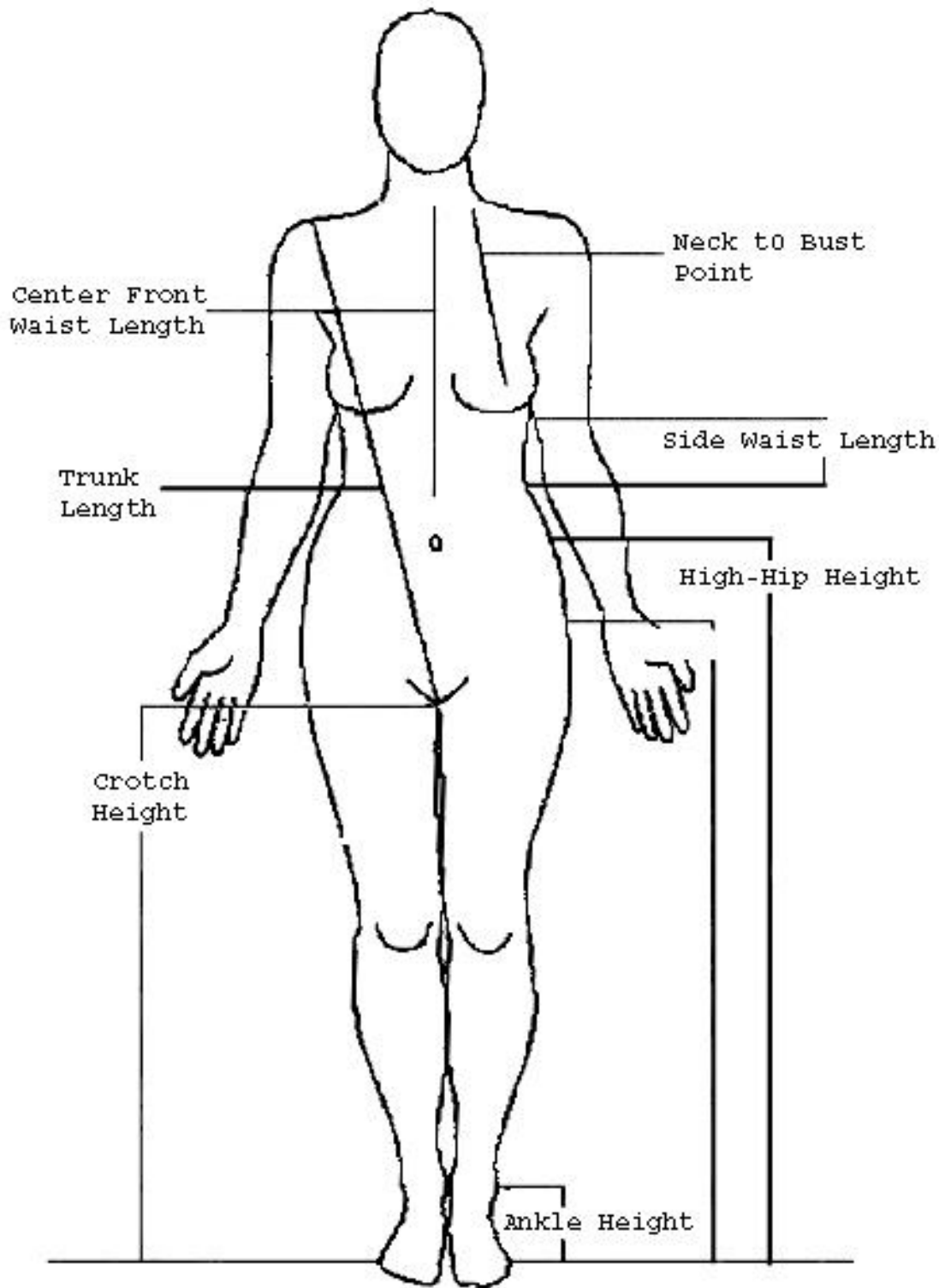


Figure 1.6

Source: ASTM D 5219-02

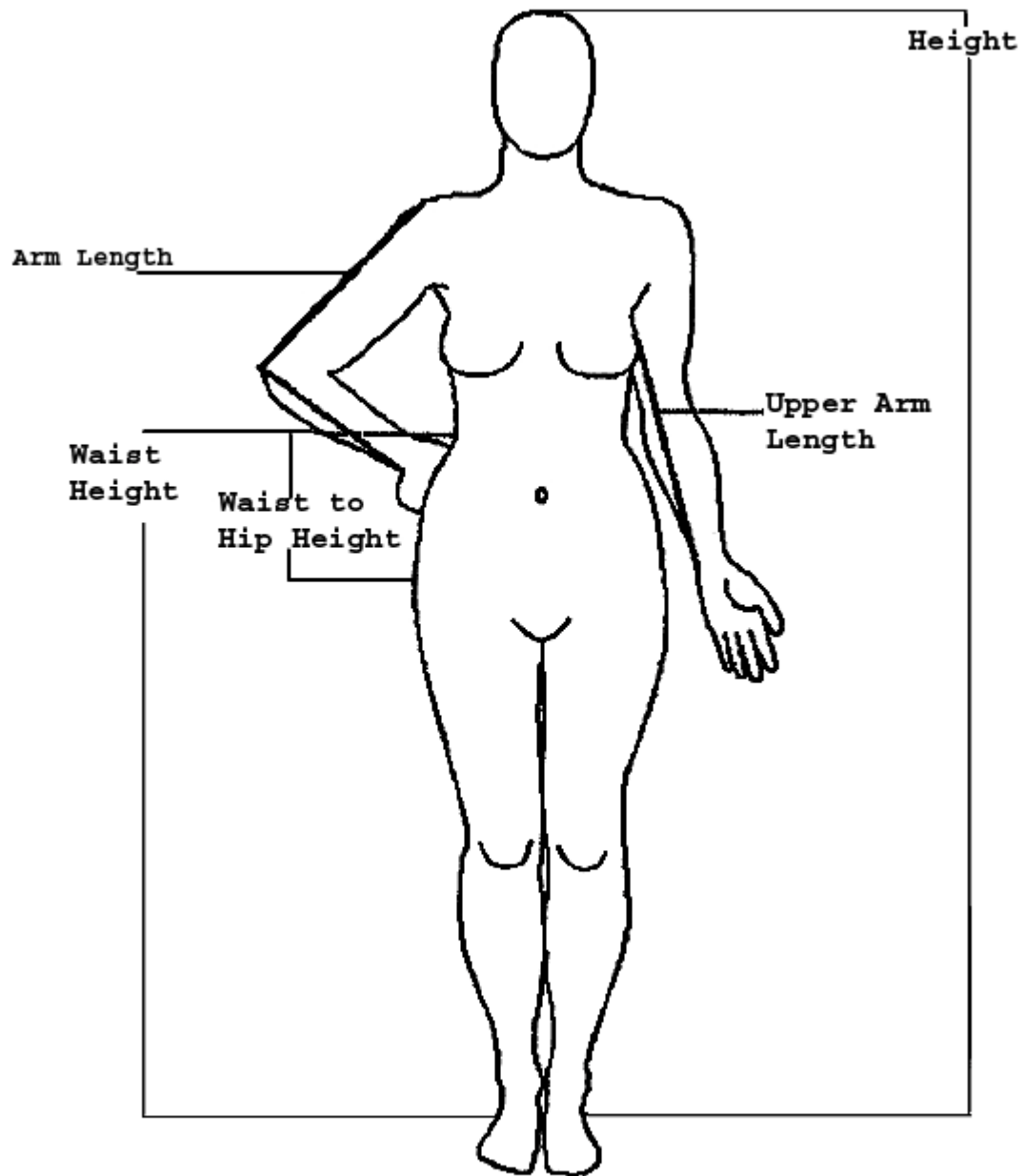


Figure 1.7

Source: ASTM D 5219-02

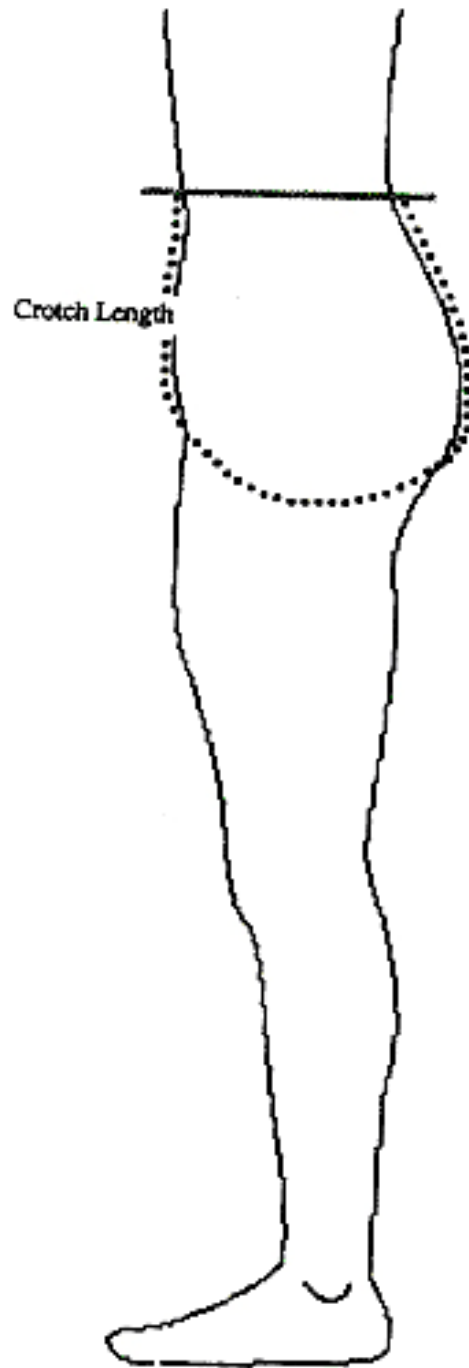


Figure 1.8

Source: ASTM D 5219-02

2.2 Sizing

The process of sizing entails fitting real, actual bodies into designated sizes that have been set by the apparel industry. However, providing satisfactory sized clothing has proven to be challenging to the industry due to the physiological changes of the American people as well as discrepancies in the methods used in creating sizes. Current sizing standards are based on body measurement data the US Dept of Agriculture collected in 1940, which was then adopted in 1942 as a Voluntary Product Standard by the US Dept of Commerce (Lee, 1994).

2.2.1 “Sizing” Standards

Sizing dimensions for the ready-to-wear industry were originally based on the perceived prototypes of the general population. Each manufacturer, based on a trial and error approach, subjectively determined the initial dimensional ranges for each size. The apparel industry, however, saw a greater need to distribute products to persons in different regional areas having different anthropometric dimensions. In an effort to satisfy the demand, apparel companies began offering many different sets of dimensions with the same size designation. As an approach to eliminate variation in size designation, the Federal Trade Commission and Dept. of Commerce established voluntary size standards in the early '70s. Although the human body's dimensions follow an approximately normal statistical distribution, a wide variance is reflected in individual measurements of height, chest, waist, and various other parts of the body. Thus, the probability is high that the statistical mean of a group of these measurements for a particular person follows a predictable range. As a result, the

voluntary size standards established in the 70's proved to be an ineffective method for producing apparel sizes for the general public. (Tamburrino, 1992, Apr)

2.2.1.1 Men's Sizing Standards

Particularly for men's apparel, the majority of men's clothing was based on a very simple incremental and proportional sizing system. This sizing system had been utilized since the introduction of ready-made apparel industry in the middle of the 19th century. The substantiating idea behind the incremental and proportional sizing system was that a correlation between girth and height existed. However, this method of sizing required a significant amount of after purchase alterations (Ahrens, 2000).

The need for alterations decreased with the development of the men's sizing system, which was based on individual body measurements. Although, this newer sizing system was based on specific body measurements, it still perceived a correlation between girth and height and a base pattern was proportionately graded to achieve garment sizes. The idea behind this system is still being used. The result is that some combinations of waist and inseam measurements are not made available in mass produced clothing sizes. Ahrens (2000) says about this system, "With a significant percentage of men outside of established proportional tolerances, dissatisfaction in fit is still an issue".

Men's apparel sizing generally reduces the various dimensions of the human body to one circumferential and longitudinal designation. The girth of the most critical point needed to fit the garment is characterized by the circumference

dimension. The circumferential designation is based on the actual dimension of the part of the body that assumes the predominant role. Chest girth for example, corresponds to the garment size of suits, coats and jackets. Waist girth determines the garment size of trousers, shorts, underwear, and anything worn from the waist down. On the other hand, the longitudinal dimension used in sizing is based on the most important length measurement to fit the garment. Due to the belief that adults change only circumferentially, the longitudinal measurement becomes secondary while girth of chest, bust, waist or hip assumes a significant role. In view of the fact that men's apparel sizes are mainly based on only one circumferential and longitudinal designation, sizing is sometimes difficult when one's body does not meet the strict criteria associated with a particular size. (Tamburrino, 1992, Apr)

A study by Macrini was designed to give the industry a scientific standard that could be applied to sizing men's apparel. Although his size study did not create any new theory, his approach created a standard for sizing men's apparel through the use of anatomical statistics. The objective was to provide a benchmark of accuracy for sizing and fit so that designers and patternmakers would have a text of dimensions to construct and grade sizes with confidence. (Jarnagin, 1990)

Macrini's study utilized landmarks, which illustrated how to measure each aspect of the body. There were 37 different measurements that were used to determine proportions of men of particular height and chest variances in addition to other specific measurements. The study's design would allow manufacturers to factor in variances of weight or height to determine accurate fit based on ethnic

background and geographical location. Macrini believed that his approach would provide a grade rule system for the men's apparel industry while adding to the industry's scientific knowledge. (Jarnagin, 1990)

2.2.1.2 Anthropometric Sizing

Anthropometry is the science of human body measurements, which provides information vital to the design of products ranging from clothing to airplane seating. In anthropometric sizing, body measurements are used to somehow classify people and summarize the people into classes to arrive at body sizes (Whitestone & Robinette, 1997). McConville, et Al (1979), described anthropometric sizing analysis as

“...based on the concept of dividing the population into subgroups of individuals who are more or less similar in certain relevant body size dimensions (e.g., tall and slender, short and heavy) and then analyzing the anthropometric data for these subgroups to arrive at appropriate dimensional design values which will accommodate the size variability within each group (Ranieri, 1985).”

In conducting an analysis of U.S. Navy women's clothing, McConville, et Al (1979), developed a sequence of steps that were found to be useful in conducting an anthropometric sizing survey. The sequence of steps was as follows:

1. Selection of an appropriate body of data for analysis.
2. Selection of the key or sizing dimensions.
3. Selection of intervals for the key dimensions (that is, the upper and lower limits of the key dimensions that will establish each size category).
4. Development of the dimensional data for each size of the established size categories.

5. Conversion of the summary statistical data to the appropriate design values.
6. Establishment of the tariff or numbers of each size needed. (Ranieri, 1985)

The first anthropometric studies were done by the military for sizing apparel for men and women. For example, studies done by Alexander et. Al. (1979) used height and weight to categorize people for flight suits for men and women (Ranieri, 1985). In addition, O' Brien and Shelton (1941) used anthropometry to produce women's size standards with measurements which were extracted from 10,000 women and then classified into "body types." The body types were divided into discrete intervals called sizes and the measurements for each size were presented (Whitestone & Robinette, 1997).

Although anthropometry is widespread, it is inherently flawed. Due to the fact that people do not come in discrete sizes based on their anthropometry, additional approaches need to be considered in establishing sizes. If people naturally sorted into sizes, the same sizes would fit regardless of the design. For example, t-shirts and dress shirts would come in the same sizes. A wide variety of people with varying body proportions demonstrate that all size mediums are not alike. Therefore, in initiating the standardization of sizes, consideration should be given to the fact that specific anthropometric differences exist between people of diverse races (Whitestone & Robinette 1997).

Ranieri's research aimed to improve the clothing fit of the U.S. Navy male recruits by utilizing anthropometric data. Due to the increased number of minorities entering the naval services, anthropometric differences among ethnic groups were

analyzed. Prior to this study, little attention had been paid in anthropometric differences. Ranieri noted in his study that on average, the use of statistical analysis of body measurements associated with garment design provided an improved fit. Statistical analysis of data provides the much needed bridge between anthropometric measurements and the pattern maker or designer (Ranieri, 1985).

Other methods of creating sizing designations have not proven to be quite successful. Gioello and Berke (1979) pointed out that an arithmetic mean is the base influence in apparel sizing. However, this approach may not be the best solution to fit problems. For example, the pooled mean measurements used for blacks and whites may be the same, yet the contours (i.e. areas of prominence) may be different (Whitestone & Robinette, 1997). Overall, anthropometry sizing has proven to be the most scientific method that would account for body type diversity. However, the resulting sizes need to be assessed statistically.

2.2.2 Sizing Studies

At an American Society of Testing Materials (ASTM) meeting in March 1982, the Task Group on Sizing (13.54.03) from both military and industry, highlighted the need to standardize sizes of garments, infant through adult, male and female (Ranieri, 1985). In 1983, Brunn stated in a study that body measurement charts needed to be revised at least every 10 years on the basis of maintaining accurate sizes. In 1987, a study done by Shannon reported that both Sweden and West Germany found important changes in body measurements when they updated their apparel sizing systems to reflect physical changes that had occurred in their

population. In addition, research done by Tait (1988) found that retailers like Marks & Spencer measure 6000 customers every 15 years to keep their size chart current. (LaBat, 1990)

Several recent apparel industry initiatives like whole-body scanning, computer assisted design (CAD), and computer assisted manufacturing (CAM) are believed to supply the tools needed to help resolve some of the issues related to out-of-date sizing standards. However, these initiatives do not address the importance of fit preference and the perceived interaction of garment fit characteristics with the body (Ahrens, 2000). Until now very little anthropometric data has been collected specifically to satisfy the needs of the U.S. apparel industry.

The following are recently conducted sizing studies that aimed to provide a variety of manufacturers with useful anthropometric data by collecting uniform data that followed a standard criterion (Tamburrino, 1992, May).

2.2.2.1 Size USA

There have been numerous sizing analyses done in the U.S. but none quite as extensive as the Size USA study. This study collected body measurement data from over 10,000 U.S. subjects. The collected body measurements support the claim made by consumers and industry that the US population has more diverse body shapes in addition to increased body weight. ("Size USA", n.d.)

The subjects were male and female from four ethnic groups and six age groups. Additional demographic information was taken to provide more substantial

information to the apparel industry. This survey used anthropometry to determine 3-D measurements taken from more than 20,000 points on the body. In less than a minute 200 body measurements and a 3-D image were produced. (Size USA, n.d.)

2.2.2.2 CAESAR

Many believed that the design of products for the 21st century would be based on CAESAR (Civilian American and European Surface Anthropometry Resource) data. Similar to Size USA, CAESAR used digital scanning techniques to create a 3-D computer simulation of its subjects. This international study had more than 20 commercial partners. CAESAR utilized a whole body scanner that was developed by Cyberware to capture a 3-D image of the human body in 17 seconds with a single scan. This comprehensive study consisted of 4000 subjects measurements from the US and Canada. The remaining 6800 were collected from sites in the Netherlands and Italy. The study included men and women between the ages of 18 and 65. (DesMarteau, 2000) CAESAR also provided software and measurement protocols like fit mapping, which is a process that determines if an individual does or does not fit a particular piece of clothing or equipment. (Hill, 2003)

2.2.3 A Changing America

Almost two out of every three adults today are overweight, reports the Center for Disease Control's National Center for Health Statistics (NCHS). However, the weight of American's is not the only facet about the population that is changing. Increased ethnic diversity along with differing body proportions with increased age, has led to the further realization that current sizing standards are truly out-of-date.

The size and shape of the “average” American consumer today is dramatically different from 60 years ago. Nevertheless, apparel companies still develop clothing sizes that are based on the proportions from the 1940’s models. (Cardyn, 2003)

2.2.3.1 The “Size” of the Population

The results of the Size USA Survey (2004) showed that nearly one in five men are “portly” and similar number so overweight they have to look under their belly to find their waist (“US clothes sizes”, 2004). The truth of the matter is that most men are larger than the traditional average which is considered to be a 40-inch chest, 34-inch waist, and 40-inch hips normally referred to as a size medium on most U.S. sizing charts. The Size USA survey recorded that even among young men aged 18-25, the average size was a 41-inch chest, 35-inch waist and 41-inch hips. In the 36-45 age group, the average White male’s measurements were 44-38-42, while the average for Black’s came in at 43-37-42, for Hispanic’s 44-38-42 and Asian’s 42-37-41. (US Clothes, 2004 & “Average Clothing”, n.d.)

Average weight for both sexes has gone up four pounds since a 1994 study by the Centers for Disease Control and Prevention (US Clothes, 2004). Poor eating habits, a lack of exercise and a lifestyle that favors inert behaviors of several kinds have contributed to the fact that Americans are getting bigger. One of the fastest selling menswear products today is the expandable waistband (Cardyn, 2003). However, this is of no surprise because 65-69 percent of American men are reported to be overweight, and 20 percent of those men are obese (Fetto, 2003 & Peterson, 2004).

In efforts to gain more information about the consumer, Simmons Market Research Bureau, a New York City-based firm that surveys over 20,000 American adults annually made the landmark decision to begin recording both the height and the weight of its survey respondents. Simmons found that for the 69 percent of all adult males in the United States that are overweight and obese, they are 35 percent less likely than men who are not overweight to say that they enjoy shopping for clothes. The survey also found a link between an individual's body mass indexes and the way they shop which suggested that a man's girth had more of an impact on the way he dresses than we ever knew. Overweight men were found to utilize fitting rooms more often than men who were not overweight. The Simmons survey results determined that heavy men are also found in higher concentrations at discount stores and wholesale clubs like Big Lots, Wal-Mart and Costco. Surprisingly, 73 percent of male shoppers at Sears are overweight compared with only 56 percent of men who shop at Nordstrom. (Fetto, 2003)

2.2.3.2 Diversity

America has a long history of being a culturally diverse nation. But never has its diversity presented as many opportunities and challenges for retailers as it does today. Many feel that the apparel manufacturers and retailers must do better to keep up with the changing needs of consumers, in a time where consumers are larger, more diverse and more demanding than ever. This is especially true as certain groups grow disproportionately to other, such as the current gains by the Hispanic population, a diverse group in its own right that has surpassed African-Americans to become America's largest minority group. (Howell, 2002)

The U.S has undergone a drastic physiological and demographic transformation since 1971. Apparel companies are doing more detailed demographic and geographic analysis of buyers' gender, race and ethnicity, and even education. The industry has found that developing an understanding of acceptable fit in clothing is the best method to reduce markdowns and increase sales. Retailers of all stripes, even those with a primarily Anglo customer base, are finding that ethnic marketing can pay off in big dividends, both in sales dollars and shopper loyalty. Population growth trends dictate that ethnic marketing must be given serious consideration now and in years to come (Howell, 2002).

Based on the Size USA study, it was determined that Hispanics and Asians tend to be shorter than their White counterparts. An average Mexican American male is 5'6," compared with 5'8" for the average non-Hispanic White male (Cardyn, 2003). In addition, eleven percent of men overall had a "prominent seat," ranging from 24 percent among Black men to 9 percent among Whites, 8 percent among Hispanics and 6 percent among "Others." (Zernike, 2004)

As mentioned earlier, anthropometric racial variation is not a factor that has been given much consideration in apparel sizing. Many studies however, substantiate the fact that ethnic groups normally have varying body proportions. As cited by Giddings and Boles (1990), a range of studies measuring height, have found that Black children were taller than White children (Garn, Clark, & Trowbridge, 1973; Verghese, Scott, Teixeira, & Ferguson, 1969). In addition, anthropometric measurements from studies have found Blacks to have a lower sitting height than

Whites (Harsha, Frerichs, and Berenson (1978), His et al, (1983) and Verghese et al. (1969).

Other anthropometric studies cited by Giddings and Boles, not only confirm these findings but also imply that blacks have longer lower extremities than Whites (His, Hsu, & Jenkins, 1983; Meredith, 1978). The findings of such studies substantiate a need to accommodate the difference in body types seen among ethnicities. Further support to this premise is found in Laska-Mierzejewska's study (1970), which indicated that Black youths had shorter trunks, longer lower and upper extremities, wider shoulders, and narrower pelvises and hips than white youths (Giddings & Boles, 1990).

Additional studies regarding Asian and Caucasian women support the fact that body proportions differ by ethnic groups. Hu's (1984) research found that Caucasian women had significantly different body proportions than Asian women on 32 variables related to height, surface, and circumference measurements. The measurements that did not significantly differ were head, neck and hand circumferences. These results were found at a .001 alpha level, which corresponds to 99.99% confidence level. In addition, in research by Gim (1988) Asian women were found to need a considerable amount of alterations done to their garments. Gim believed that this finding suggested that Asian women were not adequately represented in sizing systems being used.

2.2.3.3 Age

Baby Boomers, those individuals born between 1946 and 1964, account for 77 million of the U.S. population. The number of people aged 65 to 84 is expected to grow 80 percent in the next 30 years (“Long Term Care”, n.d.). Of the 77 million members, 38 million are male boomers (“Reelin in the Years”, 2004). Thus, understanding the relationship between age and the sizing of clothing is an important issue.

In the 1940’s sizing study, only 2 percent of the women measured were older than 60. The study was biased toward young, unmarried White women. This fact substantiates the reason that 92 percent of older women have a problem finding clothes that fit well. Older women experience body changes that include a forward head and neck angle, forward shoulder roll, back curvature, increase in girth and decreased height. According to Goldsberry and Reich, the effects of aging include a thickening waist, a lowering bustline, or a broadening back shoulder. Therefore, taking into account these findings in developing ready-to-wear fashions for the older population would provide more comfortable for its target market (Renfrow, 1996). In a study done by Susan Ashdown, the focus was to provide clothing for the mature bodies of older women. Instead of focusing on circumference and length, the study examined body stance, angles and proportions and relationships, such as how the shoulders and bust relate to each other (Lang, 1996).

Research has shown that older women experience body changes as they age which greatly affect the fit of their clothing. A similar scenario is likely to be

experienced in the sizing of older men's clothing. There is a heightened importance in understanding the factors that might relate to older men's and women's satisfaction and dissatisfaction with fit of ready-to-wear and commercial patterns. Overall, men who are over 45 are more likely to have bellies. Based on the Size USA study among men ages 18 to 25, 5 percent of Blacks and 9 percent of all other groups were labeled portly, meaning they needed extra room in the front half of a jacket, shirt or sweater. But that gap narrowed or even reversed among men 55 to 65, where 42 percent of Blacks, 32 percent of Whites, 44 percent of Hispanics and 30 percent of "Others" were considered portly. However, surprisingly, older men appeared to have trimmer thighs than younger men (Zernike, 2004).

Since clothing is generally made for a 17- to 35-year-old with an upright stance, poor fit is resulted for the different body proportions among older Americans (Lang, 1996). As individuals age, their body proportions change resulting in a need for apparel sizing that can accommodate these changes. Not until recently has there been a focus on clothing tailored for older women. On the other hand, clothing studies for older men are yet to be conducted. An important point to keep in mind when selling apparel to older consumers is that body weight and height frequently change with age. It may be assumed that mature consumers need proportionately shorter and larger sized clothing than the younger set (Posta, 1991).

2.3. Sizing vs. Patterning

The sizing system that an apparel company uses is based on the pattern grading process. Each company determines the base size from which

grading begins and the proportional change in measurements from which sizes are determined. Determining the proper proportional changes in measurements is important in providing satisfactory fit to the consumer. Currently in the U.S. a single size can vary one-half to 3 inches in nearly all dimensions of a pattern between one firm and another. (Farr et al, 1996)

2.3.1 Problems/ Inconsistencies with Pattern Grading

A Cartesian coordinate system is used in both men's and women's apparel for drafting the majority of patterns. This system derives X dimensions proportionally from the circumference of the chest, and Y dimensions from height or a combination of chest and height measurements. Therefore the maximum chest/girth measurement is fundamental to the development of upper body patterns for sizing garments. However, the sites at which measurements are taken are quite relevant. For example the ISO standard requires the chest/bust measurement be made at a point high under the armpits, over the shoulder blades and the breasts at the same time. However, these three points are rarely found on the same horizontal line. Thus, alterations are made by each company to determine the measurement they want. In turn each company's alterations result in obvious variations among commercial tables, primarily with the true difference between a man's chest and hips or a woman's busts and hips. Although the chest/bust girths of commercial tables are increased to obtain a value closer to maximum girth to that of a tailor's method, values are still considered empirically acceptable, but scientifically questionable (Tamburrino, 1992, May).

Sizing systems developed by individual manufacturers are generally structured so that each incremental size is larger than the previous one by a set amount. These size increments are based on the manufacturer's concept of the size of their customer, and on the size ranges that have fit the most customers in the past. The process of arriving at incremental sizes is called grading. The amounts added to a pattern in the process of grading it to get to the next size are different for each manufacturer. (Ashdown, 1991) Thus, the proportion of the pattern will vary according to the experience, the accuracy, and the personal judgment of the grader (Ranieri, 1985). The result is a single size that varies one-half to three inches in nearly all dimensions between one firm and another (Farr et al, 1996).

The proportional drafting system which was implemented in the 1800's and is still used today, proves to no longer be effective for the American population. In the 1800's this system was adopted by tailor shops to meet the demand of ready to wear garments by developing a standardized method for cutting garment parts. Proportional drafting systems, however, do not take into account the variety of body types that exist in the population (Ashdown, 1991). The human body unfortunately does not always grow according to standard measurements set by the grader (Ranieri, 1985). Those consumers who do not correspond exactly to a designated incremental size must choose either a size just larger or smaller than their own body size, or a size that fits one area of the body but it is larger or smaller in another area (Ashdown, 1991). As cited by DesMarteau, researchers Moore, Mullet and Young agreed that it is not necessary to grade on a continuum of one-inch increments if a

more complex grading system can be implemented with CAD, allowing for better fitting garments and extended size ranges (DesMarteau, 2000).

DesMarteau cited research done by Schofield, which compared 42 different sizing charts from a variety of catalogs, textbooks, manufacturers and major retailers against actual women's body measurement data, gathered by the U.S. Army in 1988. Most size standards assumed that the difference between the principal girths (i.e., hip to bust, bust to waist, etc.) is constant for all sizes; however, Schofield found that this assumption was not supported by actual human measurements. His comparison also found false assumptions in the grading rules. Most grading rules assume that the bust point maintains the same vertical position in the bodice for all sizes; however, human measurements actually indicate that the bust point drops as size increases in most cases. (DesMarteau, 2000)

Robert Garner, a pattern maker with VF Corp's Wrangler's division commented, "Fit problems are like bad genes—they can keep moving from style to style". Radford University's Carolyn Moore and Kathy Mullet, and Wolfe Fording Co.'s Margaret Prevatt Young has studied four of the most commonly used grading systems. They concluded that two of the systems, Price & Zamkoff's and Handford's, do not account for the adverse fit problems that can be caused by continuous grading of a base size into extreme size ranges, such as extra-large. In addition, the research found that a grading system is no better than the sizing specifications from which it is developed. Therefore, unless it is based on good

anthropometric data, a grading system should not be adopted unless a test run of garments can be made to check the fit of all sizes. (DesMarteau, 2000)

2.3.1.2 Ideal Imaging

As cited by Labat and Delong, each society develops an image of the ideal body. The image changes over time and is readily recognized by members of society (Roach & Eicher, 1973). The fashion industry, which is a major facet of American society, receives and interprets the social message of the ideal figure and creates an ideal customer; which rarely ever exists. Due to the fact that many Americans deviate from the fashion industry's "ideal figure," the need for garment alterations has always been necessary for many individuals. In fact, people that do not fall into the industry's set boundaries are reported as being "oddly" figured, resulting in a poor self image (LaBat & Delong, 1990).

The ideal figure created by the fashion industry has lead to influence the underlying systems for sizing apparel (LaBat & Delong, 1990). To portray its product in a desirable way the apparel industry presents its product on an idealized symmetrical figure, with an upright stance and aesthetically pleasing body proportions (Workman & Lentz, 2000). As cited by LaBat (1987), an "average" figure as described by Horn is,

Approximately 7-1/2 heads high, with the fullest part of the hipline at wrist level dividing the total length exactly in half. The neck is about one-third the length of the head, and the shoulder line slopes a distance of a half head length from the level of the chin. The fullest part of the bust or chest is located 2 heads lengths from the crown, and the smallest part of the waist (which coincides with the bend of the elbow) is two-and-two-thirds heads from the crown (Horn, 1968, pp. 313-314).

In addition, the description of a men's suit for the average size 40 is,

A size 40 men's suit is made for a body 5'8" to 5'11" tall with a chest girth of 40"; in addition, the suit is expected to fit a body with a waist of 33" to 34", a neck of 15.2" to 15.5" and a sleeve length of 33.5" to 34.5". (Tamburrino, 1992, Apr).

Illustrations of an "average" figure, as described above, play a significant role in how consumers interpret the fit of apparel.

In Ranieri's (1985) study to improve garment and pattern designs for U.S Navy Male Recruits, several patternmakers and tailors were contacted for their individualized concept of size and fit. For example, a visit to Leaburey's, a male clothing manufacturer, resulted in an interesting finding. Attilio Balestra, the chief designer, indicated that Leaburey's produces men's suits, sports jackets, and trousers for 5 different firms, including Brooks Brothers, as well as its own brand. The patterns used for each firm vary in measurements anywhere from ¼" to 1". When asked what measurement he uses as a standard to grade from, Attilio stated, "I use a 40 regular because I am a 40 regular. I take the measurements that I am comfortable with and grade up and down". (Ranieri, 1985)

2.4 Fit

The fact that many Americans are dissatisfied with the fit of their apparel is of no surprise since there are dissatisfactory methods used in developing sizes to accommodate U.S. consumers. Fit is defined as the way that a garment relates to the body. (Ashdown, 1991) Fit entails obtaining a satisfactory relationship between the garment and body, which involves achieving a certain level of physical comfort, psychological comfort, and appearance of the garment specific to each individual.

LaBat and DeLong (1990) found that the most obvious reason for consumer dissatisfaction with fit of apparel is that it does not conform to the body in key areas. Dissatisfaction with fit has resulted in customers not purchasing a garment even if the style, color, and price are satisfactory. (Chen, 1987)

2.4.1 Approaches to Fit

There are several approaches that can be taken in establishing body sizes for garments. As cited by Jarnagin, according to Gennaro Macrini, more than three quarters of the apparel industry fit the American consumer by ritual rather than by science (Jarnagin, 1990). The simplest and probably least satisfactory method of establishing sizing for garments is to force the body to fit. In this method a designer develops a garment or work environment and then only those personnel who have the proper body dimensions wear the garment. This is one of the reasons fashion models fall within restricted body parameters. It can readily be seen that this sizing method has definite limiting factors. Customers who have the proper body parameters such as fashion models would be very happy with the fit, but clientele will be limited. (Ranieri, 1985)

Another method is the “tailor-mades.” This is just the opposite of the “force the body fit” in that the garment is designed around the individual body. In this method the fit is perfect and the cost is high because the time required to fabricate the garment is lengthy (Ranieri, 1985). In custom tailoring, those dimensions that are important to the type of garment are measured directly. Specifically, the number of measurements taken depends on the coefficient of variation empirically

experienced among dimensions. Dimensions that have a low degree of variation suggest that they can be determined proportionally and therefore are not measured directly. (Tamburrino, 1992, Apr)

However, the emergence of mass customization gives apparel manufacturers the abilities to mass produce garments individualized for fit that can meet the needs and preferences of a much larger percentage of apparel customers. In turn, consumers must accurately communicate their sizing and preference requirements and the manufacturer must provide garment-related fit characteristics and style features in the ordering process. If any of these components are missing, unacceptable or poor fitting garments may result. (Ahrens, 2000)

For the first time, the concept of apparel custom-fitted to individual consumers, is efficient enough to compete with ready-to-wear apparel. Apparel that is custom-fitted by computer allows every body size and body shape, to be accommodated with no assumption of misfit for individuals that fall between different size ranges. With the U.S. population accustomed to the limitations of incremental sizing, consumers who have had no experience of clothes that fit consistently, some of whom may have never had clothing that relates to their individual proportions, will have no means of judging preferences in fit. (Ashdown, 1991)

2.4.2 Creating the Right Fit

Fit issues require companies to look closely at the many different shapes and sizes of the human body, with little to no clothes on for best results. For example, analysis of prevalent fat deposits (i.e., “love handles,” etc.) can be critical to

designing better fitting garments (DesMarteau, 2000). Since manufacturers create clothing intended for a specific body type, a consumer may be forced to try on a variety of garments from different manufacturers until acceptable fit can be achieved. The result of this quest usually ends in either failure or a lowering of fit-related expectations for the consumers (Ahrens, 2000).

Whitestone and Robinette (1997) suggested that the best way to ensure a good fit is to start with a good design. Their research has found that there are definite problems caused by defining sizes before establishing the design. One effective solution to these problems is to include fit testing in the development process rather than merely for verifying or refuting the success of the fit after development. This is believed to: 1) establish good item proportioning, 2) establish the range of fit per size and the impact of design trade-offs, 3) minimize the number of sizes, and 4) optimize the design. Whitestone and Robinette (1997) also suggested two components to data collection during fit testing: 1) measuring quality of fit and 2) anthropometry.

2.4.2.1 Quality of Fit

Measuring quality of fit generally means more than just quantifying comfort. Determining the level of fit quality that is acceptable involves not only setting the individual factor levels that are acceptable, but also the combination of factor levels that are acceptable. As cited by Whitestone and Robinette (1997), the advantage of this approach was demonstrated in a Navy program to develop a new women's uniform. In this study an existing uniform was used as a prototype and fit test

(Mellian et al., 1990). Fit testing revealed that some sizes were unnecessarily duplicated and that the diversity of sizes that were needed was not represented. A follow-up study by Robinette et al. (1990) described the sizing scheme derived after fit testing. This new sizing scheme reduced the number of major alterations required from 75% to less than 1% without increasing the number of sizes. It also cut the time and cost of issuing the uniforms by 50% and reduced inventory waste. Millions of dollars were saved in the first purchase alone. (Whitestone & Robinette, 1997)

2.4.3 Psychology of Fit

It is necessary to understand how the fit of clothing affects people's comfort both physically and psychologically. Research has shown, as cited by Freedman (2003) that the psychological discomfort of "fitting wrongly" is tolerated less than physical discomfort such as constriction and lack of wearing ease (Slater 1985). The psychological comfort of clothing is found to be a response to a combination of the both physical comfort and the appearance of a garment (Ashdown, 1991). Issues affecting the psychology of fit include an individual's idea of acceptable fit, body cathexis and how closely an individual believes they correspond to society's description of the "ideal" body.

2.4.3.1 Acceptable Fit

Since the consumer determines on an individual basis what constitutes satisfactory fit, an understanding of fit from the consumer' perspective is an important and yet complex issue. Studies have shown that one judges the fit of a new article of clothing based on a memory of clothing that proved to be satisfactory

in the past (Ashdown, 1991). Turnbladh (1988) distinguished between two separate judgments about fit made by persons trying on clothing. The first is the comfort of the clothing, or the way it feels on the body. The second is the fit of the clothing, or the way the clothing looks on the body. (Ashdown, 1991)

The perception of satisfactory fit for a consumer may range from a desire for a garment to conform loosely to the body for added comfort, to a desire for a garment to conform perfectly to the body and thus provide maximum appearance (Chen, 1987). Due to differing fit preferences, providing satisfactory fit to consumers is an inherently difficult task. Czepiel suggested that there should be a greater focus on determining the specific product variables that have the greatest influence on consumer satisfaction for a given product (LaBat, 1987).

As cited by Workman (2000), a study done by Ashdown and DeLong (1995) investigated the smallest difference in fit that can be perceived by individuals. The investigation showed that individuals varied in tolerance for fit variations at different locations on the body. For example, participants were able to discern variations as small as 1.0 cm at the hip and crotch and .5 cm at the waist. The inconsistencies discerning variations can be partially explained by the fact that each man or woman independently decides on the measurement specifications and size designations for their body (Workman, 2000).

In addition, an investigation by Giddings and Boles focused on the fit problems encountered in the purchase of dress pants by Black males and White males between the ages of 18 and 30. Specific findings of this study were based on

the use of commercially produced men's dress pants. Results found that although Black males were able to find good fitting pants, they had problems with fit in the thigh area and frequently had the waist altered (Giddings & Boles, 1990).

Improved fit of the commercially produced dress pants was established by adding width in the thigh area and length in the back hip region to accommodate the high curvaceous buttocks. The anthropometric measurements of this study revealed that the Black males generally had smaller waists, larger medial thighs and higher buttock curves than white males. The research also suggested that, in order to obtain a good fit, the Black males would either have to purchase knit dress pants to get more flexibility in the thigh area or purchase a larger size pant to fit the thigh area and, consequently, alter or decrease the waist to accommodate their smaller sizes (Giddings & Boles, 1990).

2.4.3.2 Body Cathexis

Body cathexis is the evaluative dimension of body image, which results in positive and negative feeling towards one's body. As cited by LaBat and Delong (1990), many researchers who have studied body cathexis believe that evaluation of one's body is developed through interaction with others (Bershcheid, Walster, & Bohrnstedt, 1973; Kleemeier, 1959; Lewis, 1978; Secord & Jourard, 1953).

Clothing that does not fit, may result in the consumer perceiving the cause as related to the body and not the clothing, with resulting negative feelings about the body (LaBat, 1990). Hethorn, a professor at the University of Delaware who has devoted years of research to apparel fit problems, stated that " We have come to internalize

fit problems and trash our bodies rather than realizing, this clothing doesn't relate to the body I have (DesMarteau, 2000).” As a result of body cathexis, many manufacturers have been motivated to increase the dimensions within a size to fit two to four sizes bigger than they did 10 years ago (Tamburrino, 1992, Apr).

Research by LaBat and DeLong also found that individuals predominately have issues with finding garments that fit their lower bodies. A consumer satisfaction study found that for 100 subjects tested, they were all less satisfied with fit of garments to the lower body. The scores for upper and total body fit were slightly higher. This dissatisfaction with lower body fit were suggested to be the result of trying to fit real bodies into garments that are sized according to an ideal of slim hips balances to upper body. As cited by LaBat and DeLong (1990), subjects were also least satisfied with their lower bodies on measures of body cathexis; this finding has also been substantiated by other studies (Fisher, 1973; Harris, 1987).

2.4.3.3 The Image

Many times the consumer's satisfaction/dissatisfaction with fit of ready-to-wear goes beyond the physical dimension of clothing to include reactions to implicit societal messages. LaBat (1987) suggested that the consumer's perception of fit may be related to how closely the individual conforms to the societal definition of ideal body. Many clothing marketers have realized the importance of going beyond physical measurements to satisfy consumers with apparel that fits. As cited by Brantley (1999), cultural factors such as ethnicity, socio-economic status, age, sexuality, and gender have been found to have dynamic impact on how the

members of society interact with one another (Frietas, Kaiser, & Hammidi, 1996; Richards, 1988). Therefore, members who share the same types of cultural characteristics tend to socialize in smaller; homogeneous groups wherein discussion, expression, and celebration of their similarities take place (Brantley, 1999).

There is much to be determined when aiming to develop acceptable fit for the heterogeneous ethnic background of many Americans. The fit, silhouette, and details of construction of apparel are culturally determined, largely in response to social, technological, and economic forces. Perception of good fit is determined by concepts of comfort and other choices that are culturally and individually set ideas. For example, clothing that is considered appropriately snug by one individual or by members of one culture may be unbearably tight to another individual or members of another culture. Climate or seasonal variation in temperature may influence how closely one would like their clothing to fit.

Demographic and social trends exert an increasing influence on the industry's critical focus on fit (Cardyn, 2003). Due to the changing ethnic makeup of the U.S. population it is needful to consider how fit relates to specific ethnic groups as well as those that fall outside of society's norm. Therefore, an understanding of fit preferences must be developed for such individuals namely, image-conscious men of today-metrosexuals. The term coined "metrosexuals" describes a generation of men who grew up hanging out in the mall to socialize; as a result their sense of fashion is largely influenced by trends once reserved for females and gay men. A

metrosexual can be more specifically described as a heterosexual American male, living in urban, metropolitan setting who embraces their feminine side. An acceptable fit in clothing for “metrosexual” males may be entirely different from the preferred fit for males that are not deemed to be “metrosexual.”

In addition, the fit preferences of younger adult males that consider themselves to be a part of the hip-hop generation are likely to be different from the fit preferences of older adult males (Fenley, 2004). This is due to the fact that, “in our consumer culture people do not define themselves according to sociological constructs. They do so in terms of the activities, objects, and relationships that give their lives meaning (Brantley, 1999).”

2.5 Men’s Underwear

Men traditionally wear the same type of underwear their fathers wore and maintain wearing the same type throughout their entire lives. Comfort and satisfaction of fit in men’s underwear has always been key to this sector of the industry. This is one of the reasons that brand loyalty has always been high (Mintel, 2003). Brand loyalty has been readily based on comfort and value rather than fashion and status (Rovny, n.d.). The following section will discuss the men’s underwear sector as it relates to fit.

2.5.1 Men’s Underwear & Fit

There are three basic types of underwear men can choose from: briefs, roomy boxer shorts and tight boxer shorts. According to The Ultimate Underwear survey 57% of men prefer briefs, 18% prefer tight boxers (boxer briefs), and 29%

prefer roomy boxers (Rovny, n.d.). Men's underwear has never really been considered to be a 'fashion' apparel item. Historically, the men's underwear industry saw little potential for self-expression or aspirational purchasing. However, men's underwear is now going through a transformation. The men's underwear industry has begun to see the importance of offering variety in design and also providing more satisfactory fit to the male consumer. 2(x)ist, one of the more successful new brands of designer underwear, aims to provide the consumer a new look in underwear that fits well and provides comfort ("Briefly Noted", 2004).

2.5.2 Men's Underwear Market

Younger consumers tend to experiment with different styles and prioritize fashion in their underwear purchases more than older consumers. This has become a bright spot for the industry, resulting in substantial product innovation in the past years to encourage men under age 35 to pay more for underwear (Mintel, 2003). For example, the hardcore hip-hop segment of the underwear market urges young men to purchase underwear brands at higher price points. The idea behind purchasing brands such as Tommy Hilfiger, Calvin Klein and Gianni Versace is that the noticeable logos worn advertise a hip-hoppers personal financial status. This is done by underwear being worn so that the logo is noticeable above the waist of the baggy, blue jeans (Brantley, 1999).

Overall, men's underwear is a profitable sector to be tapped. In 1999, the USA men's & boys' underwear market grew by 1.0%, to reach a value of \$608 million. The compound annual growth rate of the market in the period of 1995-1999

was 0.7%. The strongest growth was in 1998, when the market grew by 1.2%. However, the largest fall in the market came in 1996, when the market shrank by 0.3%. For the year 2005, market forecast expect the US men's & boys underwear market to reach \$648.4 million, which will be an increase of 5.6% since 2000. In addition, the expected compounded annual growth rate of this sector over the period of 2000-2005 is predicted to be 1.1% (Quick & Baldwin, 2001).

2.5.3 Fit Related to Underwear

Satisfactory fit of underwear is important to the male consumer. Whether the consumer is an athlete or a professional who is seated all day, designing intimate apparel that will provide comfort makes a difference. Based on past research, Ahrens's (2000) found that the perception of fit could also occur when garment dimensions are changed at other areas of the body. This is an important finding in relationship to designing more satisfactory fitted underwear for men. For example, a shorter crotch length can give the wearer the perception that the waistband is tighter as well. By changing one dimension of the garment, manufacturers can achieve an acceptable fit when multiple changes are identified by consumer responses. A tighter crotch in effect can meet a subject's requirement for a tighter waist. As cited by Ahrens, Ashdown & DeLong, (1995), also found that the majority of fit preference adjustments can be made by varying only crotch and waist measurements according to a predetermined set of grading rules. (Ahrens, 2000)

In addition, Ahrens (2000) found that casual shorts provide an excellent test garment for fit preference and self-measurement reliability and validity. The

relationship between crotch length and waist measurements can be measured in relative isolation from other body dimensions. Ahrens cited that in the case of DeLong, et al. (1993) variations in seat dimensions may also impact perception of fit and satisfaction for consumers. In addition, thigh measurements of male test subjects may impact perception of fit and satisfaction.

Since garment fit characteristics have historically remained in the hands of apparel designers, pattern makers, and graders, consumers have had little or no input in the determination of comfort ease, styling ease, or pattern grading rules or manufactured clothing. Fit preference responses can give manufacturers the ability to optimize size selection or pattern changes for individual consumers and improve overall ordering satisfaction (Ahrens, 2000).

The results of this present examination will be useful for manufacturers in determining accurate size designations for retail customers. In addition, an understanding of fit issues encountered by male consumers pertaining to underwear will be determined.

III. METHODOLOGY

This study was designed to examine the sizing and fit satisfaction issues associated with men's underwear as influenced by age and ethnicity. The research methodology is discussed in the following order: 1) research design, including objectives and hypotheses, 2) data collection and survey design and 3) technique selection and development.

3.1 Research Design

3.1.1 Objectives & Hypotheses

As mentioned earlier, the research objectives for this study were:

1. To determine the difference, if any, in body measurements of males in the U.S. based on age and ethnicity.
2. To determine if body measurements of males in U.S. are satisfied by the ASTM Size Standards.
3. To create "Proposed" size classifications by altering the ASTM Size Standards to provide a more satisfactory fit to male consumers.
4. To determine if males in the U.S. are satisfied with the fit of their undergarments.

This research was designed to test the following null hypotheses:

1. There are no differences in body measurements of males in U.S. based on age.

2. There are no differences in body measurements of males in U.S. based on ethnicity.
3. There are not a significant number of U.S. males that do not meet ASTM Standards.
4. Males in the U.S. are not dissatisfied with the fit of undergarments.

3.2 Data Collection

The data for this research originated from two sources: the Size USA National Size Study and an administered online fit survey. Both sources were useful in meeting the above objectives. The specifics of the data used for this research are explained in detail below.

3.2.1 Size USA

The Size USA National Study (2003) collected body measurement data from 3691 U.S. males. The study collected measurements from subjects of four ethnic groups; Non-Hispanic White, Non-Hispanic Black, Hispanic or Mexican American, and Other (Native American and Asian subjects included) and six age groups; 1:18-25, 2:26-35, 3:36-45, 4:46-55, 5:56-65 6:66+. This survey used anthropometry to determine 3-D measurements taken from more than 20,000 points on the body. Table 3.1 and 3.2 gives the total number of male subjects in the Size USA Study based on ethnicity and age group.

Table 3.1: Size USA Subjects by Ethnicity

| Ethnicity | Total | Percentage |
|------------------|--------------|-------------------|
| Blacks | 709 | 19% |
| Others | 597 | 16% |
| Hispanics | 639 | 17% |
| Whites | 1746 | 47% |

Table 3.2: Size USA Subjects by Age Group

| Age Group | Total | Percentage |
|------------------|--------------|-------------------|
| 1: 18-25 | 995 | 27% |
| 2: 26-35 | 788 | 21% |
| 3: 36-45 | 838 | 23% |
| 4: 46-55 | 626 | 17% |
| 5: 55-65 | 282 | 8% |
| 6: 66+ | 162 | 4% |

The Size USA data included the ASTM measurements for male subjects as described in ASTM D 6240-98, Standard Tables of Body Measurements for Men Size Thirty-Four to Sixty (34 to 60) Regular (Appendix 1-A). This research utilized the ASTM body measurements from all four ethnic groups and six age groups that are used for producing men’s underpants and undershirts. The key measurement points chosen for analysis are described below, additional explanation is found in the definition of terms:

Underpants

- *Waist* - Measure horizontally around the body at waist height, with subject breathing normally and the abdomen relaxed. (See Figure 1.1 & 1.3)
- *Seat (hip)* - Measure horizontally around the body at hip height. (See Figures 1.1 & 1.3)
- *Thigh girth* - Measure the maximum circumference of the upper part of the leg close to or near the crotch. (See Figure 1.3).

- *Total crotch length* - Measure the distance from waist level at the center front through the crotch and to the waist level at the center back. (See Figure 1.8)

Undershirts:

- *Neck base girth* - Measure the circumference at base of the neck. (See Figure 1.2)
- *Chest* - Measure the circumference of the body parallel to the floor, under the arms, and over the fullest part of the chest. (See Figure 1.4)
- *Armhole circumference* - With arm hanging down, measure the distance from the shoulder joint through the front break point, the armpit, the back break point, and to the starting point. (Figure 1.3)
- *Across shoulder* - Measure across the back from one shoulder joint to the other shoulder joint. (Figure 1.5)

3.3 Survey Design

The other method of data collection used was an online survey used to assess U.S. males fit satisfaction or dissatisfaction with underwear. A sample survey is found in Appendix A. The “self-administered” survey consisted of 52 items, which were divided into four areas of interest to determine the following: demographics, background information (brands, size, etc), individualized perception of fit, and satisfaction and dissatisfaction with key locations on underwear.

Information regarding background and demographics was determined through multiple choice questions that allowed both single and multiple responses. For questions regarding fit perception, a 5-point Likert scale anchored at one end

with “tight” and the other end “loose” was used to record responses. This survey approach is validated by LaBat and Delong’s (1990) research which also used a 5-point Likert scale to record responses that assessed subjects’ satisfaction/dissatisfaction with clothing at 19 body sites. The Likert scale used in LaBat and Delong’s research recorded responses from always satisfied to never satisfied.

In addition, questions regarding fit satisfaction/dissatisfaction with underwear at specific body sites were recorded through multiple choice questions. As reported by LaBat (1987), subjects differ in levels of fit satisfaction at different areas of the body. Therefore, questions that specifically assessed fit satisfaction/dissatisfaction in key areas of men’s underwear were useful in this study.

3.3.1 Men’s Fit Survey

A goal of 200 survey responses was set. Responses from the survey were obtained through a series of forwarded emails. The survey aimed to obtain responses from U.S males between ages 18-65. The survey was not limited to any specific region of the U.S. in order to obtain data from respondents of diverse demographics. In addition, the survey aimed to obtain respondents from various ethnic groups as represented in the 2000 US Census for the 18-65 year old male population. The survey attempted to obtain the following demographics:

- 70 percent White (at least 140)
- 11.5 percent Black (at least 23)
- 12.5 percent Hispanic (at least 25)

- 4.5 percent Asian (at least 9)
- 1.5 percent Other-Native American, Biracial (at least 3)

A pilot online survey was first conducted and resulted in 127 responses. The responses from the pilot survey helped to create more effective final survey questions. For example, more detailed answer options were created for greater accuracy in describing respondents purchase behavior. In addition, responses from the pilot survey regarding styles of underwear worn helped determine that only the most prevalent types of underpants (briefs, boxers, boxer briefs, and bikinis) and undershirts (crew neck, v neck, and tanks) were relevant for analysis in this study.

3.4 Technique Selection and Development

3.4.1 Body Measurements: Age and Ethnicity

Based on the four key measurements for underpants and four key measurements for undershirts from the Size USA Study, multivariate analysis of variance (MANOVA) tests were performed using SAS. MANOVA was used to determine the effect of ethnicity, age, and interaction on the dependent measurement variables. MANOVA was specifically used because, like ANOVA, it allows one or more categorical independents as predictors. However, MANOVA allows more than one dependent variable (underwear measurements) to be analyzed at one time. The MANOVA tests were performed for underpants and undershirts measurement variables, independently. The following hypotheses were tested: no overall ethnicity effect, no overall age group effect and no overall

ethnicity/age group interaction effect. These hypotheses were tested at an alpha level of .05, which corresponds to a 95% confidence level.

Based on significant main effects from the MANOVA tests, at a 95% confidence level, univariate analysis of variance (ANOVA) tests and Tukey LS Means comparison tests were both performed in JMP. ANOVA tests determined whether or not ethnicity and age group were useful in predicting underwear measurements. ANOVA tests for underpants and undershirts were conducted separately. For each of the measurement variables for underpants (waist, crotch length, hip, and thigh) and undershirts (neck base, chest, and armscye, across shoulder), the following hypotheses were tested: no overall ethnicity effect, no overall age group effect and no overall ethnicity/age group interaction effect. These analyses were tested at a .05 alpha level which corresponds to a 95% significance level. These ANOVA tests were useful in determining which measurement variables are affected by ethnicity and age group.

Following the ANOVA tests for each measurement variable, Tukey LS Means comparison tests were conducted. ANOVA Tukey tests were performed rather than multiple t-tests to reduce the probability of Type I error that is usually attributed to conducting multiple comparisons. LS Means comparison tests were performed only on main effects (ethnicity and age group) that were found to be significant in predicting the measurements variables and in cases where interaction was not significant. Tukey was tested at a .05 alpha level, which corresponds to a 95% significance level. This comparison test determined which ethnic groups and age

groups had significantly different LS Means for each of the underpants measurement variables.

3.4.2 Body Measurements versus ASTM Sizing

To determine the number of subjects from the Size USA study which were accommodated by the size classes outlined by the ASTM Standard (small- 2x-large), a series of IF/THEN statements were performed in SAS. The measurement specifications used for producing underpants and undershirts are found in Table 3.3 and Table 3.4. The complete listing of the ASTM D 6240-98, Standard Tables of Body Measurements for Men Size Thirty-Four to Sixty (34 to 60) Regular, are found in Appendix B.

As seen in Tables 3.3 and 3.4, there are four sublevels within each ASTM size class. The four sublevels within each ASTM size class correspond an actual dimension. For example, as seen in Table 3.4, the four sublevels under size small: 28, 29, 30, and 31, correspond to the waist measurements which assume the predominant role in underpants sizing. To create IF/THEN statements based on sizes class specifications, the fours sublevels were combined resulting into a single range of specifications for each size class. Therefore, sublevels 28, 29, 30, and 31 were combined into the single class, size small. This was done for both underpants and undershirts specifications.

The IF/THEN statements conducted used the ASTM specifications for size classes small -to- 2x large as end points to determine the number of subjects that met sizes based on the standard. These statements were run separately for

underpants and undershirt variables. The results of the IF/THEN statements were sorted in SAS to determine the number of subjects that met the criteria for size small-2xlarge for each ethnic group and age group.

After the ASTM Standards were compared to the subject's measurements, further comparison was done with two variable (bivariate) plots in JMP. In these plots Size USA subject's measurements were compared with ASTM size classes. Bivariate plots were created using vertical and horizontal reference lines to visually depict the upper and lower bounds of the five size classes and the subjects that were and were not satisfied by them. Measurement variables for underpants were plotted against one another, likewise for undershirt variables.

Table 3.3: ASTM Standard Measurements for Underpants

| Measurements (inches) | Size | | | | | | | | | | | |
|----------------------------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|-------|-------|
| | Small | | | | Medium | | | | Large | | | |
| | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 |
| Waist | 28.00 | 29.00 | 30.00 | 31.00 | 32.00 | 33.00 | 34.00 | 35.00 | 36.00 | 37.00 | 38.00 | 39.25 |
| Hips | 34.00 | 35.00 | 36.00 | 37.00 | 38.00 | 39.00 | 40.00 | 41.00 | 42.00 | 43.00 | 44.00 | 45.00 |
| Thigh | 20.75 | 21.37 | 22.00 | 22.63 | 23.25 | 23.87 | 24.50 | 25.13 | 25.75 | 26.37 | 27.00 | 27.63 |
| Total Crotch Length | 24.50 | 25.13 | 25.75 | 26.37 | 27.00 | 27.50 | 28.00 | 28.50 | 29.00 | 29.50 | 30.00 | 30.50 |

| Measurements (inches) | Size | | | | | | | |
|----------------------------|---------|-------|-------|-------|-------|-------|-------|-------|
| | X Large | | | | 2XL | | | |
| | 40.50 | 41.75 | 43 | 44.25 | 45.50 | 46.75 | 48 | 49.50 |
| Waist | 40.50 | 41.75 | 43.00 | 44.25 | 45.50 | 46.75 | 48.00 | 49.50 |
| Hips | 46.00 | 47.00 | 48.00 | 49.00 | 50.00 | 51.00 | 52.00 | 53.00 |
| Thigh | 28.25 | 28.87 | 29.50 | 30.13 | 30.75 | 31.37 | 32.00 | 32.63 |
| Total Crotch Length | 31.00 | 31.50 | 32.00 | 32.50 | 33.00 | 33.50 | 34.01 | 34.50 |

***Note:** Complete ASTM D 6240-98, Standard Tables of Body Measurements for Men Size Thirty-Four to Sixty (34 to 60) Regular found in Appendix

Table 3.4: ASTM Standard Measurements for Undershirts

| Measurements (inches) | Size | | | | | | | | | | | |
|--------------------------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|-------|-------|
| | Small | | | | Medium | | | | Large | | | |
| | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 |
| Neck base | 14.00 | 14.25 | 14.50 | 14.75 | 15.00 | 15.25 | 15.50 | 15.75 | 16.00 | 16.25 | 16.50 | 16.75 |
| Chest | 34.00 | 35.00 | 36.00 | 37.00 | 38.00 | 39.00 | 40.00 | 41.00 | 42.00 | 43.00 | 44.00 | 45.00 |
| Armscye | 16.37 | 16.75 | 17.00 | 17.37 | 17.75 | 18.13 | 18.50 | 18.87 | 19.25 | 19.63 | 20.00 | 20.37 |
| Across Shoulder | 16.50 | 16.63 | 16.75 | 16.87 | 17.00 | 17.25 | 17.50 | 17.75 | 18.00 | 18.25 | 18.50 | 18.75 |

| Measurements (inches) | Size | | | | | | | |
|--------------------------|--------|-------|-------|-------|-------|-------|-------|-------|
| | Xlarge | | | | 2XL | | | |
| | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 |
| Neck base | 17.00 | 17.25 | 17.50 | 17.75 | 18.00 | 18.25 | 18.50 | 18.75 |
| Chest | 46.00 | 47.00 | 48.00 | 49.00 | 50.00 | 51.00 | 52.00 | 53.00 |
| Armscye | 20.75 | 21.13 | 21.50 | 20.81 | 21.13 | 21.44 | 21.75 | 22.06 |
| Across Shoulder | 19.00 | 19.25 | 19.50 | 19.75 | 20.00 | 20.25 | 20.50 | 20.69 |

***Note:** Complete ASTM D 6240-98, Standard Tables of Body Measurements for Men Size Thirty-Four to Sixty (34 to 60) Regular found in Appendix

3.4.3 “Proposed” Size Classifications

The results from the IF/THEN statements and plots of the subjects’ measurements applied to ASTM size classes were used to determine “Proposed” size classifications. From the inspection of bivariate plots, it was determined how the original ASTM Standards needed to be altered in order to satisfy a more significant portion of the subjects. The “Proposed” classes aimed to allow more subjects to meet a size class by increasing and/or shifting specification ranges. These specification changes were done separately for underpants and undershirts measurements.

The “Proposed’ classes created sublevels within each size class in order to minimize variability. Sublevels for underpants and undershirts were created independently. For example, as seen in Table 3.4, the ASTM neck base measurement specifications for size small was 14-14.75 inches. After analysis of the results from IF/THEN statements and bivariate plots, the neck base specification for size small may need to be broadened to 13-15.50 inches in order to satisfy more subjects. Therefore, in order to lessen variability within the size small specification, 2 sublevels may be created. As a result, sublevel 1 may include neck base measurements: 13-14.25 inches while sublevel 2 includes neck base measurements 14.25-15.50 inches.

After the ASTM measurement specifications were altered as needed, IF/THEN statements were again run in SAS to determine the effect of the “Proposed” size classifications on the total number of subjects by ethnicity and age

group to meet a size class (small –2x- large). Bivariate Plots in JMP were again produced with “Proposed” specifications.

3.4.4 Men’s Underwear Survey Analysis

The survey resulted in 210 responses; however, only 205 were analyzed. Five responses were discarded because subjects did not respond to questions regarding age group and/or ethnic group. As mentioned earlier, a sample of the online survey is included in Appendix A. The survey questions were analyzed based on 4 question categories in the survey: demographics, background information, individualized perception of fit, and fit satisfaction/dissatisfaction.

A summary of the respondents’ answers was determined by percentages. The number of respondents that answered questions differed because not all men surveyed wore all styles of underpants and undershirts that were inquired of in the survey. Questions regarding dissatisfaction were further analyzed by determining if demographics, background information (size, style, use of sizing charts, etc), and perception of fit responses had an effect on dissatisfaction. Fit dissatisfaction was determined when respondents were dissatisfied with at least 1 location on their underpants and undershirts. The survey responses were then compared to the results of the Size USA data and ASTM Standards analyses.

IV. RESULTS & DISCUSSION

This section provides the results, explanations, and discussion for the four objectives of the research. Statistical analysis of the Size USA Study and the Men's Underwear Fit Survey are discussed in detail.

4.1 Body Measurements: Age and Ethnicity

One objective of this research was to determine the difference, if any, in body measurements of males in the U.S. based on age and ethnicity. A series of hypotheses tests were run to complete this objective.

4.1.1 Size USA Study

The sample used in this portion of the research was based on four underpants and four undershirt measurements for a sample of 3,691 US males. The two independent variables in this study were age and ethnicity. Age was further categorized into six groups, while ethnicity was categorized into four groups, respectively. The groupings for age were as follows: **1:** 18-25, **2:** 26-35, **3:** 36-45, **4:** 46-55, **5:** 56-65 and **6:** 66+. The groupings for ethnicity were as follows: Black, White, Hispanic, and Other. The Size USA study, included people of Asian origin in the "Other" ethnic group.

4.1.1.1 Underpants

For the analysis of underpants measurements, four independent measurement variables from the Size USA data were used, namely waist, crotch length, hip, and thigh. These measurements were recorded in inches. A multivariate analysis of

variance (MANOVA) test determined whether or not measurements needed for designing men's underpants vary in respect to ethnicity, age and ethnicity*age (interaction). Follow up ANOVA tests were performed to determine differences, if any, between groups.

4.1.1.1.1 Overall Ethnicity Effect

The hypothesis and alternative hypothesis tested were:

H1a₀: *There are no differences in body measurements for underpants between ethnic groups.*

H1a₁: *There are differences in body measurements for underpants between ethnic groups.*

The results of the hypothesis test for no overall ethnicity effect are tabulated in Table 4.1.

Table 4.1: MANOVA test criteria and F approximations for the hypothesis of no overall ethnicity effect (H1a₀)

| Statistic | Value | F Value | Num DF | Den DF | Pr > F |
|---------------|------------|---------|--------|--------|--------|
| Wilks' Lambda | 0.92561471 | 23.95 | 12 | 9694.3 | <.0001 |

This MANOVA test resulted in a p-value of <.0001 which is significant at $\alpha = .05$. Thus, H1a₀ was rejected and H1a₁ was accepted. It was concluded that a significant difference in body measurements existed among the four ethnic groups. Therefore, body measurements used for producing underpants differ by ethnicity.

The results of this MANOVA test substantiate studies found in the literature which suggest that people of diverse ethnic groups vary in body proportions. For example, Laska-Mierzejewska's (1970) study, cited by Giddings and Boles (1990)

found that Black youths had shorter trunks, longer lower and upper extremities, wider shoulders, and narrower pelvises and hips than White youths. Although this study evaluated youth, similar relationships are expected to exist between Black and White adults. In addition, Hu's (1984) study found with 99.99% confidence that, White women's proportions were significantly different from those of Asian women on 32 variables related to height, surface, and circumference measurements. However, no significant difference between White and Asian subjects existed for head, neck and hand circumferences measurements. Although Hu's (1984) study compared body proportions of women, it is believed that a comparable relationship regarding body measurements will exist between White and Asian men. Further support is found in Ranieri's (1985) study which analyzed the anthropometric measurements of new recruits in order to improve the garment and pattern design of Navy uniforms. This study was conducted because the Navy recognized that new recruits of diverse ethnicities had varying body proportions.

4.1.1.1.2 Overall Age Group Effect

The hypothesis and alternative hypothesis tested were:

H2a₀: *There are no differences in body measurements for underpants between age groups.*

H2a₁: *There are differences in body measurements for underpants between age groups.*

The results of the hypothesis test for no overall age group effect are tabulated in Table 4.2.

Table 4.2: MANOVA test criteria and F approximations for the hypothesis of no overall age group effect (H_{2a_0})

| Statistic | Value | F Value | Num DF | Den DF | Pr > F |
|---------------|------------|---------|--------|--------|--------|
| Wilks' Lambda | 0.68681911 | 72.88 | 20 | 12153 | <.0001 |

This MANOVA test resulted in a p-value of <.0001 which is significant at $\alpha = .05$. Thus, H_{2a_0} was rejected and H_{2a_1} was accepted. It was concluded that a significant difference in body measurements existed among the six age groups. Therefore, body measurements for producing underpants differ by age group.

The results of this MANOVA test are also substantiated by the literature. Renfrow (1996) cited that older women were found to experience body changes which often include a forward head and neck angle, forward shoulder roll, back curvature, increase in girth and decreased height. The age effect on body proportions is further validated by Goldsberry and Reich's (1996) research found the effects of aging to include a thickening waist, lower bustline, or a broadening back shoulder (Renfrow, 1996). Although, the literature that supports the age effect on body proportions are based on studies regarding women, it is believed that age influences male's body proportions similarly.

4.1.1.1.3 Overall Ethnicity*Age Group Effect

The hypothesis and alternative hypothesis tested were:

H_{3a_0} : *There is no interaction between ethnicity and age group.*

H_{3a_1} : *There is interaction between ethnicity and age group.*

The results for the hypothesis testing for interaction between age and ethnicity effect are tabulated in Table 4.3.

Table 4.3: MANOVA test criteria and F approximations for the hypothesis of no overall ethnicity*age group effect ($H3a_0$)

| Statistic | Value | F Value | Num DF | Den DF | Pr > F |
|---------------|------------|---------|--------|--------|--------|
| Wilks' Lambda | 0.97380385 | 1.63 | 60 | 14305 | 0.0016 |

The MANOVA test for interaction resulted in a p-value of .0016 which is significant at $\alpha = .05$. Therefore, $H3a_0$ was rejected and $H3a_1$ was accepted. It was concluded that interaction among age group and ethnicity was significant. The presence of interaction suggested that the impact of ethnic group on a subject's body measurements depended on the subject's age group or that the impact of age group on a subjects body measurements depended on the subject's ethnic group.

4.1.1.1.4 Underpants Variables

The results of the previous MANOVA tests determined that there were significant differences in the body measurements among ethnic groups and age groups. This section provides the results from univariate ANOVA tests which were conducted to determine between which ethnic and age groups the differences in measurements occur. Following the ANOVA tests, Tukey LS Means comparison of differences tests for significant main effects were observed even in cases where interaction was marginally significant. In some cases ANOVA results detected significant differences between ethnic groups and age groups when differences in measurements were small. These significant results may be partially due to differences in sample size and standard deviation between ethnic groups or age groups.

4.1.1.1.4.1 Waist Measurements

As described in the ASTM Standards, waist measurements are taken at the location between the lowest rib and hip identified by bending the body to the side (See Figure 1.1) (ASTM D 5219-02). Table 4.4 is the ANOVA output for testing the significance of main effects as well as interaction for waist measurements. At a significance level of .05, the p-values for both ethnicity and age group were <.0001. Therefore, independently ethnicity and age group were useful in determining waist measurements. The interaction effect however, was not found to be significant.

Table 4.4: Waist Measurements Effects Test

| Source | Nparm | DF | Sum of Squares | F Ratio | Prob > F |
|---------------------------|-------|----|----------------|---------|----------|
| Ethnicity | 3 | 3 | 1092.8158 | 15.6031 | <.0001 |
| Agegroup | 5 | 5 | 6506.9665 | 55.7433 | <.0001 |
| Ethnicity*Agegroup | 15 | 15 | 486.6550 | 1.3897 | 0.1426 |

Figure 4.1 is a plot of the LS Means waist measurement by ethnicity. The results of the Tukey LS Means comparison of ethnic groups are given in Table 4.5. In Figure 4.1 the plot of LS means values based by ethnicity showed slight variations in measurements. The results from Table 4.5, suggested that there was no significant difference in waist measurements of White, Hispanic, and Black subjects. This appears to be reasonable since there was less than a 1 inch difference between the LS means values for the three ethnic groups. The waist measurements for the “Other” ethnic group were, however, found to be significantly lower than the measurements for the White, Hispanic, and Black ethnic groups.

As found in the MANOVA test which determined a significant ethnicity effect, in addition to the literature reviewed for this study, body proportions are expected to vary by ethnicity. Although White and Black subjects’ measurements are not

significantly different, as seen in Table 4.5, a slight difference exists in their waist measurements. As mentioned previously in the literature, Giddings and Boles' (1990) study which compared the fit of commercially produced dress pants on men found that Black males needed their dress pants altered by making the waist measurements smaller. The results from LS Means comparison of waist measurements supports the findings made by Giddings and Boles' (1990) research which report that Black males have smaller waist measurements than White males.

Also the inclusion of Asians in the "Other" group may have had a considerable effect on measurements for that group. As found in the literature, a study by Hu (1984) provided evidence that Asian women's body proportions are significantly smaller than White women's proportions. The only measurements that were not significantly different were head, neck, wrist, and hand circumferences. Similar differences seem likely to hold true for Asian and White men. Therefore, the significantly low measurements from the "Other" group may be due to the smaller body proportions of Asian men.

Figure 4.1: Ethnicity LS Means Plot-Waist

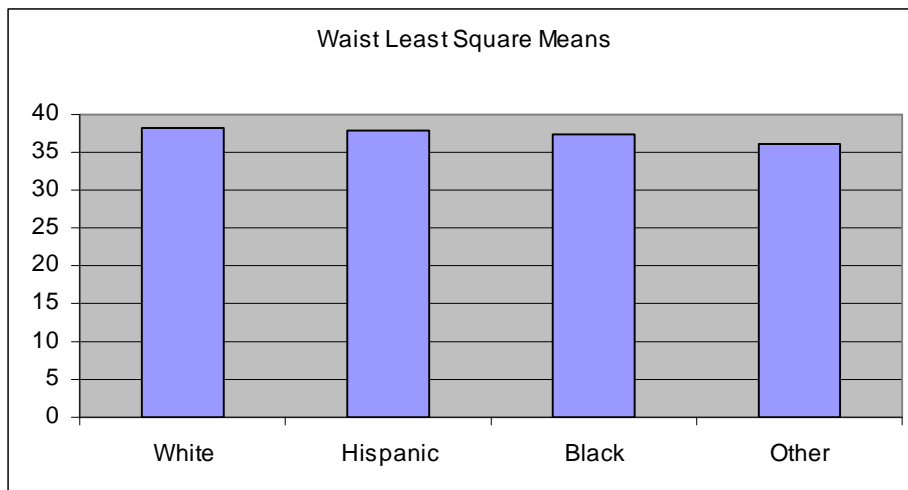


Table 4.5: Tukey Ethnicity Differences- Waist

Alpha= 0.050

| Level | | | Least Sq Mean |
|----------|---|---|---------------|
| White | A | | 38.07 |
| Hispanic | A | | 37.77 |
| Black | A | | 37.26 |
| Other | | B | 36.15 |

Note: Levels not connected by same letter are significantly different

Figure 4.2 is a plot of the LS Means differences in waist measurement by age group. As seen in Figure 4.2, there appeared to be an increasing relationship between waist measurements and age group. It was concluded that as age increases waist measurement also increases. Table 4.6 is the results of a Tukey test which compares LS Means differences by age group. Based on Table 4.6, the following was determined regarding differences in waist measurements based on age group: there was no significant difference between age groups 4, 5 and 6; there was no significant difference between age groups 3, 4, 6; and there was no significant difference between age groups 2 and 3.

As cited previously, there is an increasing relationship between LS Means waist measurements and age group. Therefore, waist size tends to increase with age. This finding is supported by Goldsberry and Reich's study, which found that one of the effects of aging include a thickening waist. In addition, findings made by Renfrow (1996) suggest that older women experience body changes that include an increase in girth measurements. Although these findings were related to older women, the same may hold true for older men.

Figure 4.2: Age group LS Means Plot-Waist

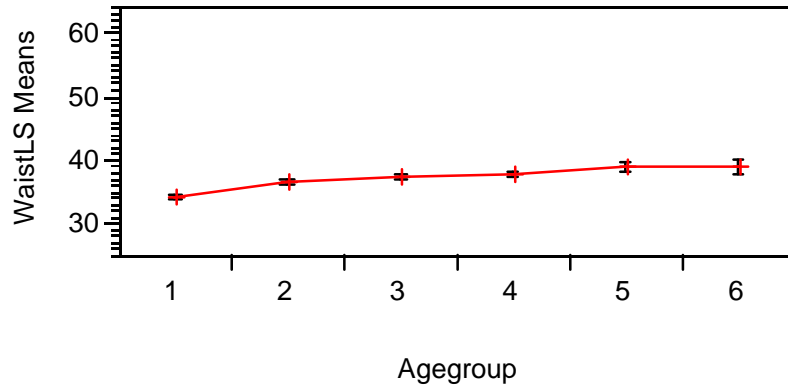


Table 4.6: Tukey Age Group Differences-Waist

Alpha= 0.050

| Level | | | | | Least Sq Mean |
|-------|---|---|---|---|---------------|
| 6 | A | B | | | 38.92 |
| 5 | A | | | | 38.85 |
| 4 | A | B | | | 37.82 |
| 3 | | B | C | | 37.31 |
| 2 | | | C | | 36.69 |
| 1 | | | | D | 34.27 |

Note: Levels not connected by same letter are significantly different

4.1.1.1.4.2 Crotch Length Measurements

Crotch length measurements as defined by ASTM Standards, is the distance from the waist level at the center front through the crotch and to the waist level at the center back (See Figure1.8) (ASTM D 5219-02). Table 4.7 is the ANOVA output for testing the significance of main effects as well as interaction for crotch length measurements. Based on the ANOVA results in Table 4.7, at a significance level of .05, the effect of ethnicity was significant with a p-value of <.0001. Age group, however, with a p value of .2902, was found to be not significant in predicting crotch length. In addition the interaction effect was not significant for crotch length

measurements with a p-value of .1261. These results suggest that the variability in crotch length measurements is explained by ethnicity.

Table 4.7: Crotch Length Measurements Effects Test

| Source | Nparm | DF | Sum of Squares | F Ratio | Prob > F |
|---------------------------|-------|----|----------------|---------|----------|
| Ethnicity | 3 | 3 | 1192.2528 | 29.9129 | <.0001 |
| Agegroup | 5 | 5 | 81.9809 | 1.2341 | 0.2902 |
| Ethnicity*Agegroup | 15 | 15 | 283.9151 | 1.4247 | 0.1261 |

Figure 4.3 is the LS Means for crotch length measurements plotted by ethnicity. It is seen that that Blacks have the longest crotch length measurements. Based on the Tukey LS Means comparison test for crotch length in Table 4.9, the following relationships were found: Blacks were significantly different from all other ethnic groups; Whites were significantly different from all other ethnic groups; and there was no significant difference in crotch measurements between Hispanics and “Others”.

Although there was no literature found that pertained specifically to crotch length measurements, research cited in the literature and previous statistical tests conducted in this study have shown that body proportions vary by ethnicity. Evidence of this relationship is found in Ranieri’s (1985) analysis of anthropometric measurements for new recruits belonging to different ethnic groups. The Navy initiated this study because they perceived a difference in the body proportions of new recruits.

The percentage of Asians found in “Other” group is unknown. However, it is believed that the presence of Asian subjects influenced the crotch length

measurements of the “Other” group. As mentioned previously, Hu’s (1984) study found that White women’s body proportions were significantly larger than Asian women. Considering that a comparable relationship exists between Asian men’s body proportions and White men’s, the results of the LS Means comparison test for crotch length may be supported by Hu’s study.

Figure 4.3: Ethnicity LS Means Plot-Crotch Length

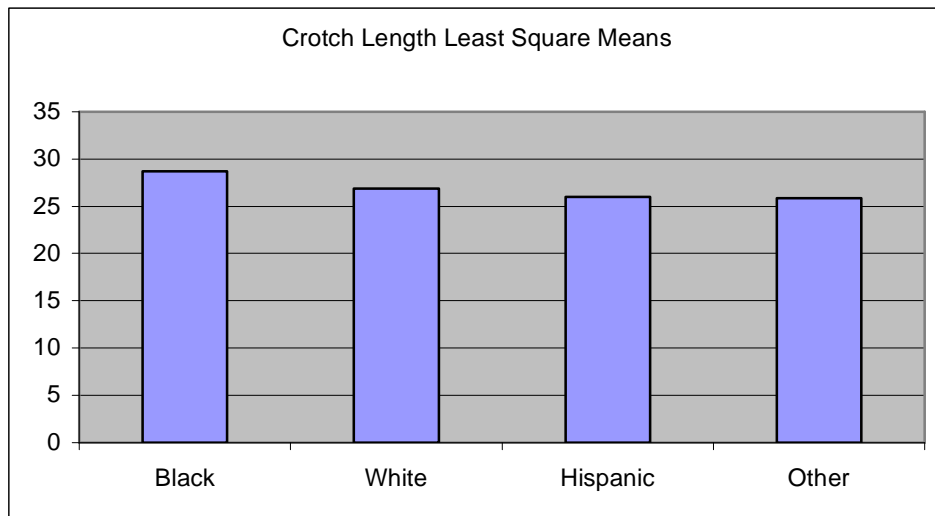


Table 4.8: Tukey Ethnicity Differences-Crotch Length

Alpha= 0.050

| Level | | | | Least Sq Mean |
|----------|---|---|---|---------------|
| Black | A | | | 28.71 |
| White | | B | | 26.86 |
| Hispanic | | | C | 26.02 |
| Other | | | C | 25.84 |

Note: Levels not connected by same letter are significantly different

4.1.1.1.4.3 Hip Measurements

The hip girth measurement is taken at the maximum horizontal circumference around the body at hip height (Figure 1.3) (ASTM D 5219-02). Table 4.9 is the ANOVA output for testing the significance of main effects as well as interaction for

hip measurements. Based on the output from the effects test in Table 4.9, at a significance level of .05, ethnicity and age effects were significant with a p-value <.0001. However, the interaction effect was not significant for hip measurements. These results suggested that independently, ethnicity and age group were both useful in determining hip measurements.

Table 4.9: Hip Measurements Effects Test

| Source | Nparm | DF | Sum of Squares | F Ratio | Prob > F |
|---------------------------|-------|----|----------------|---------|----------|
| Ethnicity | 3 | 3 | 925.6085 | 19.3807 | <.0001 |
| Agegroup | 5 | 5 | 711.2324 | 8.9352 | <.0001 |
| Ethnicity*Agegroup | 15 | 15 | 370.6443 | 1.5521 | 0.079 |

Figure 4.4 is the plot of the LS Means of hip measurements by ethnicity. Based on Table 4.10, which shows the Tukey comparison of LS Means, the following was found in regards to hip measurements based on ethnicity: since the LS mean values for Whites and Blacks were very close, there was no significant difference between these two ethnic groups. There was also no significant difference between Blacks and Hispanics. However, there was a significant difference between the Whites and Hispanics. The “Other” ethnic group was found to be significantly different from Blacks, Whites and Hispanics.

The results for the hip measurements analysis support previous findings and earlier research, which suggests that ethnic group effects body proportion. As seen in Table 4.10, Blacks have slightly (though not significantly) smaller hip measurements than Whites. This finding is supported by Laska-Mierzejewska’s (1970) study which found that Black youths had shorter trunks, longer lower and upper extremities, wider shoulders, and narrower pelvises and hips than White

youths (Giddings & Boles, 1990). Although the findings of this study were based on youth, it is expected that a similar relationship will exist for Black and White men. In addition, the significantly smaller hip measurements for the “Other” group may be due to Asian subjects, which were found in Hu’s (1984) study to have significantly smaller body proportions than White subjects. Despite the fact that Hu’s study compared women, it is likely that the same relationship exist for Asian and White men.

Figure 4.4: Ethnicity LS Means Plot-Hips

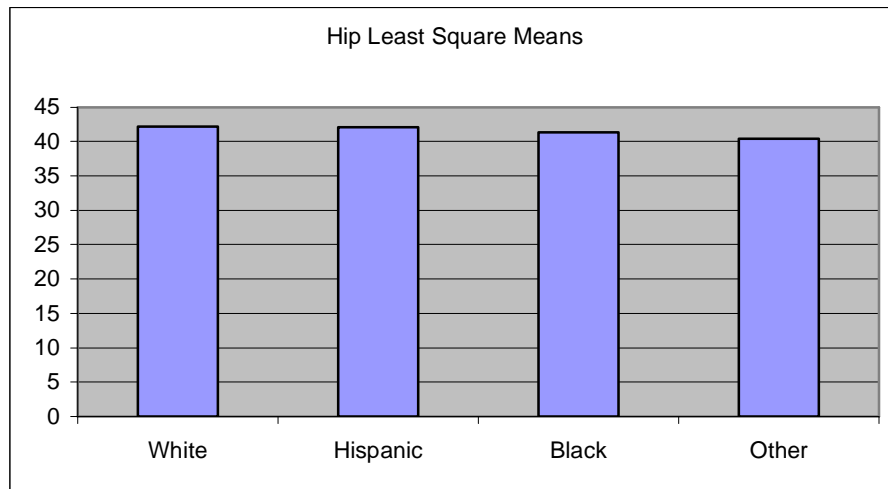


Table 4.10: Tukey Ethnicity Differences-Hips

Alpha= 0.050

| Level | | | | Least Sq Mean |
|----------|---|---|---|---------------|
| White | A | | | 42.14 |
| Black | A | B | | 42.12 |
| Hispanic | | B | | 41.37 |
| Other | | | C | 40.40 |

Note: Levels not connected by same letter are significantly different

Figure 4.5 is a plot of the LS Means of hip measurements by age group. The output of the Tukey LS Means comparison test for hip measurements by age group is given in Table 4.11. Based on Table 4.11, the following relationships were found:

there was no significant difference among age groups 2-6 and there was no significant difference between age groups 1 and 6, however, age group 1 was significantly different from age groups 2-5. The reason that age group 6 is not significantly different from age groups 2-5. The reason that age group 6 is not significantly different from age group 1 may be due to the fact that age group 6 has a small sample size (n= 162). This result provides evidence to findings made by Renfrow (1996), which suggest that older women experience body changes that include an increase in girth. Although this finding was related to older women, the relationship is expected to hold true for older men.

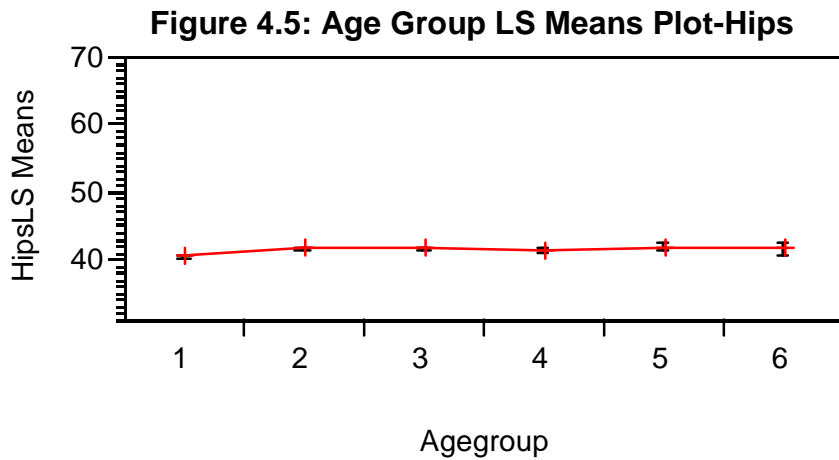


Table 4.11: Tukey Age Group Differences-Hips

Alpha= 0.050

| Level | | | Least Sq Mean |
|-------|---|---|---------------|
| 5 | A | | 41.87 |
| 6 | A | B | 41.76 |
| 3 | A | | 41.69 |
| 2 | A | | 41.65 |
| 4 | A | | 41.51 |
| 1 | | B | 40.56 |

Note: Levels not connected by same letter are significantly different

4.1.1.1.4.4 Thigh Measurements

As described by ASTM, thigh girth is measured at the maximum horizontal circumference of the upper leg, taken close to the crotch (See Figure 1.3) (ASTM D 5219-02). Table 4.12 is the ANOVA output for testing the significance of main effects as well as interaction for thigh measurements. At a significance level of .05, the independent variables, ethnicity and age group were both significant with p-values of <.0001. In addition, with a p-value of .0421, the interaction effect was also significant for thigh measurements. Due to interaction being present, it was found that the impact of ethnicity on thigh measurements depended on the age group and likewise, the impact of age group on thigh measurements depended on ethnicity.

Table 4.12: Thigh Measurements Effects Test

| Source | Nparm | DF | Sum of Squares | F Ratio | Prob > F |
|---------------------------|-------|----|----------------|---------|----------|
| Ethnicity | 3 | 3 | 389.59363 | 24.5360 | <.0001 |
| Agegroup | 5 | 5 | 489.31628 | 18.4898 | <.0001 |
| Ethnicity*Agegroup | 15 | 15 | 135.87364 | 1.7114 | 0.0421 |

Figure 4.6 is a plot of LS Means for thigh measurements by ethnic group. The output of the Tukey multiple comparison test is given in Table 4.13. Table 4.13 resulted in the following relationships: Blacks were significantly larger than all ethnic groups; Whites were significantly different from other ethnic groups; and there was no significant difference between Hispanics and “Other’s”. Hispanics and “Others” were significantly difference from other ethnic groups because their thigh measurements values were considerably lower that of Blacks and Whites.

The results of thigh measurement analysis gave further evidence that ethnic groups have varying body proportions. The results found in Table 4.13 conclude

that Black subjects have significantly larger thigh measurements than other ethnic groups. These results are supported by Giddings and Boles' (1990) research, which found that Black males experienced fit problems with commercially produced dress pants. The study found that not only did Black males have smaller waists, but also larger thighs than White males. The considerably different body proportions of Black males resulted in alterations done in the thighs area of their dress pants in order to allow comfortable fit. In addition, the "Other" group was expected to have significantly lower measurements due to previous findings regarding the measurements of the "Other" group with Asian subjects included. However, no findings in the literature suggested that thigh measurements for Hispanics and Asians were similar as found in this study.

Figure 4.6: Ethnicity LS Means Plot-Thighs

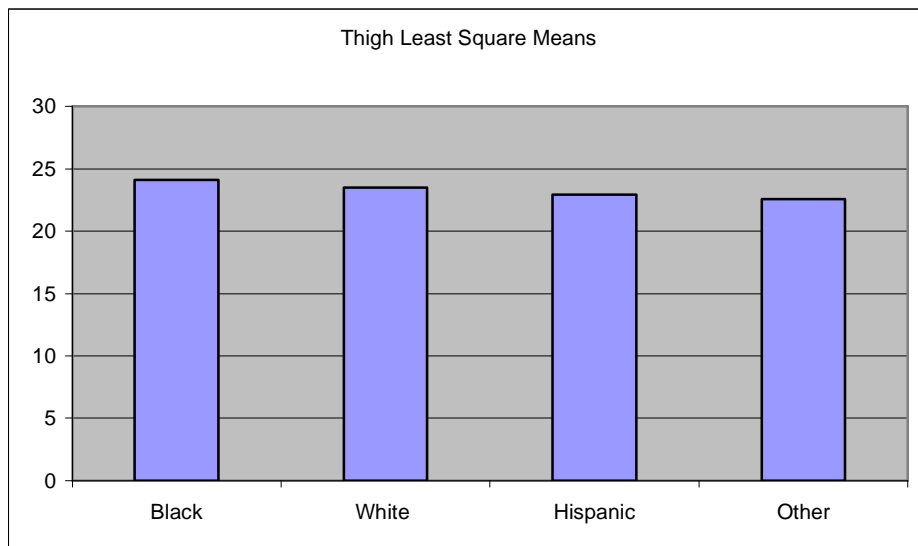


Table 4.13: Tukey Ethnicity Differences-Thighs

Alpha= 0.050

| Level | | | | Least Sq Mean |
|----------|---|---|---|------------------|
| Black | A | | | 24.09 |
| White | | B | | 23.47 |
| Hispanic | | | C | 22.93 |
| Other | | | C | 22.56 |

Note: Levels not connected by same letter are significantly different

Figure 4.7 plots the least square means of thigh measurements by age group. Based on the LS Means values, a Tukey multiple comparison test determined the differences, which are given in Table 4.14. In Figure 4.7, there appeared to be a decreasing relationship between thigh measurements by age group. In Table 4.14, no significant difference existed among the following age groups: 2 and 3; 1 and 3; 4 and 5; and 5 and 6. In turn, the following differences were found: age group 2 was significantly different from age groups 1, 4-6; age group 3 was significantly different from age groups 4-6, age group 1 was significantly different from age groups 2 and 4-6; age group 4 was significantly different from age groups 1-3 and 6; age group 5 was significantly different from age groups 1-3 and age group 6 was significantly different from age groups 1-4.

The multiple differences between age groups may be due not only to the slight fluctuations in LS Means, but also due to the relationship between age group and standard deviation. Based on Table 4.15 as age group increased the standard deviation decreased. Although there were no major differences among LS means values, the differences in standard deviations may have influenced the relationships that existed between age groups.

As seen in Figure 4.5, there is roughly a decreasing relationship between thigh measurements and age group. This result is not supported by previous research, which found that girth measurements increase with age (Renfrow, 1996). As mentioned earlier, although Renfrow’s (1996) findings were regarding women, it was expected that a similar relationship between girth measurements and age would exist with men. However, it is likely the relationship found in this research between thigh measurements and age of Size USA male subjects is a common trend that has not been previously studied.

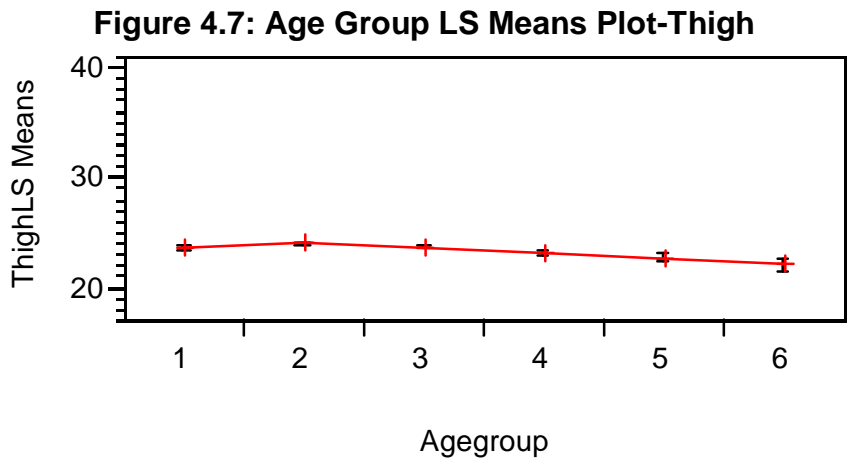


Table 4.14: Tukey Age Group Differences-Thigh

Alpha= 0.050

| Level | | | | Least Sq Mean |
|-------|---|---|---|---------------|
| 2 | A | | | 24.06 |
| 3 | A | B | | 23.72 |
| 1 | | B | | 23.68 |
| 4 | | | C | 23.14 |
| 5 | | | C | 22.79 |
| 6 | | | D | 22.17 |

Note: Levels not connected by same letter are significantly different

Table 4.15: Standard Deviation by Age Group-Thighs

| Age group | Standard Deviation |
|-----------|--------------------|
| 1 | 2.52 |
| 2 | 2.47 |
| 3 | 2.32 |
| 4 | 2.22 |
| 5 | 1.95 |
| 6 | 1.78 |

4.1.1.2 Undershirts

For the analysis of undershirt measurements four independent measurement variables from the Size USA data were selected. The variables were neck base, chest, armscye, and across shoulder all recorded in inches. A multivariate analysis of variance (MANOVA) was performed which determined whether or not measurements needed for designing men's undershirts vary in respect to ethnicity, age and the interaction of ethnicity and age. A series of follow up ANOVA tests were performed to further determine differences, if any, between groups.

4.1.1.2.1 Overall Ethnicity Effect

The hypothesis and alternative hypothesis tested were:

H4a₀: *There are no differences in body measurements for undershirts between ethnic groups.*

H4a₁: *There are differences in body measurements for undershirts between ethnic groups..*

The results of the hypothesis test for no overall ethnicity effect are tabulated in Table 4.16.

Table 4.16: MANOVA test criteria and F approximations for the hypothesis of no overall ethnicity effect (H4a₀)

| <i>Statistic</i> | <i>Value</i> | <i>F Value</i> | <i>Num DF</i> | <i>Den DF</i> | <i>Pr > F</i> |
|----------------------|--------------|----------------|---------------|---------------|------------------|
| Wilks' Lambda | 0.97238220 | 17.25 | 12 | 19452 | <.0001 |

In Table 4.16, this MANOVA test resulted in a p-value of <.0001 which is significant at $\alpha = .05$. Thus, H4a₀ was rejected and H4a₁ was accepted. Therefore, it was concluded that there was a significant difference in undershirt measurements among the four ethnic groups. Therefore, undershirt measurements differ among the Blacks, Hispanics, Others, and Hispanics. This is as expected. As discussed earlier, studies by Laska-Mierzejewska's (1970), Hu (1984), and Ranieri (1985) all concluded that there are significant differences in body measurements for different ethnic groups.

4.1.1.2.2 Overall Age Group Effect

The hypothesis and alternative hypothesis tested were:

H5a₀: *There are no differences in body measurements for undershirts between age group.*

H5a₁: *There are differences in body measurements for undershirts between age group.*

The results of the hypothesis test for no overall age group effect are tabulated in Table 4.17.

Table 4.17: MANOVA test criteria and F approximations for the hypothesis of no overall age effect (H5a₀)

| <i>Statistic</i> | <i>Value</i> | <i>F Value</i> | <i>Num DF</i> | <i>Den DF</i> | <i>Pr > F</i> |
|----------------------|--------------|----------------|---------------|---------------|------------------|
| Wilks' Lambda | 0.96625788 | 12.68 | 20 | 24385 | <.0001 |

The above MANOVA test resulted in a p-value of $<.0001$ which is significant at $\alpha = .05$. Thus, $H5a_0$ was rejected and $H5a_1$ accepted. It was concluded that there were significant differences in body measurements among the six age groups. Therefore, men's undershirt measurements are expected to differ in regards to age group.

As found in the underpants MANOVA test for age group effect and studies previously mentioned, age is likely to influence body proportions. Support for this relationship was cited by Renfrow (1996) who found that older women's bodies change, resulting in a forward head and neck angle, forward shoulder roll, back curvature, increase in girth and decreased height. In addition, according to Goldsberry and Reich, the effects of aging include a thickening waist, lower bustline, or a broadening back shoulder, which validate the age effect on body proportions (Renfrow, 1996). As stated earlier, although these findings pertained to women, similar results are expected to result for the male population.

4.1.1.2.3 Overall Ethnicity* Age Group Effect

The hypothesis and alternative hypothesis being tested are:

H6a₀: *There is no significant interaction between ethnicity and age group for undershirts.*

H6a₁: *There is significant interaction between ethnicity and age group for undershirts*

The results for the hypothesis test for interaction between age and ethnicity are tabulated in Table 4.18.

Table 4.18: MANOVA test criteria and F approximations for the hypothesis of no overall ethnicity*age effect ($H6a_0$)

| Statistic | Value | F Value | Num DF | Den DF | Pr > F |
|---------------|------------|---------|--------|--------|--------|
| Wilks' Lambda | 0.98856203 | 1.41 | 60 | 28701 | 0.0197 |

This MANOVA test resulted in a p-value of $<.0197$ for the Wilks' Lambda test statistic which was significant at $\alpha = .05$. Therefore, $H6a_0$ was rejected and $H6a_1$ was accepted. Thus, it was concluded that interaction among age group and ethnicity was significant. The presence of interaction suggested that the impact of ethnic group on a subjects undershirt measurements depended on the subjects' age group. The inverse was also true in that, the impact of age group on a subjects' undershirt measurements depended on the subjects' ethnic group. Given that the interaction was significant in addition to main effects (ethnicity and age); main effects were believed to account for a large portion of the variation in the subject's undershirt measurements.

4.1.1.2.4 Undershirt Variables

The results of the MANOVA tests determined that there were significant differences by ethnic group and age group in the body measurements used in producing undershirts. In addition, main effects were found to account for a large portion of the variability in the undershirt measurement variables, although interaction was also significant. Due to the results of the MANOVA tests, follow-up ANOVA tests were conducted to determine between which ethnic and age groups the differences in measurements occur. Tukey LS Means comparisons were also conducted based on significant main effects from ANOVA. Again, in some cases ANOVA results detected significant differences between ethnic groups and age groups when

differences in measurements were small. These significant results may be partially due to differences in sample size and standard deviation between ethnic groups or age groups.

4.1.1.2.4.1 Neck Base Measurements

Neck base girth is described by ASTM as measurement taken at the circumference of the neck, over the cervicale at the back and the top of the collarbone at the front (See Figure 1.3) (ASTM D 5219-02). Statistical results for the effect of age and ethnicity on neck base measurements are seen in Table 4.19. At a significance level of .05, ANOVA test results showed that both independent variables, ethnicity and age group were significant with p-values <.0001. In addition, the interaction effect was significant for neck base measurements.

Table 4.19: Neck Base Measurements Effects Test

| Source | Nparm | DF | Sum of Squares | F Ratio | Prob > F |
|---------------------------|-------|----|----------------|---------|----------|
| Ethnicity | 3 | 3 | 67.73574 | 15.1823 | <.0001 |
| Agegroup | 5 | 5 | 215.84696 | 29.0280 | <.0001 |
| Ethnicity*Agegroup | 15 | 15 | 39.38604 | 1.7656 | 0.0337 |

In Figure 4.8, there appeared to be slight variations in LS Means for neck base measurements based on ethnicity. From Table 4.20 it was found that there was no significant difference between Hispanics, Whites, and Blacks. However, the “Other” group was significantly different from all other ethnic groups. This significant difference was believed to be attributed not only slightly lower LS mean for neck base measurements but also due to the smaller average standard deviation (Table 4.21) for the “Other” ethnic group measurements.

The results of the LS Means comparison test in Table 4.20, gave further evidence that ethnic groups have varying body proportions. There was no literature that provided evidence that the neck base measurements for Hispanics, Whites, and Blacks are not significantly different. Again, the “Other” group had considerably smaller measurements than Hispanic, Black, and White ethnic groups. This trend was not supported by Hu’s (1984) study which compared Asian and White women’s body proportions and did not find that Asians have significantly lower neck measurement than Whites at the 99% confidence level. These opposing results may be due to the location of where neck measurements were taken. In Hu’s study, neck measurements may have not been taken at the base of the neck as described by ASTM, resulting in differing results. Also it is probable that one or more ethnicities in the “Other” group, that were not Asian, had small neck base measurements causing a significant difference to exist.

Figure 4.8: Ethnicity LS Means Plot-Neck Base

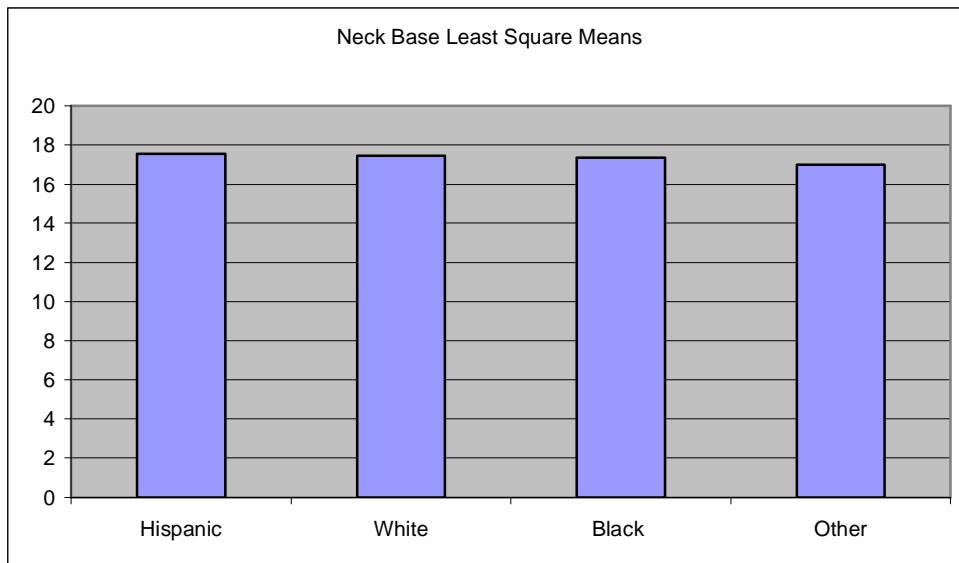


Table 4.20: Tukey Ethnicity Differences-Neck Base

Alpha= 0.050

| Level | | | Least Sq Mean |
|----------|---|---|---------------|
| Hispanic | A | | 17.56 |
| White | A | | 17.44 |
| Black | A | | 17.36 |
| Other | | B | 16.98 |

Note: Levels not connected by same letter are significantly different

Table 4.21: Standard Deviation by Ethnicity-Neck Base

| Ethnicity | Black | Hispanic | Other | White |
|--------------------|-------|----------|-------|-------|
| Standard Deviation | 1.30 | 1.34 | 1.15 | 1.24 |

In Figure 4.9 and Table 4.22 it can be seen that neck base measurements for age group 1 was significantly different from all other age groups. Age groups 2-5 measurements were not significantly different. No other differences existed between age groups. These results provided evidence that the neck measurements of subjects in age group 1: 18-25 were significantly smaller than older subjects.

There appears to be roughly an increasing relationship between age and neck base measurements. In Table 4.22, it is seen that age group 1 had significantly lower measurements than older age groups with age groups 5 and 6 having the largest measurements. As cited earlier, Renfrow (1996) suggested that body changes for older women include a forward head and neck angle and increase in girth. The forward neck angle may result in a wider neck base measurements, which would provide explanation to the increase in neck base with age as found in the results of this research. As previously stated, although this prediction is based on the findings from studies regarding women, the same results are expected to hold true for men.

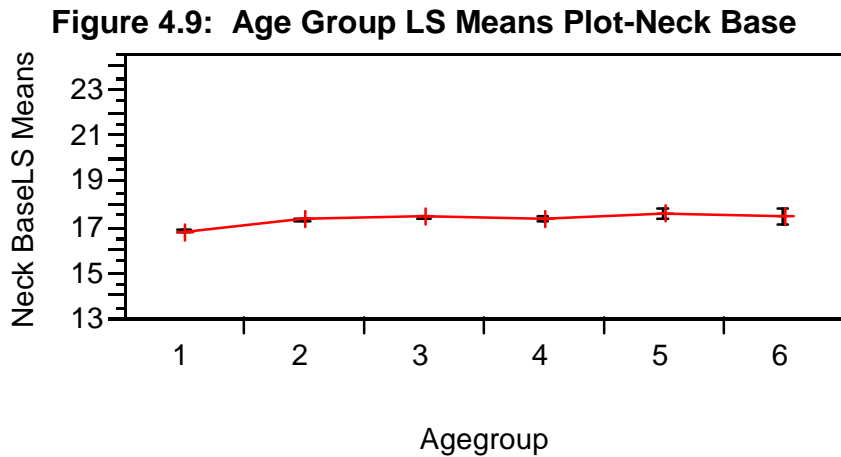


Table 4.22: Tukey Age Group Differences-Neck Base
Alpha= 0.050

| Level | | | Least Sq Mean |
|-------|---|---|---------------|
| 5 | A | | 17.59 |
| 6 | A | | 17.49 |
| 3 | A | | 17.43 |
| 4 | A | | 17.40 |
| 2 | A | | 17.31 |
| 1 | | B | 16.80 |

Note: Levels not connected by same letter are significantly different

4.1.1.2.2.2 Chest Measurements

As defined by ASTM, chest girth is the horizontal circumference around the body, taken under the arms and across the fullest part of the chest, including the lower portion of the shoulder blades (See Figure 1.4) (ASTM D 5219-02). Statistical results for the effect of age and ethnicity on neck base measurements are seen in Table 4.23. At a significance level of .05, ANOVA results showed that both independent variables, ethnicity and age group were significant with p-values of <.0001. In addition, the interaction effect was significant for neck base measurements but not as strong as main effects.

Table 4.23: Chest Measurements Effects Test

| Source | Nparm | DF | Sum of Squares | F Ratio | Prob > F |
|---------------------------|-------|----|----------------|---------|----------|
| Ethnicity | 3 | 3 | 1318.7067 | 26.6396 | <.0001 |
| Agegroup | 5 | 5 | 3266.1018 | 39.5877 | <.0001 |
| Ethnicity*Agegroup | 15 | 15 | 480.9405 | 1.9431 | 0.0157 |

Based on Figure 4.10 and Table 4.24, it was found that chest measurements of the “Other” group were significantly smaller than White, Hispanic, and Black ethnic groups. There was no significant difference in chest measurements between White, Hispanic, and Black ethnic groups.

The results from the effects tests for chest measurements support the fact that ethnic groups normally have varying body proportions. However, the literature did not cite specific ethnic differences for chest measurements. In Table 4.24, it can be observed that LS Means values are considerably different for ethnic groups. However, the most obvious difference is seen with the “Other” ethnic group, which has substantially lower measurements than Black, Hispanic, and White ethnic groups. Hu’s (1984) study found that Asians had significantly smaller body proportions; this supports the statistical results for chest measurements found in this study. As stated previously, although Hu’s study was based on women, similar results are likely to be seen for Asian and White males.

Figure 4.10 Ethnicity LS Means Plot-Chest

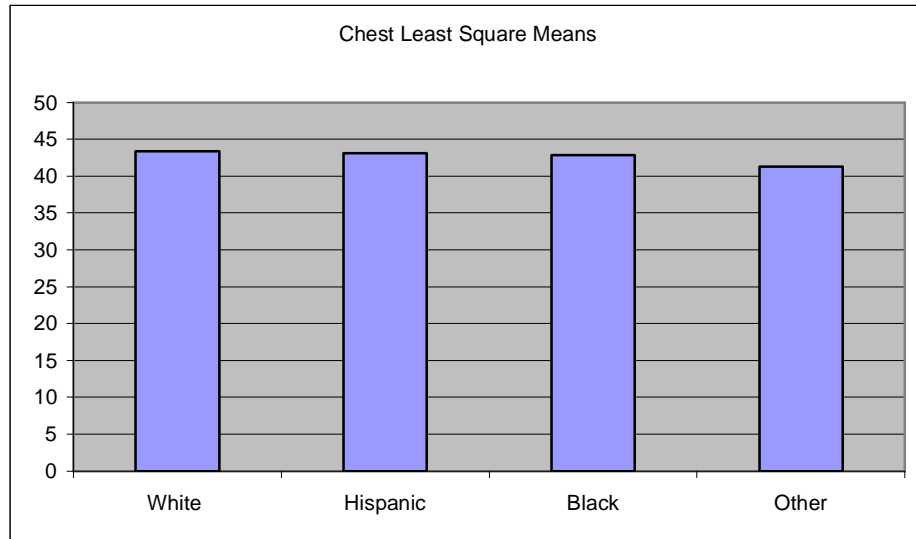


Table 4.24: Tukey Ethnicity Differences-Chest

Alpha= 0.050

| Level | | Least Sq Mean |
|----------|---|---------------|
| White | A | 43.39 |
| Hispanic | A | 43.13 |
| Black | A | 42.86 |
| Other | B | 41.25 |

Note: Levels not connected by same letter are significantly different

Based on Figure 4.11 and Table 4.25, there appears to be an increasing relationship between chest measurements and age group, except in respect to age group 6. It was found that for chest measurements, age group 1 was significantly different from age groups 2-6. In turn, there was no significant difference among age groups 2-6. Therefore, chest measurements for age group 1 were smaller than older age groups. As cited earlier, Renfrow (1996) suggested that body changes for older women include an increase in girth. However, the decrease in chest measurements as seen in age group 6 may be an age effect not previously studied. It is possible that chest girth measurements for the 65 and older population decrease with age.

Figure 4.11 Age Group LS Means Plot-Chest

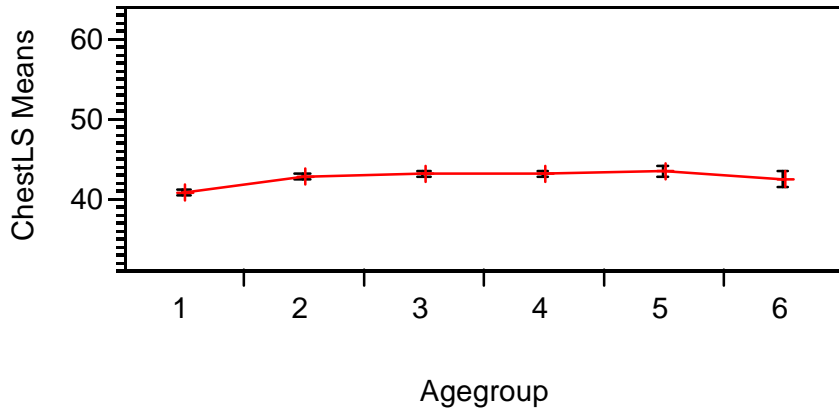


Table 4.25: Tukey Age Group Differences-Chest

Alpha= 0.050

| Level | | | Least Sq Mean |
|-------|---|---|---------------|
| 5 | A | | 43.45 |
| 4 | A | | 43.25 |
| 3 | A | | 43.22 |
| 2 | A | | 42.72 |
| 6 | A | | 42.53 |
| 1 | | B | 40.75 |

Note: Levels not connected by same letter are significantly different

4.1.1.2.4.3 Armscye Measurements

The armscye measurement, as described in the definition of terms, is the circumference taken from the shoulder joint through the front break-point, the armpit, the back break-point and the starting point, taken with the arms down (See figure 1.3) (ASTM D 5219-02). Statistical results for the effect of age and ethnicity on armscye measurements are seen in Table 4.26. Based on Table 4.26, at a significance level of .05, the independent variables, ethnicity and age group were significant with p-values of <.0001. In addition, the interaction effect was significant for armscye measurement.

Table 4.26: Armscye Measurements Effect Test

| Source | Nparm | DF | Sum of Squares | F Ratio | Prob > F |
|---------------------------|-------|----|----------------|---------|----------|
| Ethnicity | 3 | 3 | 279.47675 | 36.8927 | <.0001 |
| Agegroup | 5 | 5 | 313.94435 | 24.8656 | <.0001 |
| Ethnicity*Agegroup | 15 | 15 | 91.96295 | 2.4279 | 0.0016 |

In Figure 4.12, there were slight variations in LS Means for armscye measurements by ethnicity. Based on Table 4.27, the following was found in regards to LS means armscye measurements regarding ethnic groups: Whites were significantly different from all other ethnicities; Blacks were not significantly different from Hispanics, but both Hispanics and Blacks were significantly different from Whites and “Others”.

It can be observed that armscye LS Means values are considerably different between ethnicities, however, the most obvious difference is seen with the “Other” ethnic group, which again has substantially lower measurements than Black, Hispanic, and White ethnic groups. The results of the statistical test for armscye measurements substantiate studies in the literature which suggest that ethnic groups have varying body proportions. Specifically, these findings are supported by Hu’s (1984) study which found that White women’s body proportions were significantly larger than Asian women except for head, neck, wrist, and hand. Although, these differences were determined for women, it is probable that comparable results would exist for men. However, there was no literature found that either supported or refuted this data which shows that Blacks and Hispanics have similar armscye measurements.

Figure 4.12 Ethnicity LS Means Plot-Armscye

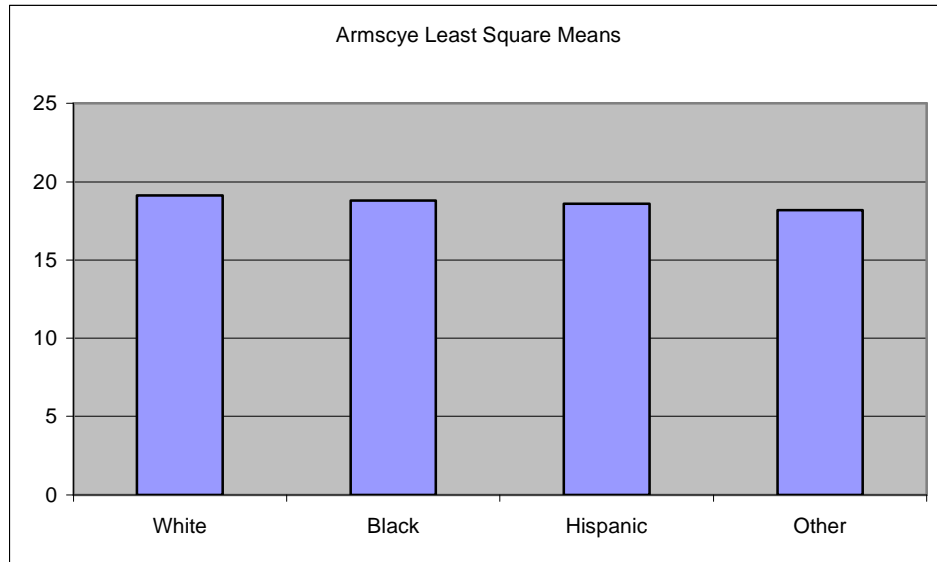


Table 4.27: Tukey Ethnicity Differences-Armscye

Alpha= 0.050

| Level | | | Least Sq Mean |
|----------|---|---|---------------|
| White | A | | 19.12 |
| Black | | B | 18.78 |
| Hispanic | | B | 18.57 |
| Other | | C | 18.18 |

Note: Levels not connected by same letter are significantly different

Based on Table 4.28, the following differences in armscye measurements in regards to age groups were found: there was no significant difference among age groups 4, 5 and 6 and there was no significant difference among age groups 2, 3, 4, and 6. In addition the following was determined: age group 1 was significantly different from all other age groups; age group 2 was significantly different from age groups 1 and 5; age group 3 was significantly different from age groups 1 and 5; age group 4 was significantly different from age group 1; age group 5 was significantly different from age groups 1 and 3; and age group 6 was significantly different from age group 1.

Based on Figure 4.13 and Table 4.28, it appears that as age increases armscye measurements also increases, except in the case of age group 6. The decrease in measurements in age group 6 may be due to the effect of aging for the 65 and older population. It is known that older adults experience body changes, thus armscye girth measurements may likely decrease after a certain age. There is no literature, however, that supports the trend found in this study regarding armscye measurements for the 65 and older population.

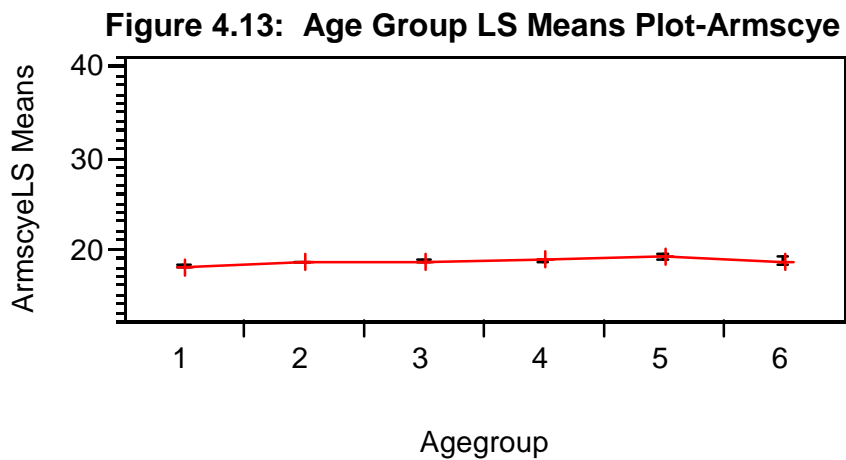


Table 4.28: Age Group Tukey Differences-Armscye

Alpha= 0.050

| Level | | | | Least Sq Mean |
|-------|---|---|---|---------------|
| 5 | A | | | 19.20 |
| 4 | A | B | | 18.78 |
| 3 | | B | | 18.71 |
| 6 | A | B | | 18.68 |
| 2 | | B | | 18.56 |
| 1 | | | C | 18.04 |

Note: Levels not connected by same letter are significantly different

4.1.1.2.4.4 Across Shoulder Measurements

Across shoulder measurements as described by ASTM, are taken at the horizontal distance across the back from the top of one shoulder joint to the top of the other shoulder joint, taken with arms down (See Figure 1.5) (ASTM D 5219-02). The statistical results for the effect of age and ethnicity on across shoulder measurements are seen in Table 4.29. The ANOVA output for across shoulder measurements detailed in Table 4.29 showed that at a significance level of .05, the independent variables, ethnicity and age group were significant with a p-values of <.0001. In addition, the interaction effect was significant for across shoulder measurement.

Table 4.29: Across Shoulder Measurements Effect Tests

| Source | Nparm | DF | Sum of Squares | F Ratio | Prob > F |
|---------------------------|-------|----|----------------|---------|----------|
| Ethnicity | 3 | 3 | 145.42448 | 28.8573 | <.0001 |
| Agegroup | 5 | 5 | 215.96961 | 25.7135 | <.0001 |
| Ethnicity*Agegroup | 15 | 15 | 45.53835 | 1.8073 | 0.0283 |

Based on Figure 4.14 and Table 4.30, across shoulder measurements for ethnicity was lower for the “Other” ethnic group. As a result, the following was determined in regards to the across shoulder differences among ethnic groups: the “Other” group was significantly different than all other ethnic groups and there was no significant difference among Whites, Blacks, and Hispanics.

The statistical results for across shoulder for ethnicity further substantiated the fact that body proportions vary by ethnic group. Again, it is seen that the “Other” group has significantly lower measurements from the other ethnic groups. It is known that the “Other” group includes measurements for Asian subjects, and it is

likely that the significantly smaller across shoulder measurements may have been attributed to the Asian subjects. This belief is due to the finding of Hu's (1984) study which found that White women had 32 significantly larger measurements than Asian women. As mentioned earlier, although this study was done specifically for women, it is expected that similar differences will be found between Asian and White men.

Figure 4.14 Ethnicity LS Means Plot- Across Shoulder

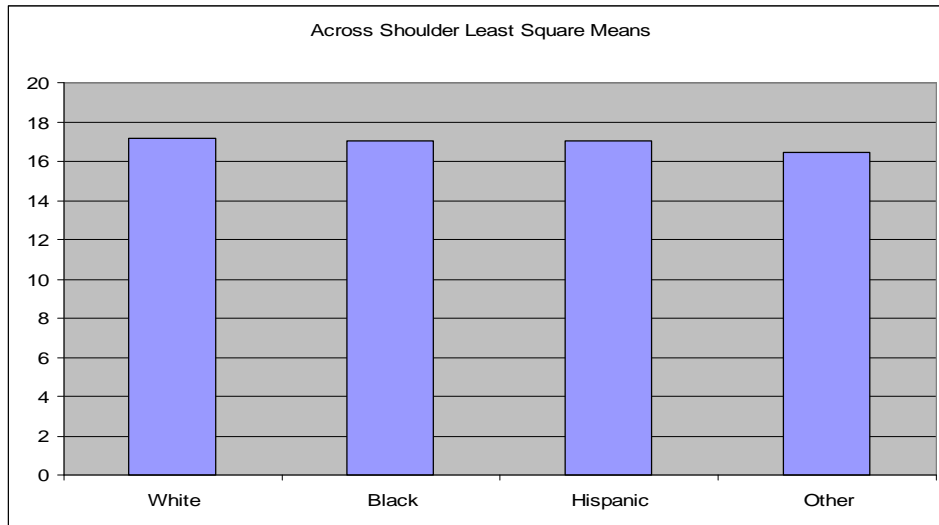


Table 4.30: Tukey Ethnicity Differences -Across Shoulder

Alpha= 0.050

| Level | | Least Sq Mean |
|----------|---|---------------|
| White | A | 17.19 |
| Black | A | 17.07 |
| Hispanic | A | 17.05 |
| Other | B | 16.47 |

Note: Levels not connected by same letter are significantly different

Based on Figure 4.15 and Table 4.31, age groups 1 and 6 have lower shoulder measurements than the other age groups. Overall it was found that in regards to shoulder measurements, there was no significant difference between age groups 2-6 and there was no significant difference between age groups 1 and 6. However, age groups 2-5 were significantly different from age group 1. The substantially lower LS mean for age group 1 caused a significant difference to exist

in relation to the other age groups. However, age group 6's LS Means value was fairly close to that of age group 1, which caused no significant difference to be found between the two age groups.

Based on Figure 4.15 and Table 4.31, age group 6 has smaller measurements than age groups 2-5; this result may have been due to the effect of aging on men 65 and older. There is no literature that specifically supports the trend found in this study regarding across shoulder measurements for the older population. However, Renfrow (1996) cited that the effect of aging for women include a forward shoulder roll and back curvature. A forward shoulder roll and back curvature may have influenced measurements of age group 6. Although these age effects were determined for women, it is expected that men will experience comparable effects in aging.

Figure 4.15 Age Group LS Means Plot-Across Shoulder

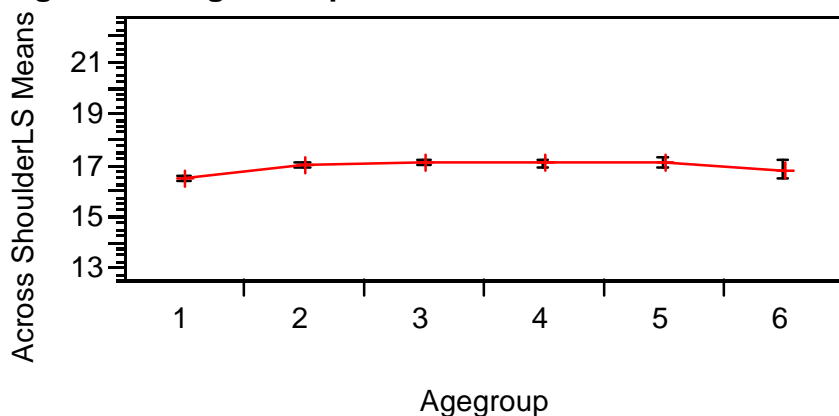


Table 4.31: Tukey Age Group Differences-Across Shoulder

Alpha= 0.050

| Level | | | Least Sq Mean |
|-------|---|---|---------------|
| 3 | A | | 17.14 |
| 5 | A | | 17.10 |
| 4 | A | | 17.06 |
| 2 | A | | 17.04 |
| 6 | A | B | 16.84 |
| 1 | | B | 16.48 |

Note: Levels not connected by same letter are significantly different

4.2 Body Measurements versus ASTM Sizing

The second objective of this research was to determine the difference, if any, between body measurements of males in the U.S and the ASTM Standards. ASTM Standards are intended to assist manufacturers in the development of patterns and garments that are said to be consistent with the anthropometric characteristics of the population of interest. These standards are believed to reduce or minimize consumer confusion and dissatisfaction related to apparel sizing. ASTM D 6240 Standards were last approved in 1998 (ASTM D 6240-98).

This objective was completed by conducting IF/THEN statements in SAS to determine the number of subjects that fell in and outside of ASTM size classes (small to 2x-large). As seen in Table 4.33, there are four sublevels within each ASTM size class. As mentioned earlier, the four sublevels within each ASTM size class correspond to the actual dimension that assumes the predominate role (See section 3.x). To create IF/THEN statements based on size specifications, the four sublevels were combined resulting in a single range of specifications for each size class. Therefore, sublevels 28, 29, 30, and 31 were combined into the single class, size small. This was done for both underpants and undershirts

In addition, bivariate plots in JMP were produced by creating horizontal and vertical reference lines for the upper and lower bounds of the specification ranges for the ASTM size classes. Subjects measurements were distributed on two measurement variables at a time. Therefore, each measurement variable is plotted against other underpants measurement variables, likewise for undershirt measurement variables.

4.2.1 Underpants

Table 4.32 provides simple statistics such as the overall mean, standard deviation, minimum and maximum values for each of the variables (waist, crotch length, hip, and thigh) used in determining sizing for men’s underpants. These statistics include measurements for all ethnic groups and age groups. Table 4.34 outlines the four sublevels for each size class and their specifications as defined by ASTM Standards.

Table 4.32: Size USA Simple Statistics for Underpants Variables

| Variable | N | Mean | Std Dev | Sum | Minimum | Maximum |
|-----------------|----------|-------------|----------------|------------|----------------|----------------|
| Waist | 3691 | 36.85981 | 5.14567 | 136050 | 25.58040 | 63.77610 |
| CrotchL | 3691 | 26.84073 | 3.74529 | 99069 | 19.57250 | 48.00180 |
| HHip | 3691 | 41.55231 | 4.07761 | 153370 | 31.72280 | 69.16810 |
| Thigh | 3691 | 23.61841 | 2.38630 | 87176 | 17.27740 | 40.64020 |

Table 4.33: ASTM Standard Measurements for Underpants

| Measurements (inches) | Size | | | | | | | | | | | |
|----------------------------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|-------|-------|
| | Small | | | | Medium | | | | Large | | | |
| | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39.25 |
| Waist | 28.00 | 29.00 | 30.00 | 31.00 | 32.00 | 33.00 | 34.00 | 35.00 | 36.00 | 37.00 | 38.00 | 39.25 |
| Hips | 34.00 | 35.00 | 36.00 | 37.00 | 38.00 | 39.00 | 40.00 | 41.00 | 42.00 | 43.00 | 44.00 | 45.00 |
| Thigh | 20.75 | 21.37 | 22.00 | 22.63 | 23.25 | 23.87 | 24.50 | 25.13 | 25.75 | 26.37 | 27.00 | 27.63 |
| Total Crotch Length | 24.50 | 25.13 | 25.75 | 26.37 | 27.00 | 27.50 | 28.00 | 28.50 | 29.00 | 29.50 | 30.00 | 30.50 |

| Measurements (inches) | Size | | | | | | | |
|----------------------------|---------|-------|-------|-------|-------|-------|-------|-------|
| | X Large | | | | 2XL | | | |
| | 40.50 | 41.75 | 43 | 44.25 | 45.50 | 46.75 | 48 | 48.50 |
| Waist | 40.50 | 41.75 | 43.00 | 44.25 | 45.50 | 46.75 | 48.00 | 49.50 |
| Hips | 46.00 | 47.00 | 48.00 | 49.00 | 50.00 | 51.00 | 52.00 | 53.00 |
| Thigh | 28.25 | 28.87 | 29.50 | 30.13 | 30.75 | 31.37 | 32.00 | 32.63 |
| Total Crotch Length | 31.00 | 31.50 | 32.00 | 32.50 | 33.00 | 33.50 | 34.01 | 34.50 |

***Note:** Entire listing for ASTM Standard Measurements, size 34-60, found in Appendix

4.2.1.1 ASTM Analysis

In comparing the mean values in Table 4.32 to the corresponding ASTM size class in Table 4.33, it was found that the average underpants measurements corresponded to more than one size category. The average waist measurement of 36.86 and hip size of 41.55 corresponded to a size large. Whereas, the average crotch length of 26.84 and thigh measurement of 23.62 corresponded to a size medium. Thus, a male possessing the measurement characteristics of the average sized male, may have trouble deciding exactly what size underpants he should purchase. The average size male from the Size USA data will either choose a size just larger or smaller than their own body size or a size that fits one area of the body but is larger or smaller in one or more areas (Ashdown, 1987). The statistical results are substantiated by Tamburrino (1992) who found that although the human body's dimensions follow a normal statistical distribution, a wide variance is reflected in individual measurements of height, chest, waist and various parts of the body.

Since the statistics reported in Table 4.32 includes all ethnicities and age groups, there was a considerable amount of variability in the data. The standard deviations for the measurements range from 2.39-5.15. The minimum and maximum measurements values did not correspond to sizes in the range of small-2x large found in Table 4.33. As reported by Peterson (2004), 69% percent of adult males in the United States are overweight while 20% of men are obese, therefore, maximum measurements presented in Table 4.32 appear to be reasonable.

4.2.1.2 Size USA vs. ASTM Sizing

The results of IF/THEN statements determined the number of subjects that met measurement requirements for ASTM sizes small through 2x-large for underpants. Table 4.34 gives a distribution for ASTM size classes by ethnic group. In addition, Table 4.35 gives a distribution for ASTM size classes by age group.

As seen in Table 4.34 only a small number of subjects fell within the ASTM Standard measurement requirements for the small-2XL size designations for any ethnic group. Overall about 3% of the subjects fell into one of five size designations. By ethnicity, measurement requirements were met by approximately 6% of Black, 3% "Other", 2% Hispanic, and 3% White subjects. Though Black males met ASTM standards more frequently than other ethnic groups, 94% noncompliance cannot be viewed as satisfactory. Among all the ethnic groups, more than half of the subjects that met requirements fell into the medium size designation. The next ASTM size category that best fit all ethnicities was a size small. No Hispanic subjects met the requirements for sizes large, x large and 2x large. None of the subjects met measurement requirements for size 2x large.

The "Other" group was no worse than meeting ASTM standards than the Black, Hispanic, and White groups; although in the previous ANOVA tests their measurements were found to be significantly different and/or smaller than the other ethnic groups. It was expected that the smaller body measurements of the "Other" group would affect their ability to conform to ASTM Standards. In addition, the non-compliance rate of the "Other" group is substantiated by Gim's (1988) study which

found that Asian women needed a considerable amount of alterations done to garments. This finding suggests that Asians are not adequately represented in sizing systems used. In addition, poor satisfaction rates for Blacks are supported by Giddings and Boles' (1990) study that tested commercially produced dressed pants and found dissatisfactory fit in Black males in the waist and thighs.

In Table 4.35, it can be noted that as age group increased, fewer subjects met measurement requirements for sizes. Measurement requirements were met by approximately 7% from age group 1: 18-25, 3% from age group 2: 26-35, 2% from age group 3: 36-45, and 1% each from age groups 4: 46-55-, 5: 56-65, and 6: 66+, respectively. Of those persons meeting a size class, medium was found to be the most satisfactory size for all age groups except age group 6. Subjects in age group 1 met ASTM standards more successfully than other age groups, however, again, 93% noncompliance cannot be considered satisfactory. Subjects from age group 4 met size designations for both size small and medium, while the subjects from age group 5 met standards for only size medium and age group 6 only met specifications for size small.

Compliance rates are poor for all age groups, however, age groups 4, 5, and 6, had the worst compliance rates. As mentioned earlier, body proportions are influenced by age. Therefore, it was expected that as age increased fewer subjects would meet ASTM size standards since clothing is generally made for a 17- to 35-year-old with an upright stance (Lang, 1996). Consequently, the result of this comparison provides evidence that apparel sizing does not accommodate the changes in body proportions of older individuals.

Table 4.34: Distribution among ASTM Sizes for Ethnic Groups

| Ethnicity | Size | | | | | Totals | | | Percent within Standard |
|----------------|--------------|--------------|--------------|-------------|-------------|-----------------|-----------------|-------------|-------------------------|
| | Small | Medium | Large | XL | XXL | Within Standard | Out of Standard | Subjects | |
| Black | 10 | 23 | 7 | 3 | 0 | 43 | 666 | 709 | 6.1% |
| Other | 3 | 13 | 3 | 0 | 0 | 19 | 578 | 597 | 3.2% |
| Hispanic | 3 | 7 | 0 | 0 | 0 | 10 | 629 | 639 | 1.6% |
| White | 10 | 29 | 6 | 0 | 0 | 45 | 1701 | 1746 | 2.6% |
| Total | 26 | 72 | 16 | 3 | 0 | 117 | 3574 | 3691 | |
| Percent | 22.2% | 61.5% | 13.7% | 2.6% | 0.0% | 3.2% | 96.8% | | |

Note: Each size includes the four sublevels

Table 4.35: Distribution among ASTM Sizes for Age Groups

| Age Group | Size | | | | | Totals | | | Percent Within Standard |
|----------------|--------------|--------------|--------------|-------------|-------------|-----------------|-----------------|-------------|-------------------------|
| | Small | Medium | Large | XL | XXL | Within Standard | Out of Standard | Subjects | |
| 1: 18-25 | 16 | 40 | 9 | 1 | 0 | 66 | 929 | 995 | 6.6% |
| 2: 26-34 | 4 | 15 | 3 | 1 | 0 | 23 | 765 | 788 | 2.9% |
| 3: 35-44 | 2 | 12 | 4 | 1 | 0 | 19 | 819 | 838 | 2.3% |
| 4: 45-54 | 3 | 3 | 0 | 0 | 0 | 6 | 620 | 626 | 1.0% |
| 5: 55-64 | 0 | 2 | 0 | 0 | 0 | 2 | 280 | 282 | 0.7% |
| 6: 65+ | 1 | 0 | 0 | 0 | 0 | 1 | 161 | 162 | 0.6% |
| Total | 26 | 72 | 16 | 3 | 0 | 117 | 3574 | 3691 | |
| Percent | 22.2% | 61.5% | 13.7% | 2.6% | 0.0% | 3.2% | 97% | | |

Note: Each size designation includes sublevels

4.2.1.3 Bivariate Fit Plot Analysis

In an attempt to understand why so few participants fit into ASTM size classes, 2 variable (bivariate) plots were drawn and compared to ASTM size ranges. This section will discuss these bivariate plots showing each of the underpants measurement variables plotted against another variable. Rectangles have been added in each plot to distinguish the five size class ranges.

In Figure 4.16, the plot of waist against crotch length measurements, it is visibly clear that most of the subjects fell outside of all ASTM size classes. Of those

fitting into a category, most subjects appear to be a size small. It appeared that as the size increased, fewer subjects met the ASTM specifications. Waist measurement specifications appeared to be satisfactory for the subjects. However, crotch length specifications appeared to be larger than what was needed for the subjects.

Figure 4.17 is the plot of hip against crotch length measurements. As underpants size increased, it appeared that fewer subjects met ASTM specifications. A considerable number of subjects fell into small and medium size categories. Again, crotch length specifications were above the range needed for most of the subject's measurements. However, hip specifications were below a significant number of subjects' measurements.

In Figure 4.18, the plot of crotch length against thigh measurements, the same trend was found in regards to an increase in size resulting in fewer subjects meeting size specifications. Thigh measurements of a significant number of subjects appeared to fall both above and below the range for ASTM thigh specifications. However, most subjects presumably fell below the specifications. As seen in previous plots, crotch length specifications were above the range needed for most of the subject's measurements.

Figure 4.19 is the plot of hips against thigh measurements. It was more evident in this plot that a significant number of subject's thigh measurements fell below the specifications. Again, hip specifications were below a significant number of subjects' measurements.

In addition, Figure 4.20, the plot of waist versus thigh measurements, very few subjects met the standard. It was confirmed in this plot that most of the subjects' measurements were below ASTM thigh specifications. Again, waist specifications appear to meet the subjects' measurements adequately.

In Figure 4.21, the plot of waist against hips measurements, a considerable number of subjects met specifications. Waist specifications did not appear to affect subjects' ability to meet specifications. However, hip specifications in this plot appeared to be slightly above subjects' measurements.

Based on the analysis of Figures 4.16-4.21, it can be determined that waist measurement specifications did not appear to chiefly account for the minimal number of subjects meeting ASTM size specifications. However, the following factors were found to have contributed to unsatisfactory fit in sizes small-2x large: crotch length specifications were larger than subjects' measurements; hip specifications were smaller than subjects' measurements; and thigh specification were smaller than subjects' measurements. The majority of subjects were clustered outside of ASTM specifications ranges.

As found in objective one, anthropometric differences exist between not only people of diverse races, but also people of diverse age groups. Based on the results from this analysis, majority of the subjects must choose underpants either a size just smaller or larger than their own body size, or a size that fits one area of the body but is smaller or larger in another area (Ashdown, 1987). In addition, the findings from the bivariate plots support Desmarteau (2000) who stated that the discrepancies found in commonly used grading systems do not account for the

adverse fit problems that are caused by grading of a base size into extreme size ranges such as x large. Therefore, it is understood why Brunn (1983) stated that there was a need to revise size charts at least every 10 years in order to maintain accurate sizes. It is obvious that ASTM sizing charts need to be based on more recent anthropometric data, like the Size USA study, in order to more adequately meet the body proportions of the U.S. population.

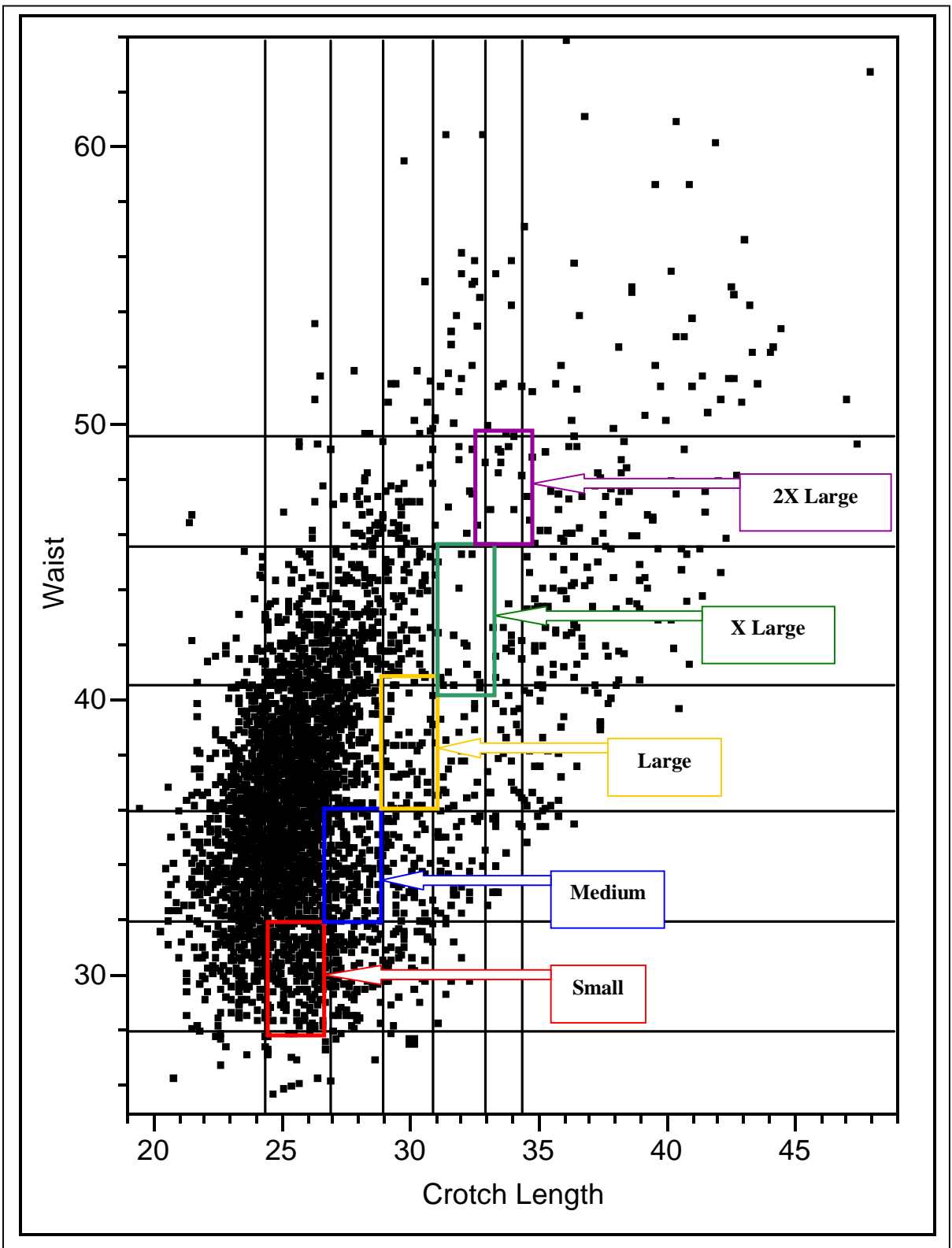


Figure 4.16: Bivariate of Waist by Crotch Length

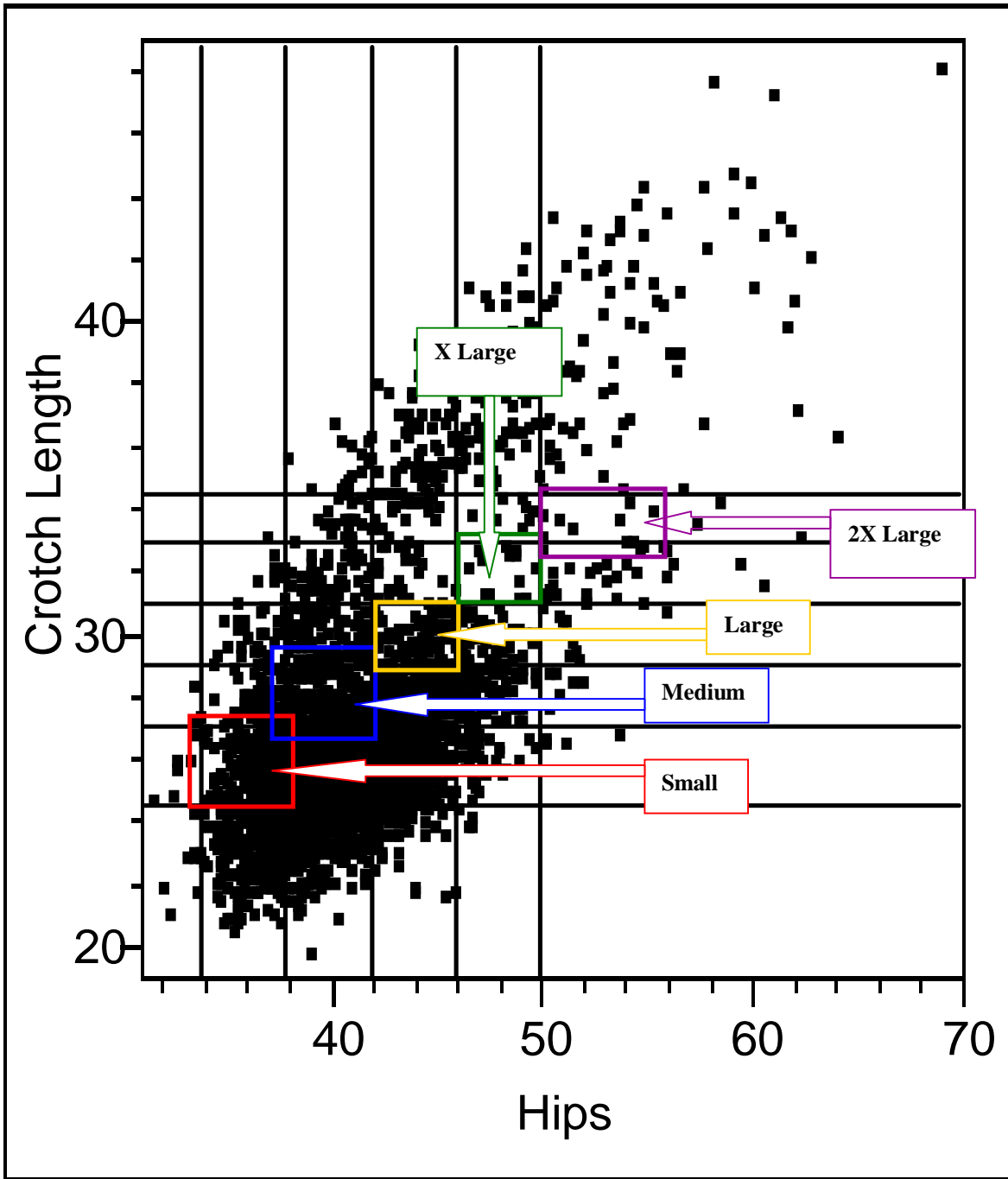


Figure 4.17: Bivariate of Crotch Length by Hips

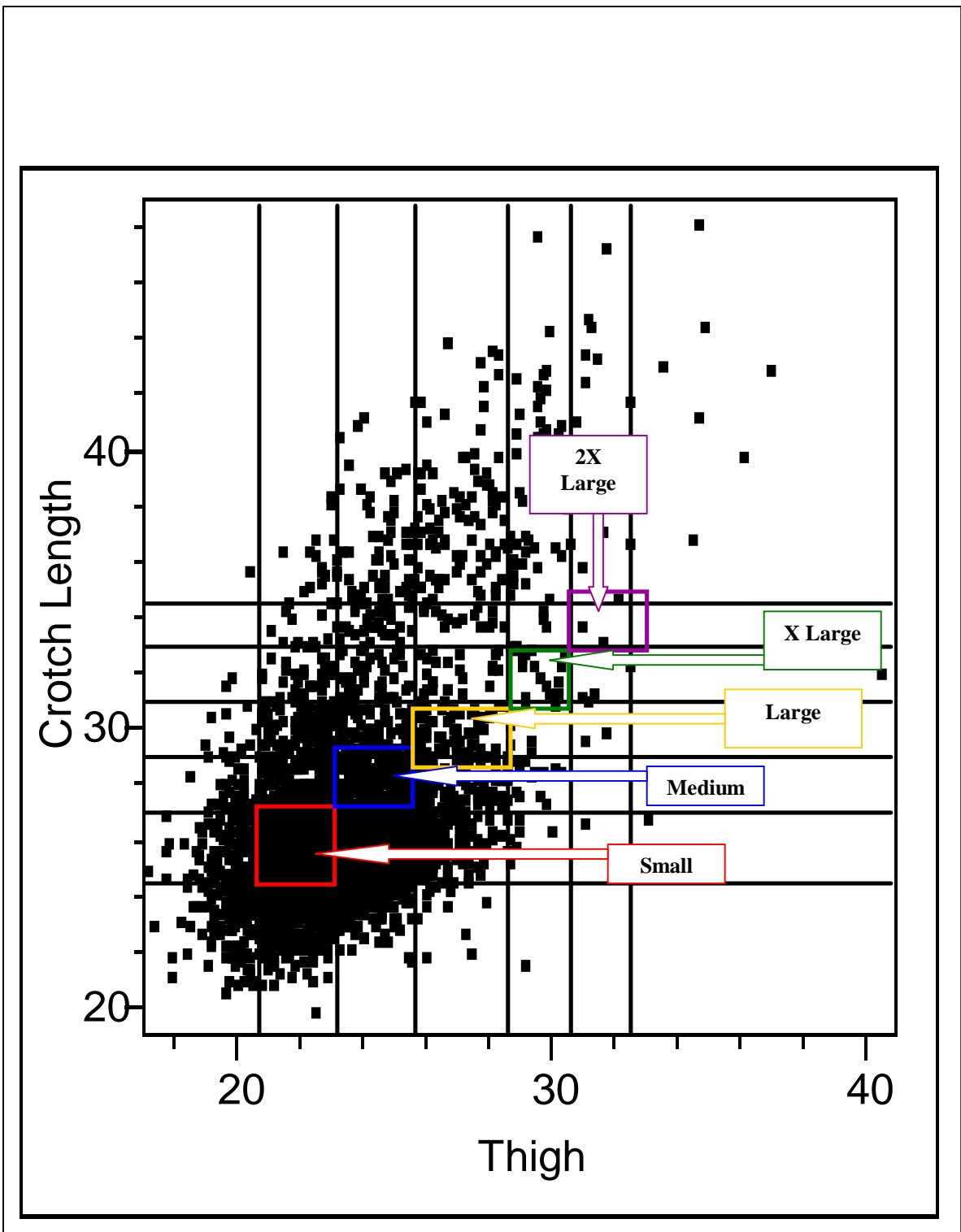


Figure 4.18: Bivariate Fit of Crotch Length by Thigh

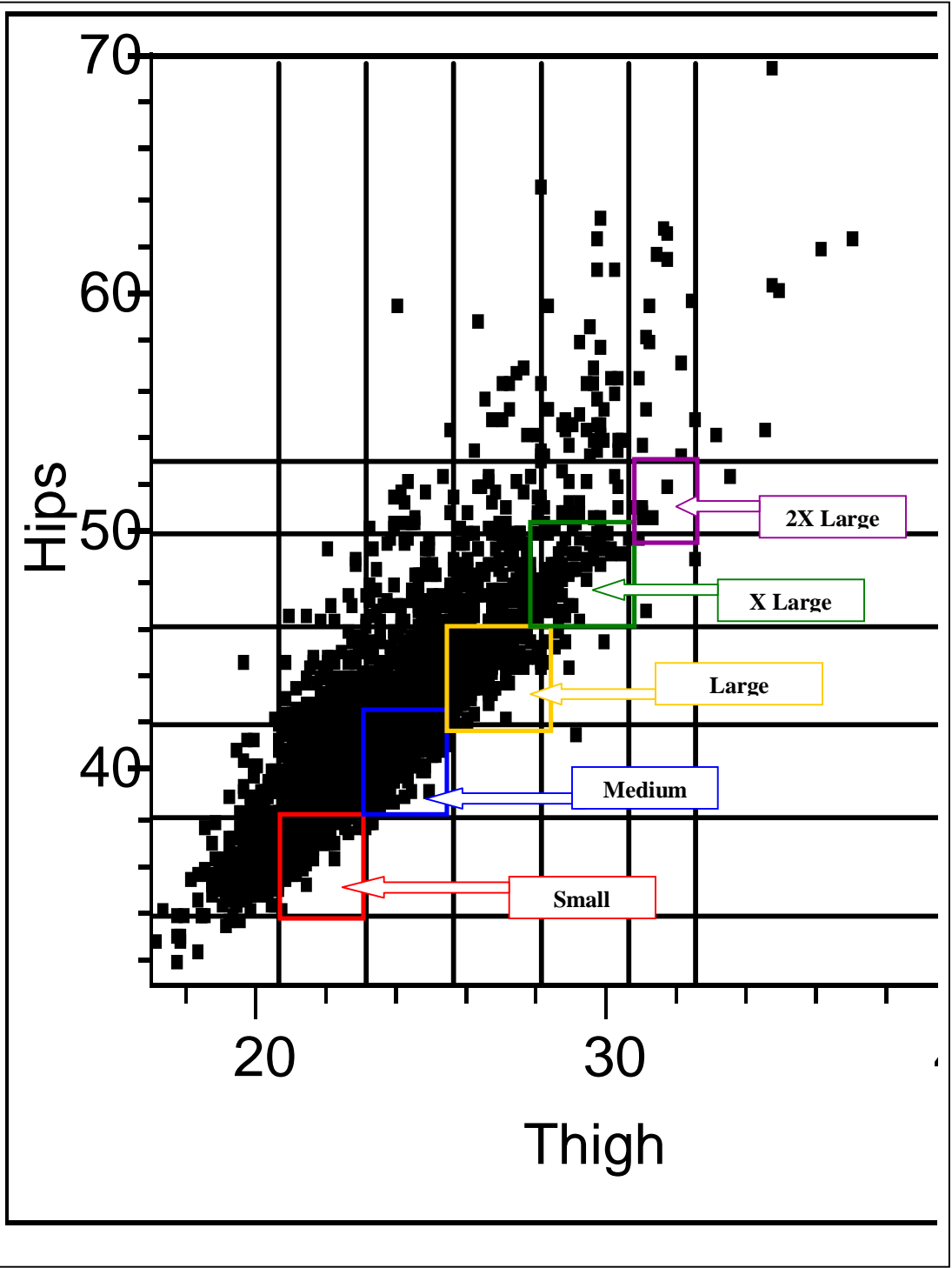


Figure 4.19: Bivariate Fit of Hips by Thigh

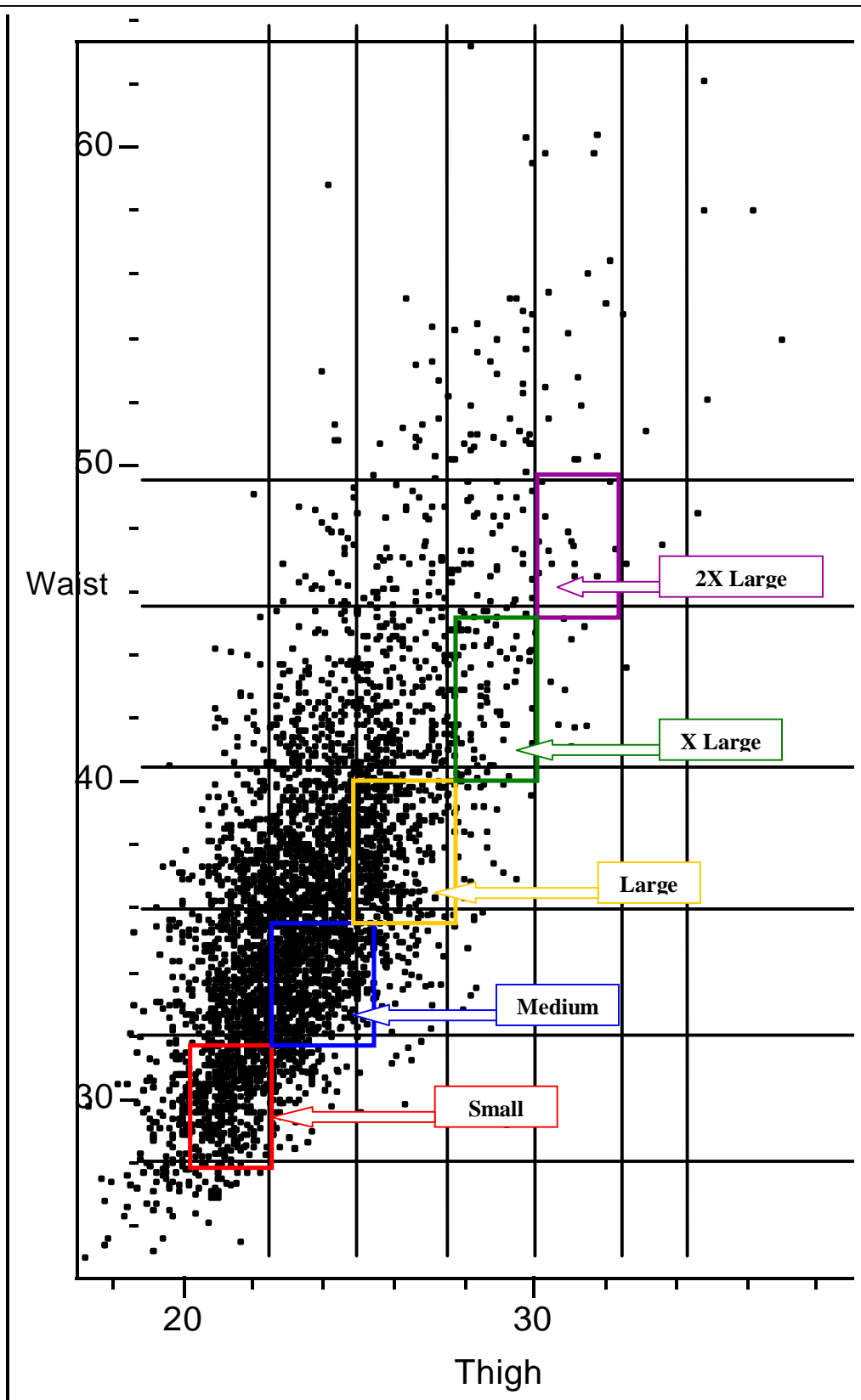


Figure 4.20: Bivariate Fit of Waist by Thigh

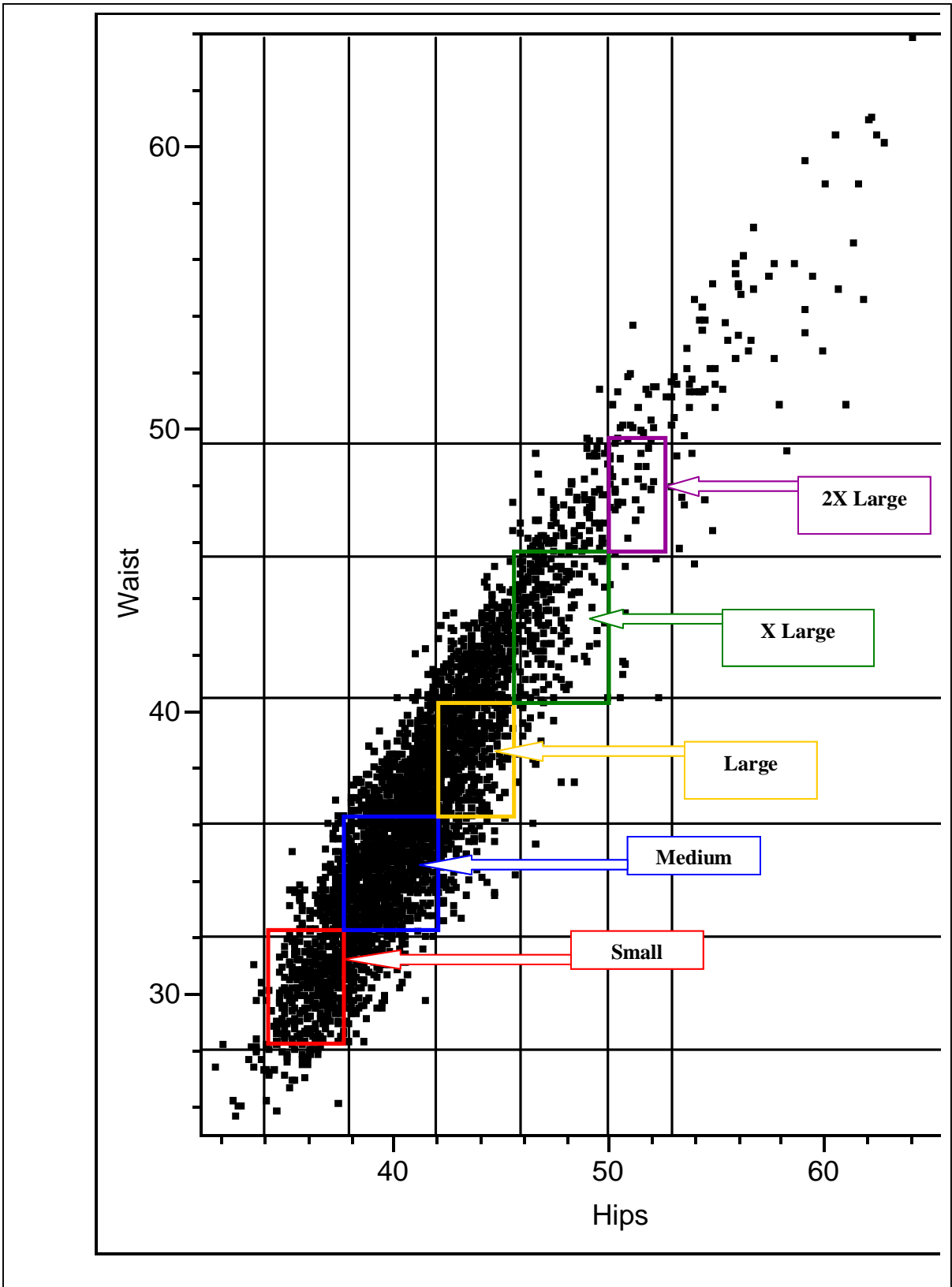


Figure 4.21: Bivariate Fit of Waist by Hips

4.2.2 Undershirts

Table 4.36 provides simple statistics such as the mean, standard deviation, minimum and maximum values for each of the independent variables (neck base, chest, armscye, and across shoulder) used in sizing men's undershirts. Table 4.37 outlines the size designations and measurement specifications for the ASTM Standard for corresponding measurement variables.

Table 4.36: Size USA Simple Statistics for Undershirt Variables

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|------------------------|----------|-------------|----------------|----------------|----------------|
| Neck_Base | 7382 | 17.27665 | 1.26574 | 13.51360 | 24.33620 |
| Chest | 7382 | 42.63862 | 4.27842 | 31.07730 | 63.10100 |
| Armscye | 7382 | 18.67241 | 1.67008 | 12.40780 | 40.09130 |
| Across_Shoulder | 7382 | 16.97658 | 1.34873 | 12.65390 | 22.61170 |

4.2.2.1 ASTM Analysis

In comparing the mean values in Table 4.36 to corresponding size categories in Table 4.37, it was found that the average undershirt measurements did not meet the requirements for any one particular size category under the ASTM Standard. The average neck base measurement of 17.28 corresponded to a size x large, while the average chest measurement of 42.64, corresponded to a size large. Both the armscye measurement of 18.67 and across shoulder measurement of 16.98 corresponded to a size medium.

Table 4.37: ASTM Standard Measurements for Undershirts

| Measurements (inches) | Size | | | | | | | | | | | |
|--------------------------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|-------|-------|
| | Small | | | | Medium | | | | Large | | | |
| | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 |
| Neck base | 14.00 | 14.25 | 14.50 | 14.75 | 15.00 | 15.25 | 15.50 | 15.75 | 16.00 | 16.25 | 16.50 | 16.75 |
| Chest | 34.00 | 35.00 | 36.00 | 37.00 | 38.00 | 39.00 | 40.00 | 41.00 | 42.00 | 43.00 | 44.00 | 45.00 |
| Armhole | 16.37 | 16.75 | 17.00 | 17.37 | 17.75 | 18.13 | 18.50 | 18.87 | 19.25 | 19.63 | 20.00 | 20.37 |
| Across Shoulder | 16.50 | 16.63 | 16.75 | 16.87 | 17.00 | 17.25 | 17.50 | 17.75 | 18.00 | 18.25 | 18.50 | 18.75 |

| Measurements (inches) | Size | | | | | | | |
|--------------------------|--------|-------|-------|-------|-------|-------|-------|-------|
| | Xlarge | | | | 2XL | | | |
| | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 |
| Neck base | 17.00 | 17.25 | 17.50 | 17.75 | 18.00 | 18.25 | 18.50 | 18.75 |
| Chest | 46.00 | 47.00 | 48.00 | 49.00 | 50.00 | 51.00 | 52.00 | 53.00 |
| Armhole | 20.75 | 21.13 | 21.50 | 20.81 | 21.13 | 21.44 | 21.75 | 22.06 |
| Across Shoulder | 19.00 | 19.25 | 19.50 | 19.75 | 20.00 | 20.25 | 20.50 | 20.69 |

Note: Entire listing for ASTM Standard Measurements, size 34-60, found in Appendix

As mentioned previously, based on these findings, the average size male from the Size USA data will either choose a size just larger or smaller than their own body size, or a size that fits one area of the body but is larger or smaller in one or more area (Ashdown, 1987). The statistical results are substantiated by Tamburrino (1992) who found that although the human body's dimensions follow a normal statistical distribution, a wide variance is reflected in individual measurements of height, chest, waist and various parts of the body.

Table 4.36 is inclusive of all ethnicities and age groups; however, variation was not large except for chest measurements where the standard deviation was 4.27. On the other hand, neck, armscye, and shoulder measurements resulted in low ranges for standard deviations (1.27-1.35). Minimum and maximum values did not correspond to any of the sizes in the range of small-2x large found in Table 4.39. As stated previously, 69% percent of adult males in the United States are overweight while 20% of men are obese; therefore, maximum measurements shown in Table 4.33 appear to be reasonable (Peterson, 2004).

4.2.2.2 Size USA vs. ASTM Sizing

Table 4.38 gives a distribution among ASTM size classes by ethnic group. In Table 4.38, there were an exceptionally low number of subjects that met ASTM undershirts standards for sizes small- 2x- large. Size specifications were not met by 99% of male subjects. Overall, less than 1% of the subjects from the four ethnic groups met ASTM Standards. Of those subjects that met ASTM specifications 33% fell into size medium and 33% fell into size 2x large. Although Whites accounted for

the highest number of subjects meeting specifications, slightly less than 1% of Whites fell within a size specification.

Again, the “Other” group was no worse than meeting ASTM standards than the Black, Hispanic, and White groups; although in the previous ANOVA test their measurements were found to be significantly different and/or smaller than the other ethnic groups. As reported earlier, the non-compliance rate of the “Other” group is substantiated by Gim’s (1988) study, which found that Asian women needed a considerable amount of alteration to garments, which suggested that they were not adequately represented in sizing systems used. Poor satisfaction rates for Blacks are supported by Giddings and Boles’ study which tested the fit of commercially produced dress pants and found dissatisfactory fit for Black males in the waist and thighs. As mentioned in the literature, size standards currently used are no longer representative of the body proportions for the U.S. population.

Table 4.39 tabulates the distribution among ASTM size classes by age group. In Table 4.39, there appeared to be no specific trend in relation to age group and conformance to ASTM Standards. No particular group met standards fairly well. Age group 4: 46-55, was the only group that had at least 1% of its subjects to meet specifications. All other age groups had considerably less than 1% of their subjects fall within any size category.

Satisfaction rates for men’s undershirts measurements based on ASTM Standards were extremely poor. The following was determined regarding undershirts measurements when compared to ASTM Standards: Whites met

specifications better than other ethnic groups and age group 4 accounted for the highest percentage of subjects to meet specifications. A substantial amount (99%) of the subjects were clustered outside of the specification range.

Compliance rates are extremely poor for all age groups. As mentioned earlier, body proportions are influenced by age. Thus, it was expected that as age increased fewer subjects would meet ASTM size standards since clothing is generally made for a 17- to 35-year-old with an upright stance (Lang, 1996).

Table 4.38: Undershirts Contingency Table Based on Ethnicity

| Ethnicity | Size | | | | | Totals | | | Percent Within Standard |
|----------------|-----------|------------|------------|------------|------------|-----------------|-----------------|----------|-------------------------|
| | Small | Medium | Large | XL | XXL | Within Standard | Out of Standard | Subjects | |
| Blacks | 0 | 1 | 0 | 0 | 0 | 1 | 708 | 709 | 0.10% |
| Others | 0 | 2 | 0 | 1 | 0 | 3 | 594 | 597 | 0.50% |
| Hispanics | 0 | 2 | 0 | 0 | 2 | 4 | 635 | 639 | 0.60% |
| Whites | 0 | 3 | 4 | 3 | 6 | 16 | 1730 | 1746 | 0.90% |
| Total | 0 | 8 | 4 | 4 | 8 | 24 | 3667 | 3691 | 1% |
| Percent | 0% | 33% | 17% | 17% | 33% | 1% | 99% | | |

Note: Each size includes the four sublevels

Table 4.39: Undershirts Contingency Table Based on Age Group

| Age Group | Size | | | | | Totals | | | Percent Within Standard |
|----------------|-----------|------------|------------|------------|------------|-----------------|-----------------|----------|-------------------------|
| | Small | Medium | Large | XL | XXL | Within Standard | Out of Standard | Subjects | |
| 1: 18-25 | 0 | 4 | 0 | 1 | 2 | 7 | 988 | 995 | 0.70% |
| 2: 26-35 | 0 | 0 | 1 | 0 | 2 | 3 | 785 | 788 | 0.40% |
| 3: 36-45 | 0 | 1 | 0 | 1 | 0 | 2 | 836 | 838 | 0.20% |
| 4: 46-55 | 0 | 3 | 2 | 1 | 4 | 10 | 616 | 626 | 1.60% |
| 5: 56-65 | 0 | 0 | 1 | 0 | 0 | 1 | 281 | 282 | 0.40% |
| 6: 66+ | 0 | 0 | 0 | 1 | 0 | 1 | 161 | 162 | 0.60% |
| Total | 0 | 8 | 4 | 4 | 8 | 24 | 3667 | 3691 | 1% |
| Percent | 0% | 33% | 17% | 17% | 33% | 1% | 99% | | |

Note: Each size includes the four sublevels

4.2.2.3 Bivariate Fit Plot Analysis

In an attempt to understand why so few participants fit into an ASTM size, 2 variable plots were drawn and compared to ASTM sizing ranges. This section will discuss these bivariate plots showing each of the undershirt measurement variables plotted against another variable. Rectangles have been added in each plot to distinguish between ASTM size class ranges.

Figure 4.22 is a plot of armscye against neck base measurements. The number of subjects that met size standards appeared to increase as the sizes increased. Of those meeting ASTM requirements, most of the subjects appeared to fall into the large and x large category. The neck base specifications were considerably lower than needed for subjects. However, the subjects' armscye measurements were smaller than the specifications for sizes small-2x large.

In Figure 4.23, the plot of across shoulder versus neck base, a large number of subjects did not fall into any size category. Considering this bivariate plot, it is understandable that very few subjects meet ASTM Standards. It appears that these two characteristics, neck base and across shoulder are out of range with subjects measurements. Subjects neck base measurements appeared to be larger than specifications, while across shoulder measurement specifications appeared to be significantly larger than needed for the subjects in the Size USA data.

Figure 4.24 is a plot of across shoulder versus chest. In this plot there were also very few subjects that fell into size specifications. This plot provided more evidence that across shoulder specifications did not closely relate to the subjects measurements. However, the chest specifications appeared to have adequately met

the subject's measurements. The same was true in Figure 4.26 regarding chest specifications.

Figure 4.25 is a plot of neck base against chest measurements. A substantial number of subjects met specifications, except in the size small category. Although, chest specifications appeared to adequately meet subject's measurements, neck base specification ranges did not satisfy a significant number of subjects. Neck specifications were found to be lower than needed to adequately satisfy subject's measurements.

In Figure 4.26, armscye is plotted against chest measurements. It appears that although a substantial number of subjects met specifications, a significant number of subjects still fell outside of the armscye specifications. Again, as seen in previous plots (Figure 4.24 and 4.25) chest specifications appear to satisfy Size USA subjects' measurements.

In Figure 4.27, which plots across shoulder versus armscye, although there are subjects that meet specifications for every size class, the majority of subjects fall outside of ASTM Standards. This appears to be largely due to the across shoulder specifications being too large to satisfy subjects measurements. In addition, a large number of subjects' armscye measurements appear to be larger than ASTM specifications.

Based on the analysis of Figures 4.22-4.27, it was found that chest measurement specifications did not chiefly account for the subjects poor conformance to ASTM Standards. However, the following factors are believed to have contributed to unsatisfactory fit in sizes small-2x large: armscye specifications

were not in the correct bounds with subjects measurements; neck base specifications were substantially smaller than subjects measurements; and across shoulder specifications were mainly larger than subjects measurements.

As mentioned previously, anthropometric differences exist between not only people of diverse races, but also people of diverse age groups. As found in these analyses, commonly used grading systems do not account for the adverse fit problems that can be caused by grading of a base size into extreme size ranges such as x-large (Desmarteau, 2000). In addition, majority of the subjects must choose either an undershirt a size just smaller or larger than their own body size, or a size that fits one area of the body but is smaller or larger in another area (Ashdown, 1987). These findings substantiate the need to revise size charts at least every 10 years in order to maintain accurate sizes (Brunn, 1983).

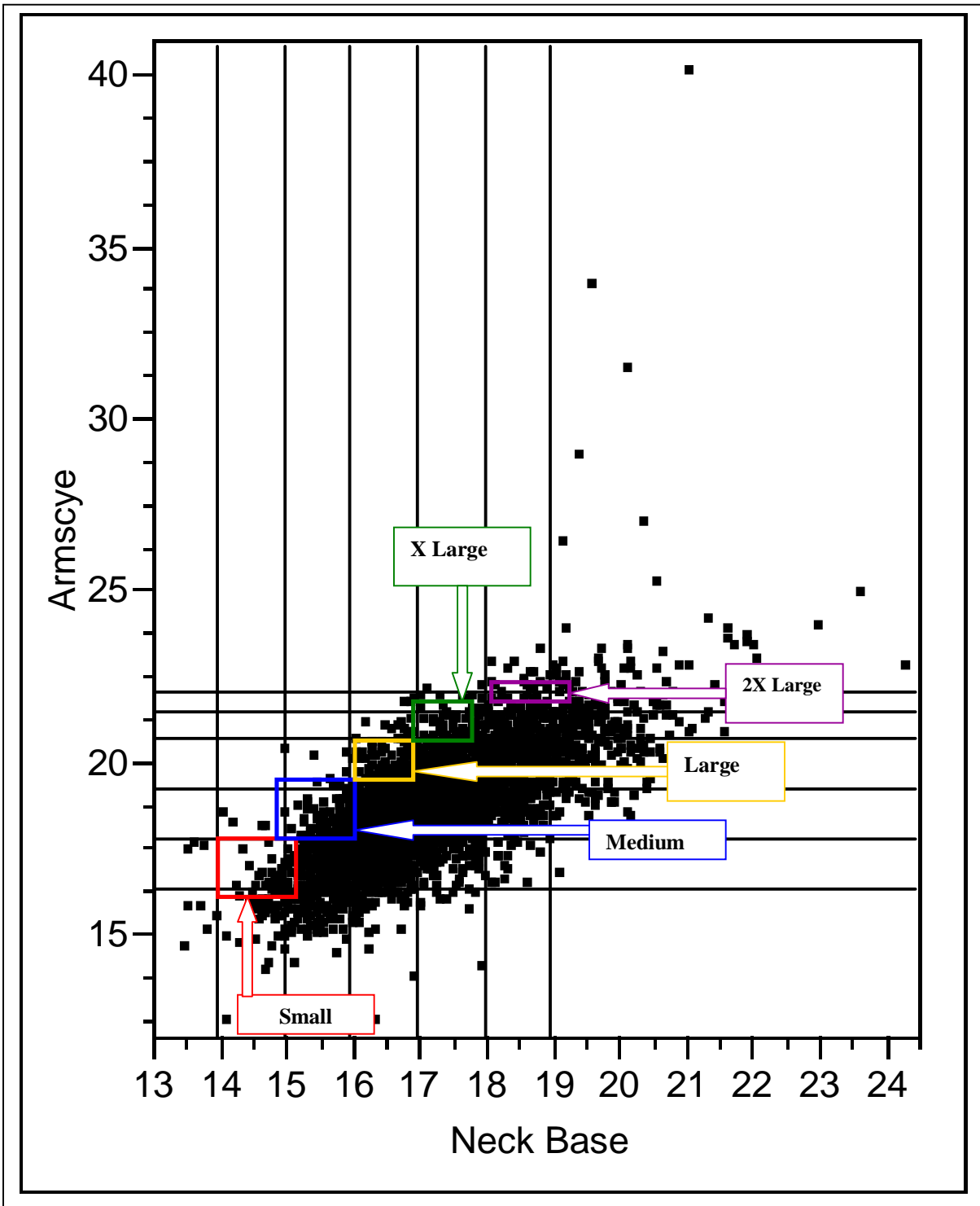


Figure 4.22: Bivariate of Armscye by Neck Base



Figure 4.23: Bivariate of Across Shoulder by Neck Base

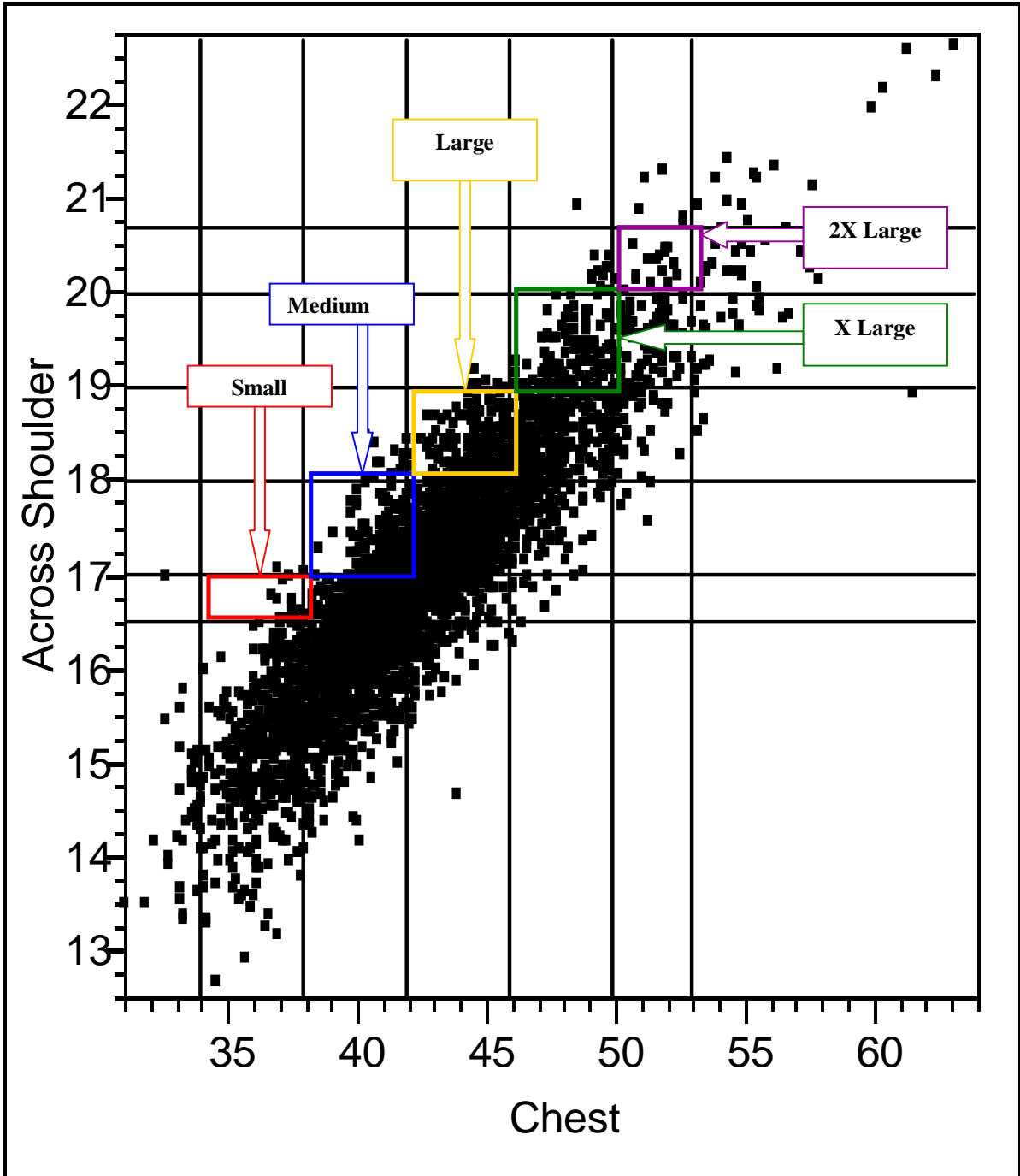


Figure 4.24: Bivariate of Across Shoulder by Chest

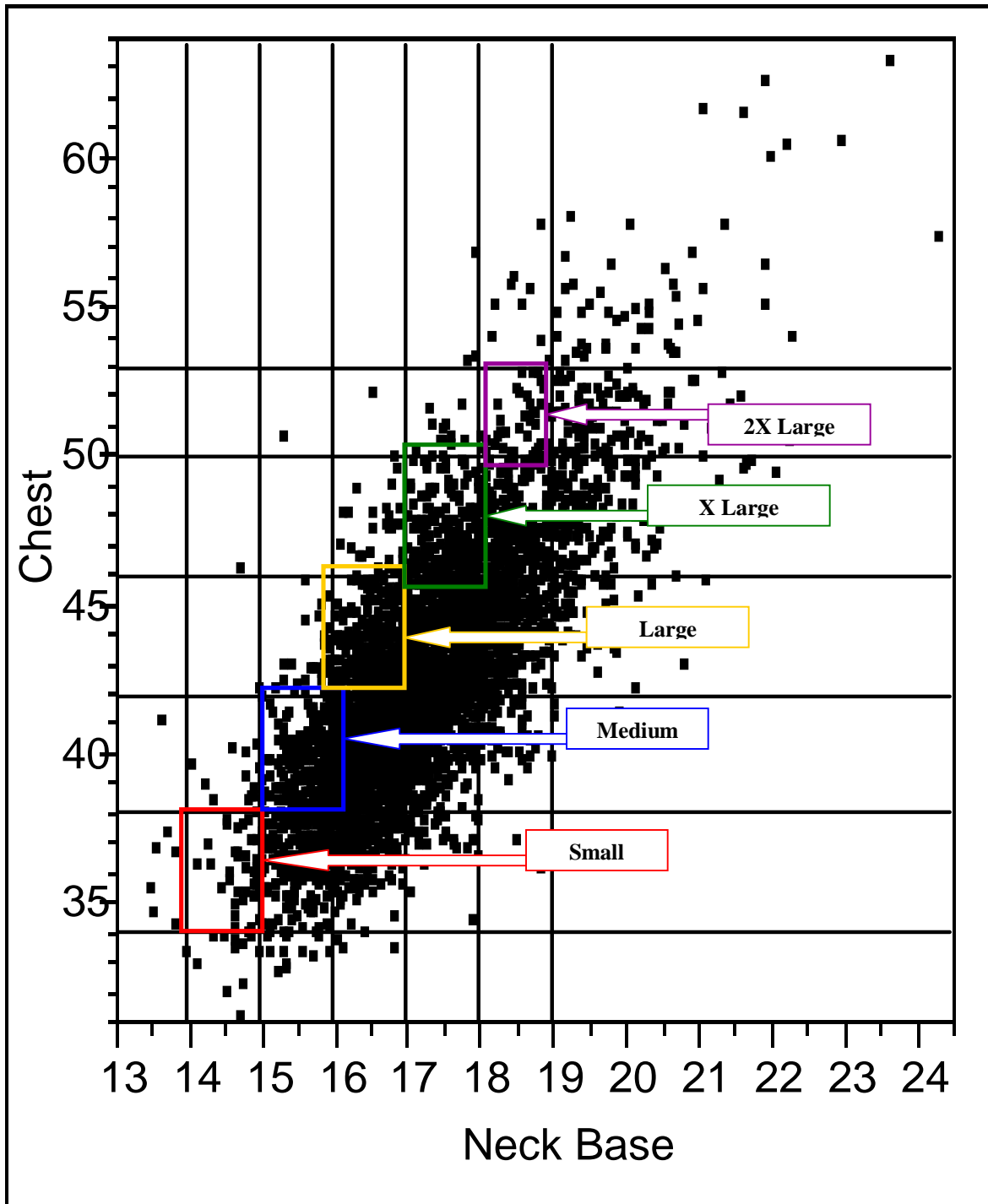


Figure 4.25: Bivariate of Chest by Neck Base

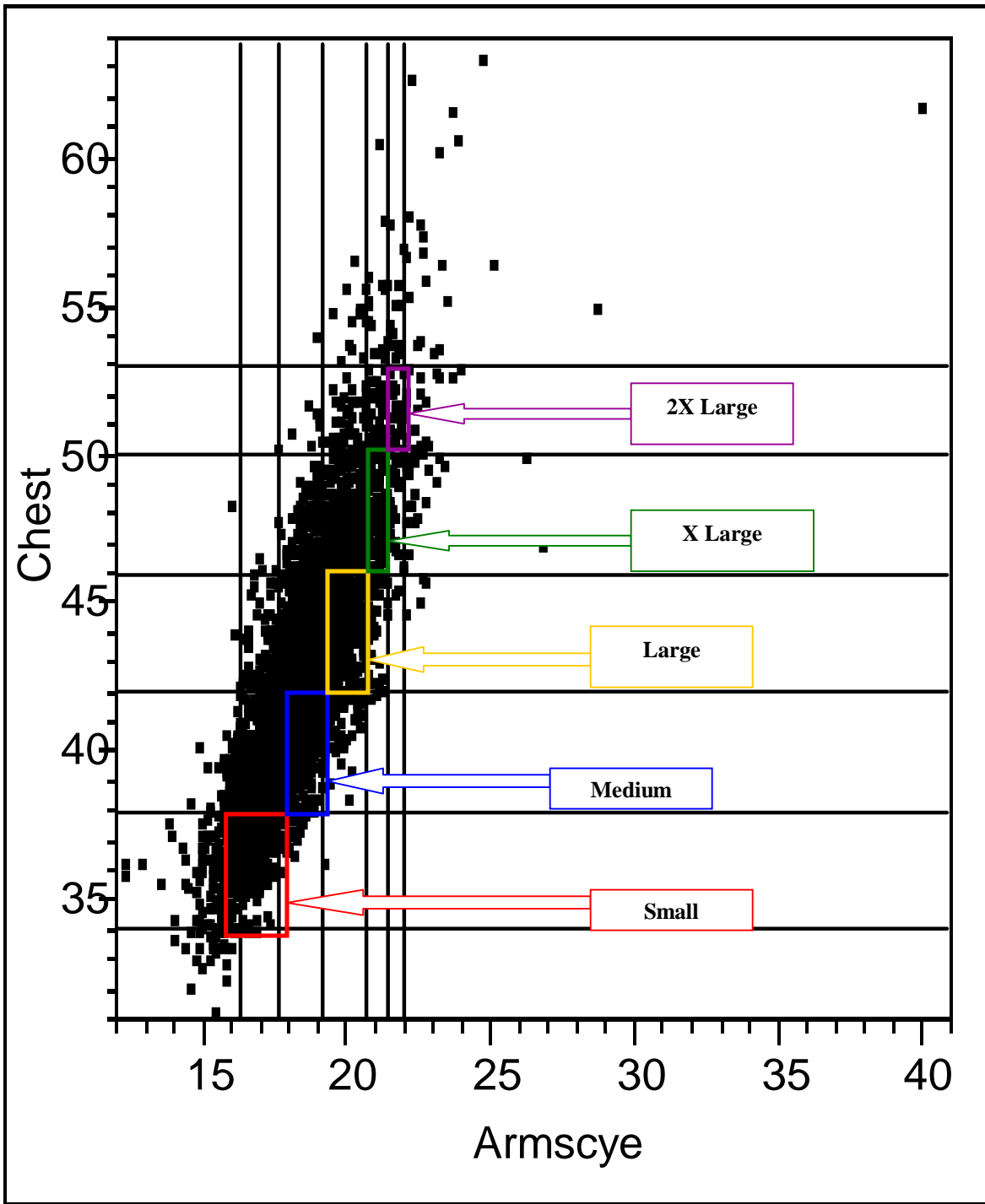


Figure 4.26: Bivariate of Chest by Armscye

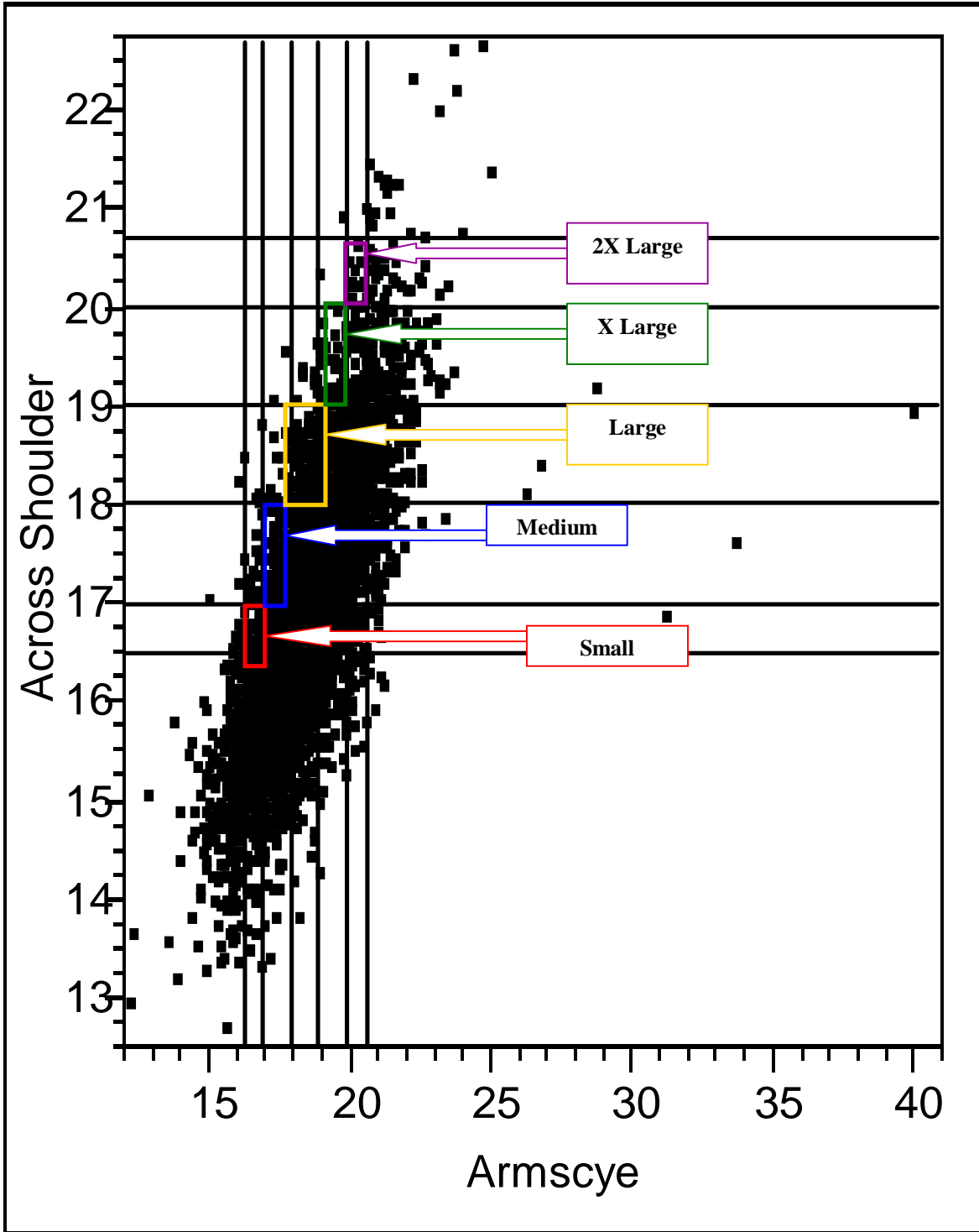


Figure 4.27: Bivariate of Across Shoulder by Armscye

4.3 “Proposed” Size Classifications

As mentioned in the literature, the process of sizing entails fitting real, actual bodies into designated sizes that have been set by the industry. Based on the results comparing ASTM Standards to the Size USA data, it is of no surprise that 60% of consumers overall, according a Kurt Salmon Associates survey, have difficulty finding clothes that fit well (Campbell, 2004). The findings of this study give further evidence to the fact that ASTM Standards, which are based on earlier anthropometric studies, provide unsatisfactory fit for most of the U.S. population.

The third objective of this portion of the research is to create “Proposed” classifications which would satisfy a more significant percentage of the male subjects from the Size USA study. This objective was completed by altering ASTM size specifications used in the IF/Then statements created for Objective 2 in an effort to enable more subjects to fall into a size class. In addition, new bivariate plots were produced from the “Proposed” specifications.

4.3.1 Changes to Underpants Specifications

Alterations were made to the ASTM Standards in order to create a model that would provide more satisfactory fit to male subjects. ASTM waist specifications were not altered because waist specifications appeared to adequately meet subject’s measurements. However, hip, thigh, and crotch length specifications were changed in order to allow more subjects to fall into a size category.

Table 4.40a & 4.40b, are the “Proposed” underpants measurement classifications. For each size class (small, medium, large, x large, 2x large), waist

measurement specifications remained the same. To allow more subjects to meet specifications, sublevels were created which resulted in widening, narrowing, and/or shifting of the original specifications. As mentioned previously, the ASTM Standard had 4 sublevels under each size class. The sublevels were based on one circumferential dimension of the body that assumed the predominant role. For underpants, sublevels were based on waist measurements. However, for the “Proposed” classifications, 3 sublevels were created to minimize variability in the altered measurement specifications. The levels created do not correspond to any body dimension. For example, as seen in Table 4.40a, the “Proposed” hip measurement specification for size small are 34-40 inches. A 6-inch spread in hip measurements would be too wide to assure satisfactory fit to those who are considered a size small. However, with 3 sublevels created, there is less variability in the specifications and a considerable number of subjects will meet the standard.

With waist specs held constant, altering the range of hip, thigh, and crotch length specifications within each size class created the 3 sublevels. Table 4.41 outlines the changes made in inches to the upper and lower bounds of hip, thigh, and crotch specifications. The effects of the proposed specifications are illustrated in Figures 4.28-4.30. In bivariate plots of the new specifications, hip, thigh and crotch length were only plotted on waist since it was the only variable that remained constant.

For hip measurements, in order to satisfy more subjects, the lower bounds of all specifications were altered except for size small. The lower bounds of sizes medium and large were narrowed, while the lower bounds of sizes XL and 2XL were

widened. The upper bounds of sizes S, M, and L were widened to include the cluster of subject's with higher hip measurements. The changes to this specification are illustrated in Figure 4.28.

In regards to thigh specification, the lower bounds of all sizes were widened except for size small. This was done to include the sizeable cluster of subjects that had thigh measurements smaller than specification. However, the upper bounds of the specification remained about the same since very few subjects had larger thigh measurements than the specification. The changes to this specification are illustrated in Figure 4.29.

In addition, the lower bounds of crotch length measurements were extended in order to capture the subjects that fell below measurement requirements. The upper bounds for size small were increased. However, upper bound for sizes medium and large remained constant, but size XL and 2XL bounds were narrowed. These changes allowed specifications to include a significant number of subjects. The changes to this specification are illustrated in Figure 4.30.

Table 4.40a: Proposed Underpants Specifications (Small-Large)

| Measurements (inches) | Size | | | | | | | | |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | Small | | | Medium | | | Large | | |
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Waist | 28.00-31.44 | | | 31.45-35.45 | | | 35.45-39.26 | | |
| Hips | 34.00-36.00 | 36.00-38.00 | 38.00-40.00 | 35.00-37.66 | 37.66-40.32 | 40.32-43.00 | 40.00-43.14 | 43.14-46.29 | 46.30-49.44 |
| Thigh | 19.00-20.50 | 20.50-22.00 | 22.00-23.50 | 20.00-21.66 | 21.67-23.32 | 23.33-25.00 | 20.00-22.50 | 22.50-25.00 | 25.00-27.63 |
| Total Crotch Length | 22.50-24.00 | 24.00-25.50 | 25.50-27.00 | 22.00-24.18 | 24.18-26.36 | 26.36-28.54 | 23.00-25.50 | 25.50-28.00 | 28.00-30.54 |

Table 4.40b: Proposed Underpants Specifications (XLarge-2X Large)

| Measurements (inches) | Size | | | | | |
|----------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | X Large | | | 2X Large | | |
| | 1 | 2 | 3 | 1 | 2 | 3 |
| Waist | 39.26-44.29 | | | 44.29-49.51 | | |
| Hips | 40.00-43.00 | 43.00-46.00 | 46.00-49.00 | 46.00-48.33 | 48.33-50.66 | 50.66-53.00 |
| Thigh | 21.00-24.00 | 24.00-27.00 | 27.00-30.00 | 24.00-27.33 | 27.33-29.66 | 29.66-31.00 |
| Total Crotch Length | 23.00-25.67 | 25.67-28.33 | 28.33-31.00 | 27.00-28.50 | 28.50-30.00 | 30.00-31.54 |

Table 4.41: Specification Alterations

| HIP (inches) | Lower Bound | Upper Bound |
|----------------------------|------------------------|------------------------|
| <i>Small</i> | 0.00 | 2.56 |
| <i>Medium</i> | 2.45 | 1.88 |
| <i>Large</i> | 1.45 | 4.00 |
| <i>X Large</i> | -5.45 | -0.44 |
| <i>2X Large</i> | -3.45 | 0.00 |
| THIGH (inches) | Lower Bound | Upper Bound |
| <i>Small</i> | 1.75 | 0.13 |
| <i>Medium</i> | -2.63 | -0.13 |
| <i>Large</i> | -5.14 | 0.00 |
| <i>X Large</i> | -6.64 | -0.13 |
| <i>2X Large</i> | -3.14 | -0.54 |
| CROTCH (inches) | Lower Bound | Upper Bound |
| <i>Small</i> | -2.00 | 0.63 |
| <i>Medium</i> | -4.38 | 0.00 |
| <i>Large</i> | -5.55 | 0.00 |
| <i>X Large</i> | -7.55 | -1.54 |
| <i>2X Large</i> | -6.54 | -3.54 |

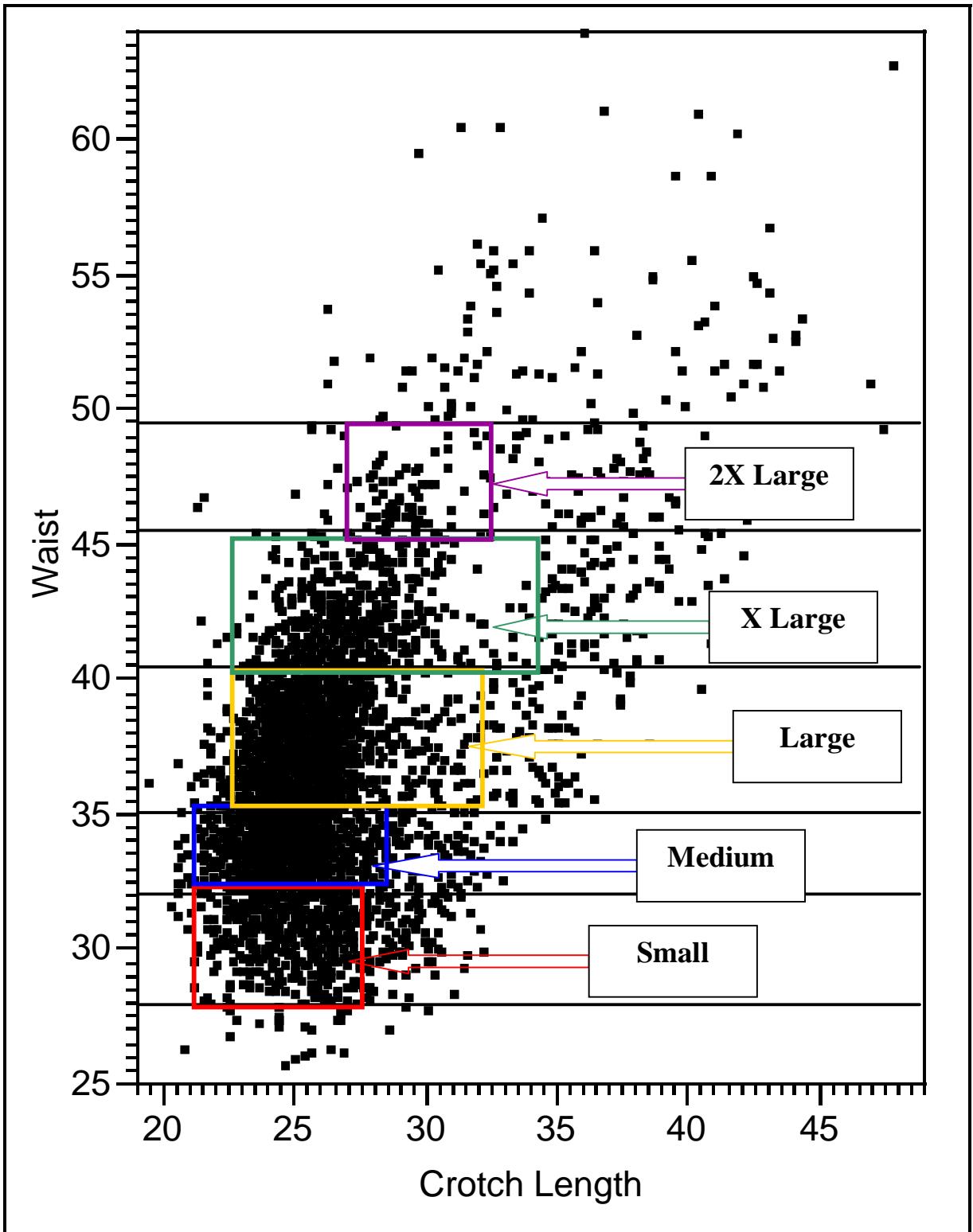


Figure 4.28: Proposed Bivariate Plot of Waist by Crotch Length

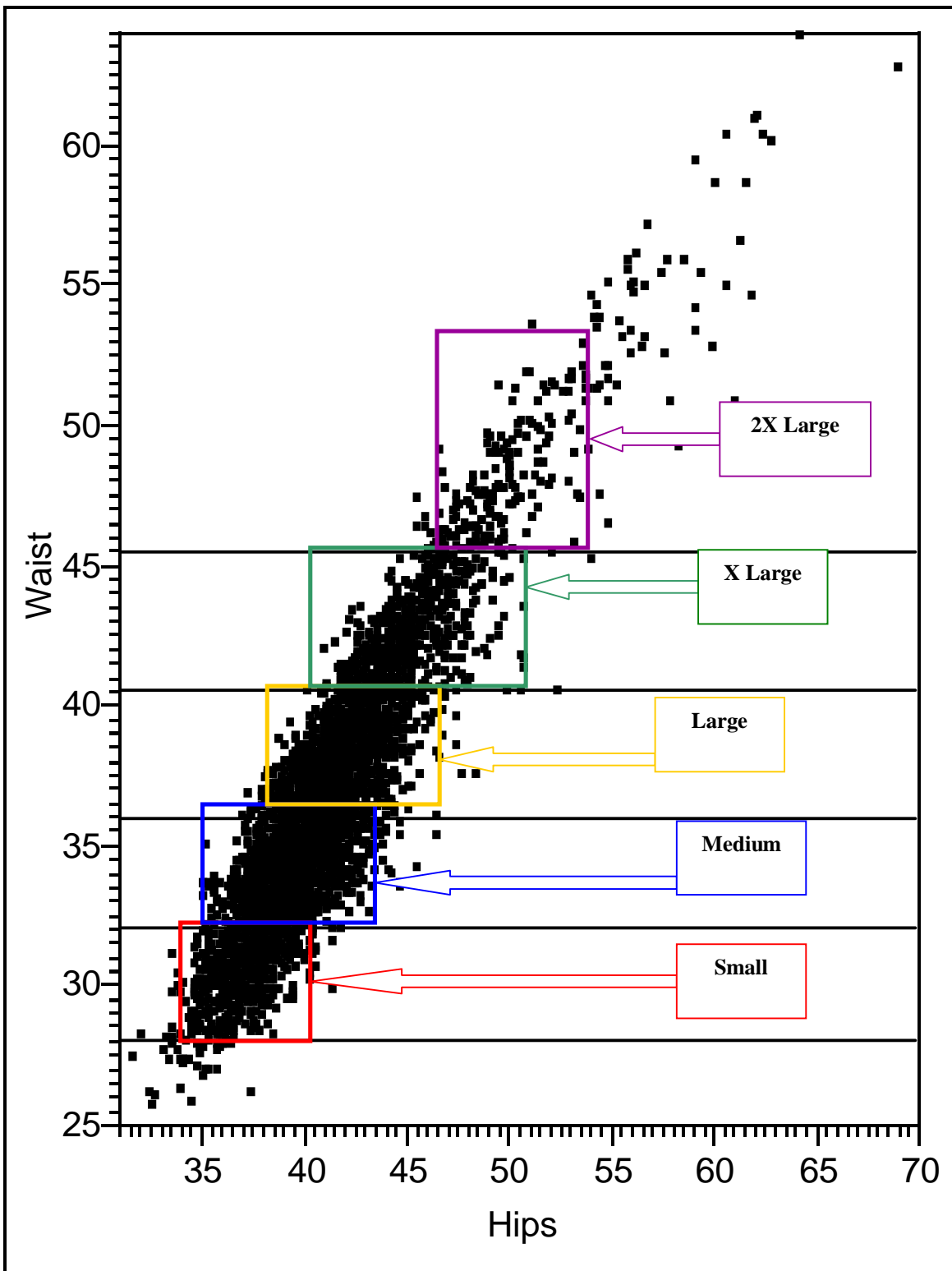
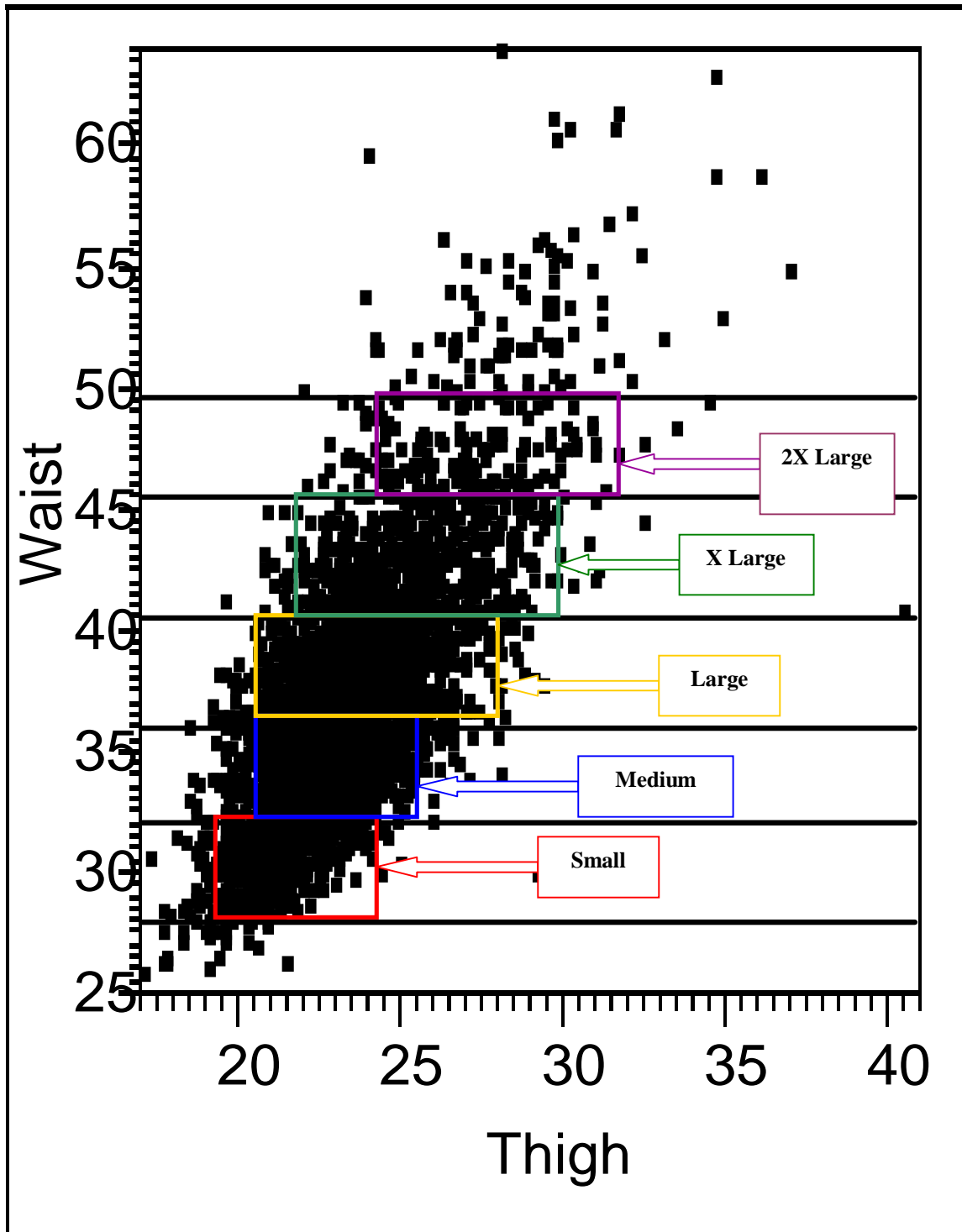


Figure 4.29: Proposed Standard Bivariate Plot of Waist by Hips



4.30: Proposed Standard Bivariate Plot of Waist by Thigh

4.3.1.1 Effect of Specification Changes

Tables 4.42 and 4.43 show the effect of the changes to the ASTM Standard on subject's ability to meet specifications. The changes to the ASTM Standard allowed 75% of the subjects to meet specs for sizes S-2XL. Since a significant number of subjects that did not meet the original specifications were clustered together, the alterations that were made allowed the majority of the clustered group to fall within the new "Proposed" specifications. The new classifications enabled more subjects to meet one of the size classes. In the ASTM Standard a size medium satisfied most subjects. However, for "Proposed" classifications, although a size medium satisfied a significant number of the subjects, most subjects were satisfied by the size large specifications.

As shown In Table 4.42, the new specifications satisfied greater than 65% of subjects in all ethnic groups. The "Proposed" specifications resulted in specifications being met by 65% Blacks, 77% "Others", 76% Hispanics, and 79% Whites. In the original standards, Blacks accounted for the largest group meeting specs, however, in the Proposed Standard, Whites were more likely to be satisfied. It is possible that Blacks complied to specifications with less success because of their significantly larger thigh measurements. The results of the ANOVA test for thigh measurements showed that Blacks had considerably larger measurements than other ethnic groups.

Using the "Proposed" classifications, greater than 68% of the Size USA participants in each age group would meet size specifications of small to 2x-large. In the original standard, age group 1:18-25 accounted for the largest number of

subjects to meet specs, however, in the “Proposed” Standard subjects in age groups 3:35-44 and 4:45-54 will most likely be satisfied. Earlier results from ANOVA tests found that age group 1’s waist and hip measurements were significantly lower than other age groups. The considerably low waist and hip measurements of age group 1 may have influenced their ability to meet standards as well as other age groups.

Table 4.42: Distribution for “Proposed” Sizes by Ethnic Group

| Ethnicity | Size | | | | | Totals | | | Percent within Standard |
|----------------|-------------|--------------|--------------|--------------|-------------|-----------------|-----------------|-------------|-------------------------|
| | Small | Medium | Large | XL | XXL | Within Standard | Out of Standard | Subjects | |
| Black | 71 | 160 | 140 | 74 | 13 | 458 | 251 | 709 | 64.6% |
| Other | 70 | 178 | 135 | 68 | 6 | 457 | 140 | 597 | 76.5% |
| Hispanic | 42 | 157 | 169 | 106 | 12 | 486 | 153 | 639 | 76.1% |
| White | 84 | 403 | 526 | 311 | 47 | 1371 | 375 | 1746 | 78.5% |
| Total | 267 | 898 | 970 | 559 | 78 | 2772 | 919 | 3691 | 75.1% |
| Percent | 9.6% | 32.4% | 35.0% | 20.2% | 2.8% | 75.1% | 24.9% | | |

Note: each size class includes the 3 sublevels created

Table 4.43: Distribution for “Proposed” Sizes by Age Group

| Age Group | Size | | | | | Totals | | | Percent Within Standard |
|----------------|-------------|--------------|--------------|--------------|-------------|-----------------|-----------------|-------------|-------------------------|
| | Small | Medium | Large | XL | XXL | Within Standard | Out of Standard | Subjects | |
| 1: 18-25 | 152 | 279 | 162 | 74 | 12 | 679 | 316 | 995 | 68.2% |
| 2: 26-34 | 45 | 238 | 183 | 108 | 12 | 586 | 202 | 788 | 74.4% |
| 3: 35-44 | 43 | 211 | 263 | 132 | 19 | 668 | 170 | 838 | 79.7% |
| 4: 45-54 | 22 | 116 | 215 | 127 | 20 | 500 | 126 | 626 | 79.9% |
| 5: 55-64 | 3 | 40 | 83 | 83 | 11 | 220 | 62 | 282 | 78.0% |
| 6: 65+ | 2 | 14 | 64 | 35 | 4 | 119 | 43 | 162 | 73.5% |
| Total | 267 | 898 | 970 | 559 | 78 | 2772 | 919 | 3691 | |
| Percent | 9.6% | 32.4% | 35.0% | 20.2% | 2.8% | 75.1% | 24.9% | | |

Note: each size class includes the 3 sublevels created

4.3.2 Changes to Undershirt Specifications

In an attempt to increase the number of males meeting sizing specifications, changes were also made to the undershirt ASTM specifications. ASTM chest specifications were not altered because they appeared to adequately meet subject's measurements. However, neck, arm, and across shoulder specifications were changed in order to allow more subjects to meet a size category.

Table 4.44, is the "Proposed" classifications for undershirts. For each size designation (small, medium, large, x large, 2x large), chest measurement specifications remained the same. To allow more subjects to meet specifications sublevels needed to be created that resulted in a widening, narrowing, and/or shifting of the original specifications. As mentioned previously, the ASTM Standard had 4 sublevels under each size class. The sublevels were based on the one circumferential dimension of the body that assumed the predominant role. For undershirts, sublevels in the ASTM Standard were based on chest measurements. However, for "Proposed" classifications, 2 sublevels were created to minimize variability. With chest measurements held constant, 2 sublevels were created by altering the ranges of the neck, arm, and across shoulder specifications within each size designation.

Table 4.45 outlines the changes made in inches to the upper and lower bounds of neck, arm, and across shoulder specifications. The effects of the "Proposed" specifications are illustrated in Figures 4.31-4.34. Bivariate plots of the new specifications, neck, arm, and across shoulder are plotted only against chest measurements since it is the only variable that remained constant.

For neck measurements, in order to satisfy more subjects, the lower bounds were slightly narrowed except for size small, which remained the same. The upper bounds of all sizes were widened by at least 1 ¼ inch, which allowed a sizeable number of subjects with higher neck base measurements to meet specifications. The changes to this specification are illustrated in Figure 4.31.

The armscye specifications were widened for all sizes. The lower bounds of all sizes were widened to include the significant cluster of subjects that had thigh measurements smaller than the specifications. In addition upper bounds of all sizes except small were widened. The changes to this specification are illustrated in Figure 4.32.

Across shoulder specifications for all size categories were slightly shifted to the left. The lower bounds were increased by adding about 2 inches, which allowed clusters of subjects to fall within a specification range. The upper bounds for all sizes decreased which caused an almost uniform shift. For all sizes, ASTM measurement specifications for across shoulder were too large for a significant portion of the subjects. The changes to these specifications are illustrated in Figure 4.33.

Table 4.44: Proposed Undershirts Specifications

| Measurements (inches) | Size | | | | | | | | | |
|--------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| | Small | | Medium | | Large | | X Large | | 2X Large | |
| | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| Chest | 34.00-37.45 | | 37.45-42.45 | | 42.45-46.45 | | 46.45-49.45 | | 49.45-53.40 | |
| Neck base | 14.00- 15.50 | 15.50- 17.00 | 15.00- 16.50 | 16.50- 18.00 | 16.00- 17.00 | 17.00- 18.00 | 17.00- 18.00 | 18.00- 19.00 | 18.00- 19.50 | 19.50- 21.00 |
| Armscopye | 15.00- 16.20 | 16.20- 17.37 | 16.00- 18.00 | 18.00- 20.00 | 16.00- 18.75 | 18.75- 21.50 | 18.00- 20.00 | 20.00- 22.00 | 19.00- 20.75 | 20.75- 22.50 |
| Across Shoulder | 14.00- 15.25 | 15.25- 16.50 | 15.00- 16.50 | 15.50- 17.00 | 15.00- 16.50 | 16.50- 18.00 | 16.00- 17.50 | 17.50- 19.00 | 17.00- 18.50 | 18.50- 20.00 |

Table 4.45: Specification Alterations

| NECK | Lower Bound | Upper Bound |
|-----------------|--------------------|--------------------|
| <i>Small</i> | 0.00 | 2.25 |
| <i>Medium</i> | 0.24 | 2.25 |
| <i>Large</i> | 0.24 | 1.26 |
| <i>X Large</i> | 0.25 | 1.25 |
| <i>2X Large</i> | 0.25 | 1.25 |
| ARMSCYE | Lower Bound | Upper Bound |
| <i>Small</i> | -1.37 | 0.00 |
| <i>Medium</i> | -1.38 | 1.13 |
| <i>Large</i> | -2.38 | 1.13 |
| <i>X Large</i> | -2.38 | 1.19 |
| <i>2X Large</i> | -1.82 | 0.44 |
| SHOULDER | Lower Bound | Upper Bound |
| <i>Small</i> | -2.50 | -0.37 |
| <i>Medium</i> | -1.88 | -0.75 |
| <i>Large</i> | -2.76 | -0.75 |
| <i>X Large</i> | -2.76 | -0.75 |
| <i>2X Large</i> | -2.76 | -0.69 |

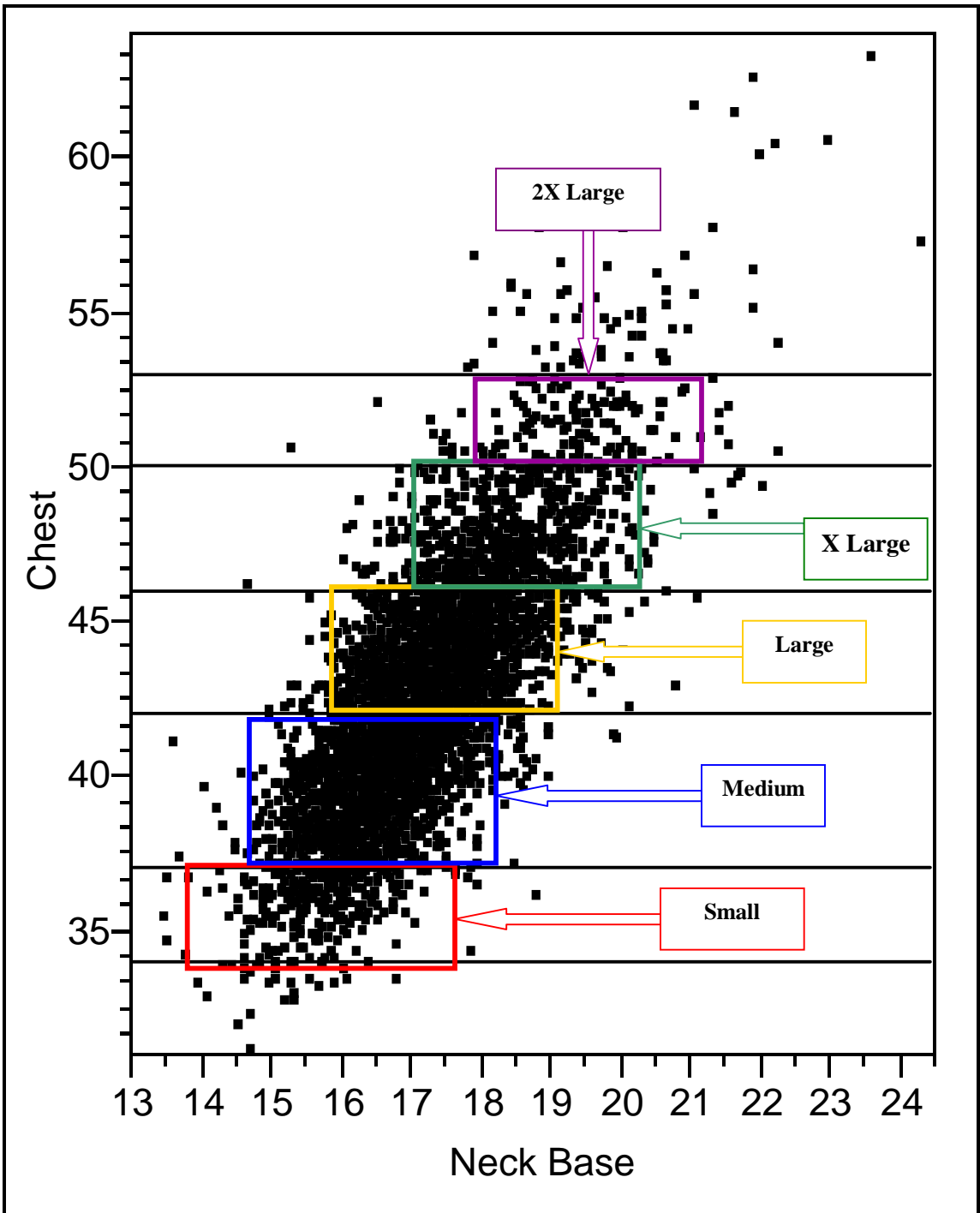
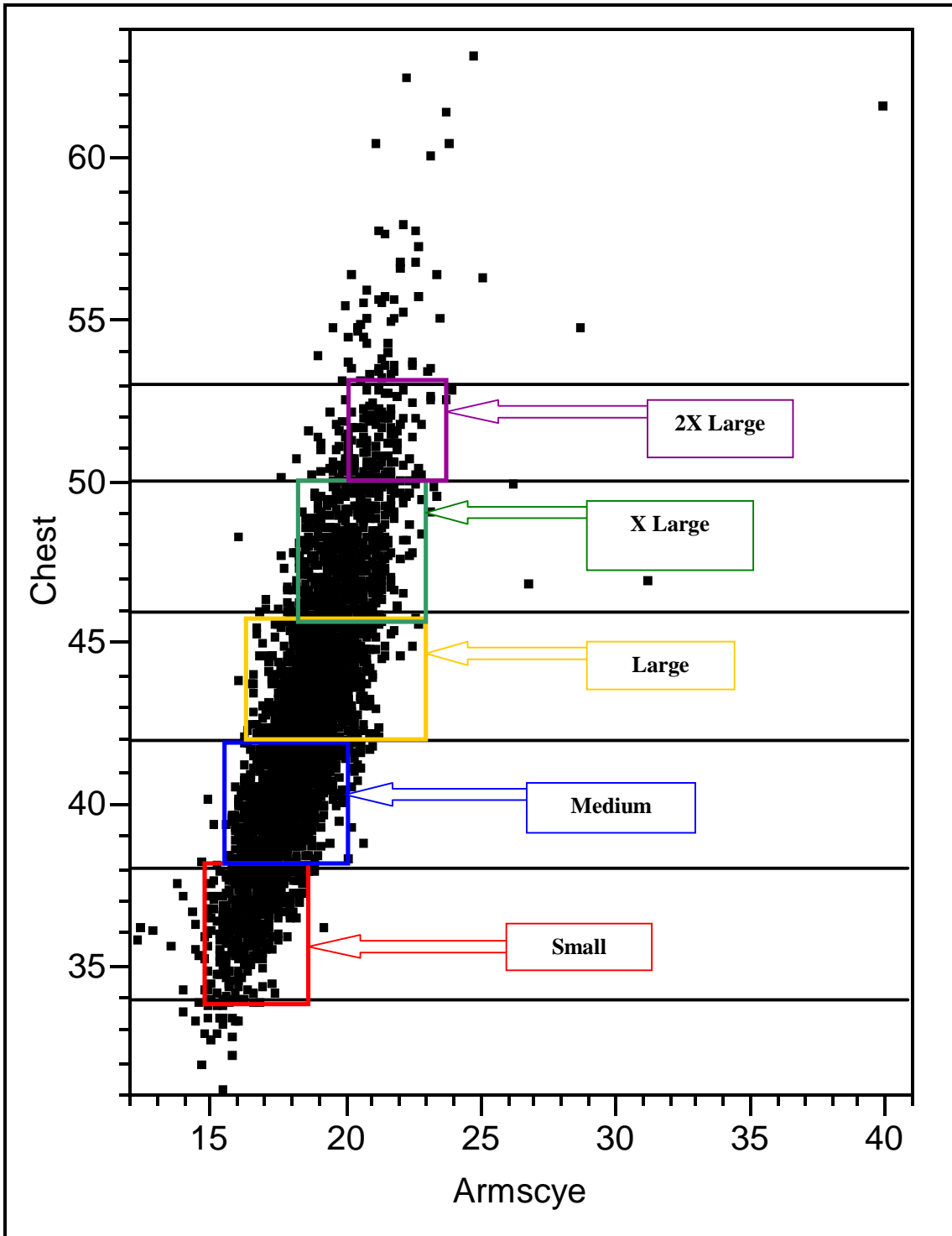


Figure 4.31: Proposed Bivariate Plot of Chest by Neck Base



4.32: Proposed Bivariate Plot of Chest by Armscye

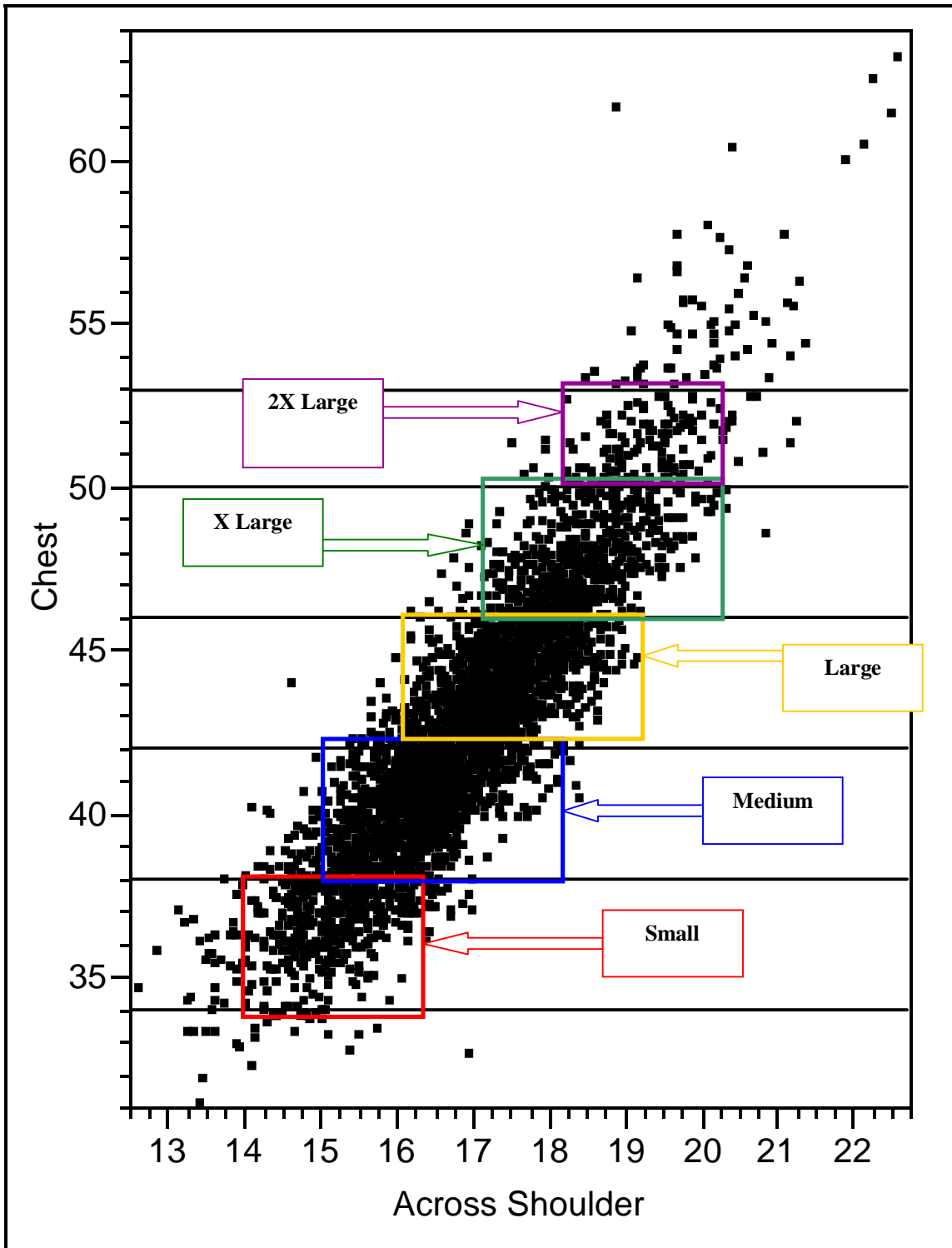


Figure 4.33: Proposed Bivariate Plot of Chest by Across Shoulder

4.3.2.1 Effect of Specification Changes

Tables 4.46 and 4.47 show the results of the changes to the ASTM Standards. The changes to the ASTM Standard allowed 81% of the subjects to meet specs for sizes small to 2x-large. The “Proposed” classifications allowed a sizeable number of subjects to fall into size designations. In this “Proposed” classification there was only a 19% failure rate, with a total of 81% of all subjects falling within a size category. This is a significant improvement when compared the original standard’s 99% failure rate. Large portions of the subjects were clustered outside of the original specifications. The “Proposed” specifications enabled more subjects to meet a size designation. In the original standard, sizes medium and 2XL satisfied most subjects, however, for the Proposed classification, sizes medium and large satisfied more than 75% of subjects.

In Table 4.46, the new specifications satisfied at least 79% of all ethnic groups. The Proposed specifications resulted in specs being met by 79% Blacks, 81% Others, 81% Hispanics, and 79% Whites. In the original standards Whites conformed to standards with most satisfaction, however, for the “Proposed” specifications, Hispanics and Others will be most satisfied. In Table 4.47, at least 70% of each age group met undershirts size specifications. In the original standard, age group 4:45-54 accounted for the largest number of subjects to meet specifications, however, for the “Proposed” classification, age groups 1-4 (18-54) all have the highest satisfaction rate of 82%. Due to the fact that these new specifications do not take into account the body changes that effect the 55 and older population (age groups 5 &6) experience, those age groups did not comply with

standards all well as younger age groups. The variability seen in ethnic and age group's compliance to the "Proposed" classifications is likely due to varying body proportions within these groups.

Table 4.46: Distribution for "Proposed" Sizes by Ethnic Group

| Ethnicity | Size | | | | | Totals | | | Percent Within Standard |
|------------------|-------|--------|-------|-------|------|-----------------|-----------------|----------|-------------------------|
| | Small | Medium | Large | XL | XXL | Within Standard | Out of Standard | Subjects | |
| Blacks | 46 | 248 | 187 | 60 | 18 | 559 | 150 | 709 | 79% |
| Others | 65 | 238 | 128 | 38 | 14 | 483 | 114 | 597 | 81% |
| Hispanics | 47 | 212 | 175 | 65 | 19 | 518 | 121 | 639 | 81% |
| Whites | 77 | 595 | 524 | 176 | 63 | 1435 | 311 | 1746 | 82% |
| Total | 235 | 1293 | 1014 | 339 | 114 | 2995 | 696 | 3691 | |
| Percent | 7.8% | 43.2% | 33.9% | 11.3% | 3.8% | 81.1% | 18.9% | | |

Table 4.47: Distribution for "Proposed" Sizes by Age Group

| Age Group | Size | | | | | Totals | | | Percent Within Standard |
|-----------------|-------|--------|-------|-------|------|-----------------|-----------------|----------|-------------------------|
| | Small | Medium | Large | XL | XXL | Within Standard | Out of Standard | Subjects | |
| 1: 18-25 | 138 | 438 | 172 | 45 | 22 | 815 | 180 | 995 | 82% |
| 2: 26-35 | 41 | 287 | 220 | 72 | 23 | 643 | 145 | 788 | 82% |
| 3: 36-45 | 30 | 258 | 274 | 95 | 31 | 688 | 150 | 838 | 82% |
| 4: 46-55 | 23 | 179 | 208 | 76 | 26 | 512 | 114 | 626 | 82% |
| 5: 56-65 | 1 | 88 | 96 | 31 | 8 | 224 | 58 | 282 | 79% |
| 6: 66+ | 2 | 43 | 44 | 20 | 4 | 113 | 49 | 162 | 70% |
| Total | 235 | 1293 | 1014 | 339 | 114 | 2995 | 696 | 3691 | |
| Percent | 7.8% | 43.2% | 33.9% | 11.3% | 3.8% | 81.1% | 18.9% | | |

4.4 Men's Underwear Survey Analysis

The fourth and final objective of the research was to determine if males in the US were satisfied with the fit of their undergarments. Analysis of the online Men's Underwear Fit Survey was used to complete this objective.

A total of 210 respondents replied to the survey. However, due to unanswered questions regarding pertinent demographics, such as ethnicity and age, 5 respondents and their answers were eliminated from the analysis. Therefore responses from a total of 205 respondents were analyzed. A sample of the survey is found in Appendix 1-B. The survey was broken into 4 sections: demographics, background information, fit description, and fit satisfaction/dissatisfaction. Results of the survey are presented in this section. Survey results were summarized in percentages based on the total number of respondents to answer each question. On some questions respondents were allowed to select multiple answers. Where this is the case, percentages will not total to 100%.

4.4.1 Demographics

The summary of the demographic information that resulted from the Men's Fit Survey is found in Table 4.48, 4.49 and 4.50. Regarding age, it was observed that most of the respondents were from the 18-25 age group. There were fewer respondents that took the survey as age group increased. The desired percentage by ethnic designation, based on the U.S. 2000 Census was not achieved. However, the following percentages were achieved by ethnicity: 22% Black, 66% White, 5% Hispanic, 5% Asian, and 2% "Other". More than half of the respondents were in the 150-199 lbs weight range. In addition, more than half of the respondents were professional, while students accounted for a considerable percentage of respondents.

Table 4.48: Demographics-1

| Age | Percent |
|---------------------|----------------|
| 18-25 | 39% |
| 26-35 | 24% |
| 36-45 | 20% |
| 46-55 | 13% |
| 56-65 | 4% |
| Ethnicity | Percent |
| Black | 22% |
| White | 66% |
| Asian | 5% |
| Hispanic | 5% |
| Native American | 0% |
| Other | 2% |
| Weight (lbs) | Percent |
| <97 | 0% |
| 97-119 | 1% |
| 120-149 | 14% |
| 150-199 | 53% |
| 200-249 | 27% |
| >250 | 5% |

Note: Age Group and Ethnicity percentages are based on 205 responses.
Weight percentages are based on 204 responses

Table 4.49: Demographics-2

| Occupation | Percent |
|----------------------------|----------------|
| Professional/Office Worker | 53% |
| Technical/Craftsperson | 4% |
| Service Worker | 2% |
| Entertainer | 1% |
| Construction/Landscape | 2% |
| Athlete | 0% |
| Homemaker | 0% |
| Retired | 0% |
| Student | 35% |
| Other | 1% |

Note: Occupation percentages are based on 202 responses.

Table 4.50: Demographics-3

| State | Number of respondents | Percent |
|-----------------|-----------------------|---------|
| Arkansas | 2 | 1% |
| California | 2 | 1% |
| Washington D.C. | 5 | 2% |
| Florida | 5 | 2% |
| Georgia | 2 | 1% |
| Illinois | 2 | 1% |
| Kentucky | 1 | 0% |
| Maryland | 1 | 0% |
| Michigan | 1 | 0% |
| Minnesota | 1 | 0% |
| North Carolina | 148 | 73% |
| New Jersey | 5 | 2% |
| New York | 14 | 7% |
| Ohio | 1 | 0% |
| South Carolina | 1 | 0% |
| Texas | 1 | 0% |
| Virginia | 7 | 3% |
| Vermont | 1 | 0% |
| Washington | 1 | 0% |
| Wisconsin | 1 | 0% |

Note: State percentages are based on 202 responses.

4.4.2 Background Information

In an attempt to understand more about the respondent's questions regarding underwear styles (i.e. boxers, briefs) and brands worn (i.e. Hanes, Jockey) and purchase behavior (use of sizing charts) were asked. Based on the number of responses obtained for each answer option, a summary in percentages was given. As seen in Table 4.51, the type of underwear that was worn mostly by respondents was boxer shorts, at 38%. A considerable percentage of the men surveyed also wore boxer briefs (31%) and briefs (~25%). Based on Table 4.52, about 40% of the respondents wore crew neck undershirts.

Table 4.53 summarizes the underwear brands worn by respondents. It is seen that Hanes was the most popular brand worn for both underpants and undershirts. The second most identified brand worn was Fruit of the Loom. However, the percent of men selecting “Other” in lieu of a brand name was approximately the same as those selecting either Hanes or Fruit of the Loom. Also, based on Table 4.54, an important finding from the survey was that approximately 25% of the respondents reported that they “sometimes” used sizing charts while 36% “always” used sizing charts when purchasing underwear.

Table 4.55 summarizes the percentage of respondents that wear sizes small to 3x-large or larger. Based on these results it was found that most of the men surveyed wore sizes medium and large underpants. This parallels the results from Objective 2 which found that based on ASTM standards, most of the male subjects in Size USA data met the specifications for size medium underpants (refer to Table 4.38). Regarding undershirts, most of the respondents wore sizes medium and large. Objective 2’s findings for undershirts showed that most of the subjects from the Size USA data met the specifications for sizes medium and 2x- large. The results from the survey in addition to the results from Objective 2 provide evidence that size medium undershirts were selected by a significant number of U.S. males.

Table 4.51: Underpants Styles Worn

| Boxer | Boxer Briefs | Briefs | Bikinis | Other |
|--------------|---------------------|---------------|----------------|--------------|
| 38.02% | 31.31% | 24.60% | 5.11% | 0.96% |

Note: Percentages based on 205 responses.

Table 4.52: Undershirts Styles Worn

| Tank | V-Neck | Crew |
|--------|--------|--------|
| 17.25% | 16.93% | 48.56% |

Note: Percentage based on 193 responses.

Table 4.53: Brands Worn

| | Jockey | Hanes | Fruit of the Loom | Calvin Klein | Tommy Hilfiger | Polo Ralph Lauren | Other |
|--------------------|--------|--------|-------------------|--------------|----------------|-------------------|--------|
| Underpants | 10.09% | 24.65% | 18.08% | 9.15% | 6.10% | 8.69% | 23.24% |
| Undershirts | 7.46% | 34.33% | 22.39% | 6.57% | 2.69% | 5.67% | 20.90% |

Note: Percentages based on 204 responses for UNDERPANTS and 185 responses for UNDERSHIRTS

Table 4.54: Use of Sizing Charts

| Always | Sometimes | Not Sure | Rarely | Never |
|--------|-----------|----------|--------|--------|
| 36.10% | 25.37% | 4.39% | 20.98% | 13.17% |

Note: Percentages based on 204 responses

Table 4.55: Underpants & Undershirt Sizes

| | Small | Medium | Large | XLarge | 2XLarge | ≥3XL |
|--------------------|-------|--------|--------|--------|---------|-------|
| Underpants | 3.83% | 29.39% | 22.68% | 7.99% | 1.28% | 0.64% |
| Undershirts | 4.15% | 16.61% | 23.96% | 13.42% | 3.83% | 0.96% |

Note: Percentages based on 205 responses for UNDERPANTS and 196 responses for UNDERSHIRTS

4.4.3 Fit Description

Respondents assessed the fit of different styles of underwear based on a scale of 1-5, (1 implied tight and 5 implied loose) at key locations. It was determined based on percentages how men perceived the fit of their underpants (too tight or too loose). Table 4.56, summarizes the results by percentages. Respondents described the fit of boxer shorts in various locations as: waistband fit was neutral, leg opening was slightly loose, hips were neutral, and the fit in the seat was described equally as neutral and slightly loose. For boxer briefs, the majority of respondents was either neutral or found the fit of key areas slightly tight. Likewise, for briefs and bikinis, respondents were predominately neutral or found the fit slightly tight in locations of interest. More respondents described bikinis as being tight than any other underpants. On average, approximately 20% of respondents described bikinis as too tight in all locations.

Respondents also assessed the fit of undershirts as reported in Table 4.57. The following was reported for undershirts: 1. the majority of respondents were neutral about the overall fit of crew neck shirts. Also, similar percentages reported crew neck undershirts to be slightly tight; 2. most described the fit in the chest and abdomen of tanks to be slightly tight and on average 20% described the fit in chest and abdomen of tanks as tight; and 3. respondents found the overall fit of v-necks to be neutral. However, 12% of respondents who wear v-neck undershirts reported the neck to be loose.

Table 4.56: Underpants Fit Description

| BOXERS | | | | | |
|------------------------|----------------|----------|----------|----------|----------------|
| Fit Description | | | | | |
| Location | 1=Tight | 2 | 3 | 4 | 5=Loose |
| Waistband | 5% | 22% | 57% | 14% | 2% |
| Leg Opening | 2% | 8% | 26% | 34% | 30% |
| Hips | 1% | 11% | 41% | 33% | 14% |
| Seat | 0% | 8% | 38% | 38% | 15% |
| BOXER BRIEFS | | | | | |
| Fit Description | | | | | |
| Location | 1=Tight | 2 | 3 | 4 | 5=Loose |
| Waistband | 16% | 41% | 38% | 5% | 0% |
| Leg Opening | 14% | 40% | 28% | 13% | 4% |
| Hips | 10% | 36% | 37% | 15% | 1% |
| Seat | 12% | 31% | 41% | 12% | 5% |
| BRIEFS | | | | | |
| Fit Description | | | | | |
| Location | 1=Tight | 2 | 3 | 4 | 5=Loose |
| Waistband | 14% | 37% | 42% | 7% | 0% |
| Leg Opening | 13% | 33% | 50% | 3% | 1% |
| Hips | 8% | 20% | 60% | 9% | 2% |
| Seat | 9% | 20% | 53% | 15% | 2% |
| BIKINIS | | | | | |
| Fit Description | | | | | |
| Location | 1=Tight | 2 | 3 | 4 | 5=Loose |
| Waistband | 19% | 44% | 22% | 15% | 0% |
| Leg Opening | 19% | 48% | 26% | 4% | 4% |
| Hips | 22% | 37% | 37% | 4% | 0% |
| Seat | 26% | 37% | 33% | 4% | 0% |

Note: Percentages are based on the following: BOXERS 130 responses; BOXER BRIEF 104 responses; BRIEFS 86 response; and BIKINIS 25 responses

Table 4.57: Undershirts Fit Description

| CREW NECK | | | | | |
|------------------------|------------------------|----------|----------|----------|----------------|
| | Fit Description | | | | |
| Location | 1=Tight | 2 | 3 | 4 | 5=Loose |
| Neck | 5% | 36% | 40% | 14% | 6% |
| Upper Arms & Shoulders | 6% | 36% | 32% | 21% | 5% |
| Chest | 8% | 33% | 37% | 19% | 3% |
| Abdomen | 3% | 19% | 42% | 26% | 9% |
| TANK | | | | | |
| | Fit Description | | | | |
| Location | 1=Tight | 2 | 3 | 4 | 5=Loose |
| Chest | 22% | 52% | 16% | 7% | 3% |
| Abdomen | 18% | 40% | 27% | 12% | 3% |
| V-NECK | | | | | |
| | Fit Description | | | | |
| Location | 1=Tight | 2 | 3 | 4 | 5=Loose |
| Neck | 1.5% | 24% | 41% | 22% | 12% |
| Upper Arms & Shoulders | 7% | 26% | 46% | 15% | 6% |
| Chest | 9% | 32% | 38% | 15% | 6% |
| Abdomen | 4% | 19% | 47% | 21% | 9% |

Note: Percentages are based on the following: CREW 143 responses; TANK 65 responses; and V-NECK 66 responses.

4.4.4 Fit Satisfaction/Dissatisfaction

In this portion of the survey, respondents were asked to determine satisfaction and dissatisfaction with underpants and undershirts at key locations. Responses in this section were summarized based on the percentage of respondents that found either satisfaction or dissatisfaction with one of the key locations of their underwear. For underpants, respondents determined satisfaction and dissatisfaction with the following locations on their underpants: waistband, seat, hips, and thighs. For undershirts, respondent’s satisfaction and dissatisfaction with fit in the following areas was assessed: neck, upper arms and shoulder, chest and waist.

Table 4.58 summarizes respondent’s satisfaction with key locations of their underpants. For briefs, satisfaction was mostly found with the waistband (33%), followed by seat, hips, and thigh, respectively. Respondents were most satisfied with the waistband of boxers (33%). This was followed by seat, thigh and hips, respectively. Satisfaction for boxer briefs was found to be highest for thighs. This was followed by waistband, seat, and hips respectively. For bikinis, waistbands were found to be most satisfactory to respondents. This was followed by seat and hips (19%), which were equally satisfactory, and thigh (13%)

Table 4.58: Underpants Satisfaction

| Style | Waistband | Seat | Hips | Thighs |
|--------------|------------------|-------------|-------------|---------------|
| Briefs | 33% | 25% | 19% | 17% |
| Boxers | 33% | 21% | 16% | 24% |
| Boxer Briefs | 26% | 24% | 19% | 27% |
| Bikinis | 25% | 19% | 19% | 13% |

Table 4.59 summarizes the percentage of respondents satisfied with the fit of their undershirts at key areas. For crew neck tees, satisfaction was mostly found with the neck area (30%). This was followed by upper arms and shoulders, waist, and chest, respectively. Respondents found most satisfaction with the waist of tanks, followed by upper arms and shoulders, chest, and neck, respectively. The location of highest satisfaction for v-neck tees was the neck (27%). This was followed by upper arms and shoulder, waist and chest, respectively.

Table 4.59: Undershirt Satisfaction

| Style | Neck | Upper Arm and Shoulder | Chest | Waist |
|--------------|-------------|-------------------------------|--------------|--------------|
| Crew Neck | 47% | 24% | 31% | 16% |
| Tank | 18% | 27% | 34% | 16% |
| V-Neck Tee | 32% | 18% | 32% | 11% |

It was determined that out of the 205 respondents, 76% were dissatisfied with at least one location of either their underpants and/or undershirts. In addition, 50% of respondents were dissatisfied with both underpants and undershirts. A summary of the characteristics of the dissatisfied respondents are found in Table 4.60. Of the 76% of respondents who were dissatisfied, 39% of them “always” used sizing charts when purchasing underwear. Dissatisfaction by age group was as follows: 76% of 18-25 year olds, 82% of 26-35 year olds, 83% of 36-45 year olds, 88% of 46-55 year olds, and 56% of 56-65 year olds. By age group, it appeared that as age increased dissatisfaction also increased, up to age 55. The trend may be due to the standards used in producing underwear that do not take into account the effect of age on body proportions. In addition, based on ethnic group dissatisfaction was found by the following percentages: 89% of Black, 76% of White, 73% Asian, 60% Hispanic, and 50% “Other”. As mentioned earlier, Giddings and Boles’ (1990) study found that the fit of commercially produced dress pants were not adequate for Black males who typically have small waists, large thighs, and high curvaceous buttocks. Therefore, the high dissatisfaction seen by Black respondents may be due to their varying body proportions.

Tables 4.60 and 4.61 show respondent’s dissatisfaction with underpants in key locations. Based on the 205 responses, 67% of the respondents were

dissatisfied with a least 1 area of their underpants. Of those dissatisfied with underpants, 41% of respondents wore a size medium and 32% wore size large. Fit dissatisfaction was found the in following areas: the thighs/leg opening of boxers, briefs, and boxer briefs and the seat of the bikinis. In Objective 2, it was determined that thigh and hip/seat specifications did not satisfy a considerable portion of the subjects in the Size USA study. This explains why those surveyed also were dissatisfied with the fit in those areas.

Table 4.62 summarizes the percentage of respondents dissatisfied with the fit of their undershirts at key areas. Based on the 205 responses, 60% of the respondents were dissatisfied with a least 1 area of their undershirts. Of those dissatisfied with undershirts, 25% of respondents wore a size x-large and 35% wore size large. Fit dissatisfaction with undershirts was found the in following areas: the neck and chest of the crew neck, the upper arm/ shoulder of the tank, and the neck and chest of the v-neck. In Objective 2 it was determined that specifications for neck, armscye, and shoulder were inadequate for the male population, based on Size USA measurement data. In addition, it was found that 99% of the subjects from the Size USA data did not meet the ASTM Standards for sizes small to 2x- large. The findings in Objective 2 gave further explanation as to why the respondents of this survey experienced such high levels of dissatisfaction for undershirts.

Table 4.60: Dissatisfied Respondents

| Ethnicity | Asian | Black | Hispanic | Other | White |
|------------------------------|---------------|------------------|-----------------|----------------|-----------------|
| | 89% | 76% | 73% | 60% | 50% |
| Age | 18-25 | 26-35 | 36-45 | 46-55 | 56-65 |
| | 76% | 82% | 83% | 88% | 56% |
| Sizing Charts | Always | Sometimes | Not Sure | Rarely | Never |
| | 39% | 21% | 21% | 12% | 8% |
| Size Worn-Underpants | Small | Medium | Large | X-Large | 2X-Large |
| | 6% | 42% | 32% | 15% | 2% |
| Size Worn-Undershirts | Small | Medium | Large | X-Large | 2X-Large |
| | 4% | 21% | 35% | 25% | 7% |

Table 4.61: Underpants Dissatisfaction

| Style | Waistband | Seat | Hips | Thighs |
|--------------|------------------|-------------|-------------|---------------|
| Briefs | 20% | 19% | 13% | 24% |
| Boxers | 14% | 19% | 14% | 25% |
| Boxer Briefs | 16% | 19% | 11% | 24% |
| Bikinis | 19% | 27% | 18% | 19% |

Table 4.62: Undershirt Dissatisfaction

| Style | Neck | Upper Arm and Shoulder | Chest | Waist |
|--------------|-------------|-------------------------------|--------------|--------------|
| Crew Neck | 47% | 24% | 31% | 16% |
| Tank | 18% | 27% | 34% | 16% |
| V-Neck Tee | 32% | 18% | 32% | 11% |

V. CONCLUSIONS

Conclusions for this research will be based on objectives stated in section 3.1.1 of the Methodology.

5.1 **Body Measurements: Age and Ethnicity**

- 1) There are significant differences in the body measurements of ethnic groups with 95% confidence. Therefore, body measurements used in producing men's underpants and undershirts will differ among ethnic groups.
- 2) There is a significant difference in the body measurements of age groups with 95% confidence. Therefore, body measurements used in producing men's underpants and undershirts will differ among age groups.
- 3) Interaction between ethnicity and age group is significant at a 95% confidence level for both underpants and undershirt measurements. Thus, the impact of ethnic group on body measurements will depend on the age group and the impact of age group on body measurements will depend on the ethnicity.
- 4) Waist
 - a. There are no significant differences in waist measurements of Black Americans, White Americans, and Hispanic Americans. However, waist measurements for the category containing the "Other" group are significantly smaller than African Americans, White Americans, and Hispanic American.
 - b. Men in age group 1, ages 18-25, have significantly smaller waist measurements than all other age groups. In addition, waist measurements increased as age increased.
- 5) Crotch Length
 - a. There is no significant difference between the crotch length measurements of Hispanics and "Others". However, crotch length measurements for Blacks are significantly different than White, Hispanic, and "Other" men. In addition, Whites crotch length measurements are significantly different than Black, Hispanic, and "Other" men.
 - b. There is no significant effect of age group on crotch length measurements.
- 6) Hip
 - a. There are no significant differences in hip measurements between Blacks and Whites or Blacks and Hispanics. However, hip measurements for the group labeled "Other" are significantly

smaller than Black Americans, White Americans, and Hispanic Americans.

- b. Although men in age group 1 had the smallest hip measurements, there is no significant difference in hip measurements between age groups 1:18-25 and 6:66+. In addition, there are no significant differences in hip measurements between men in age groups 2-5 (ages 26-65).

7) Thigh

- a. There is no significant difference between the thigh measurements of Hispanics and "Others". However, thigh measurements for Blacks are significantly different than White, Hispanic, and "Other" men. In addition, thigh measurements of White men are significantly different than Black, Hispanic, and "Other" men.
- b. There are no significant differences between the thigh measurements of age groups: 2:26-35 and 3:36-45; 1:18-25 and 3:36-45; 4:46-55 and 5:56-65; 5:56-65 and 6:66+.

8) Neck

- a. There is no significant difference in neck base measurements of Black Americans, White Americans, and Hispanic Americans. However, neck base measurements for the category containing the "Other" group are significantly smaller than African Americans, White Americans, and Hispanic Americans.
- b. Men in age group 1, ages 18-25 have significantly smaller neck base measurements than age groups 2-6 (ages 26-66+). However, there are no significant differences between age groups 2-6.

9) Chest

- a. There are no significant differences in chest measurements of Black, White, and Hispanic men. However, chest measurements for the category containing the "Other" group are significantly smaller than African Americans, White Americans, and Hispanic Americans.
- b. Men in age group 1, ages 18-25 have significantly smaller chest measurements than age groups 2-6 (ages 26-66+). However, there are no significant differences between age groups 2-6.

10) Armscye

- a. There are no significant differences between the armscye measurements of Hispanics and Blacks. However, the "Other" groups armscye measurements are significantly smaller than Black, Hispanic, and "Other" men. In addition, armscye

measurements for Whites are significantly different than White, Hispanic, and “Other” men.

- b. Men in age group 1:18-25, have armscye measurements significantly smaller than age groups 2-5.

11) Across Shoulder

- a. There are no significant differences in across shoulder measurements of Black Americans, White Americans, and Hispanic Americans. However, across shoulder measurements for the category containing the “Other” group are significantly smaller than African Americans, White Americans, and Hispanic Americans.
- b. There was no significant difference between age groups 1 and 6. Age group 1 has significantly different (smaller) across shoulder measurements than age groups 2-5.

5.2 **Body Measurements versus ASTM Sizing**

- 1) Only 3% of the subjects from the Size USA Study met specifications for underpants size designations (small to 2x- large). Within that 3%, Blacks and age group 1:18-25 met ASTM Standards most aptly. In addition, size medium was most fitting to subjects within that 3%.
- 2) Only 1% of the subjects from the Size USA Study met specifications for underpants size designations (small to 2x- large). Within that 1%, Whites and age group 4:46-55 met ASTM Standards most aptly. In addition, sizes medium and 2XL were most fitting to subjects within that 1%.

5.3 **“Proposed” Size Classifications**

- 1) The “Proposed” classifications for underpants and undershirts accommodate several different ethnic groups and age groups.
- 2) Based on the “Proposed” classifications, 75% of the Size USA subjects met specifications for underpants. Of that 75%, Whites and age groups 3:36-45 and 4:46-55 met “Proposed” specifications more aptly. In addition, size large was most fitting to subjects.
- 3) Based on the “Proposed” classifications, 81% of the Size USA subjects met specifications for undershirts. Of that 81%, “Others” and Hispanics as well as age groups 1-4(18-55) met the “Proposed” specifications more aptly. In addition size medium was most fitting to subjects.

5.4 Men's Fit Underwear Survey

- 1) Blacks and the 46-55 year olds experienced highest dissatisfaction with their underwear (underpants and undershirts).
- 2) 67% of survey respondents were dissatisfied with at least one area of their underpants. Of that 67%, the most dissatisfaction was found with the thigh opening of briefs, boxers, and boxer briefs. However, the seat area was found to be most dissatisfactory for bikinis.
 - a. Of the 67% of respondents that were dissatisfied with underpants, most (42%) wore a size medium.
- 3) 60% of survey respondents were dissatisfied with at least one area of their undershirts. Of that 60%, the most dissatisfaction was found with the neck of crews, chest of tanks, and neck and chest equally were dissatisfactory to subjects.
 - a. Of the 67% of respondents that were dissatisfied with underpants, most (35%) wore a size large.

VI. Future Research

This thesis provides the framework and background for further study in the area of resizing men's clothing and improving fit satisfaction. Studies based on these findings may include a concentration on the effect of size specifications on individuals as they age and the effect of ethnicity on sizing and fit satisfaction. Further investigation into these areas might include more detailed surveys and/or interactive interviews combined with further statistical analysis of studies such as the Size USA study. This approach would provide a more complete investigation into the problem of inadequate size standards.

Further investigation into creating new size standards for men's underwear will require additional analysis of the ASTM Size Standards and the "Proposed" classifications as they relate to the American population. A continuation to this research would be to apply the "Proposed" specifications to pattern making in order to determine the U.S. male population's satisfaction with the "Proposed" classifications. A suggested experiment can be based on a sampling of U.S. male subjects from at least Asian, Black, Hispanic, White ethnic groups, who are between ages 18-65. The subjects would assess the fit of underwear (underpants and undershirts) produced with ASTM specifications and the "Proposed" specifications. The fit assessments would then be compared. In order to obtain unbiased responses, prior to fit assessment the subjects would not be made aware of the difference in underwear design. The findings from this study may substantiate the need to apply partially or entirely, the "Proposed" specifications to men's underwear sizing.

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APPENDIX



Standard Tables of Body Measurements for Men Sizes Thirty-Four to Sixty (34 to 60) Regular¹

This standard is issued under the fixed designation D 6240; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript (epsilon) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These standard tables cover the body measurements of men from size thirty-four to sixty. Although these are body measurements, they can be used in designing apparel for men in this size range when such factors as fabric type, ease of body movement, styling, and fit are taken into account.

1.2 The values stated in either acceptable metric units or in other units shall be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system must be used independently of the other, without combining values in any way.

1.3 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. Referenced Documents

2.1 ASTM Standards:

- D 123 Terminology Relating to Textiles²
- D 5219 Terminology Relating to Body Dimensions for Apparel Sizing³

2.2 ISO Standard:

- ISO 3635 Size Designation of Clothes, Definitions, and Body Measurement Procedures Apparel Sizes⁴

3. Terminology

3.1 Definitions:

3.1.1 For definitions relating to body dimensions, refer to Terminology D 5219.

3.1.2 For definitions of other textile terms used in these tables, refer to Terminology D 123.

4. Significance and Use

4.1 The use of the body measurement information in Tables 1-4 will assist manufacturers in the development of patterns and garments that are consistent with the current anthropometric characteristics of the population of interest. These standard tables in turn should reduce or minimize consumer confusion and dissatisfaction related to apparel sizing. (Also refer to ISO 3635.)

5. Apparatus

5.1 *Tape Measure*, (dimensionally stable and approximately 1.5 cm (1/2 in.) wide and graduated accurately in cm (1/16 in.)).

5.2 *Plastic Goniometer*, to measure the radian (degree) of shoulder slope.

5.3 *Scale*, standard, calibrated, body weight type.

5.4 *Metal Ruler*.

6. Procedure

6.1 General Procedure:

6.1.1 For all vertical and most horizontal measurements, subject is to be standing erect without shoes and with feet approximately 15 cm (6 in.) apart.

6.1.2 Take measurements over basic undergarments normally worn.

6.1.3 Take all measurements except torso circumferences, height, and weight from the same side of the body for consistency.

6.2 Body Measurements:

6.2.1 *Body weight*—Weigh the subject.

6.2.2 *Chest*—Measure the circumference of the body parallel to the floor, under the arms, and over the fullest part of the chest.

6.2.3 *Waist*—Measure horizontally around the body at waist height.

6.2.4 *Seat (hip)*—Measure horizontally around the body at hip height.

6.2.5 *Head circumference*—Measure the circumference of the head above the ears. 6

¹ These tables are under the jurisdiction of ASTM Committee D-15 on Textiles and is the direct responsibility of Subcommittee D15.53 on Body Measurement for Apparel Sizing.

Current edition approved March 10, 1998. Published August 1998.

² Annual Book of ASTM Standards, Vol. 09.01.

³ Annual Book of ASTM Standards, Vol. 09.02.

⁴ Available from: American National Standards Institute, 11 W. 42nd St., 12th Floor, New York, NY 10036.

TABLE 3 New ASTM Men's Measurement Table

| | Small (34-37) | | | | Medium (38-41) | | | | Large (42-45) | | | | X-Large (46-49) | | | |
|-----------------------------------|-----------------------------|--------|--------|--------|----------------|--------|--------|--------|---------------|--------|--------|--------|-----------------|--------|--------|--|
| Weight (Approximate pounds) | 128 | 131 | 138 | 145 | 153 | 165 | 180 | 185 | 195 | 200 | 210 | 215 | 230 | 235 | 245 | |
| | Girth Measurements (in.) | | | | | | | | | | | | | | | |
| Sizes | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | |
| Chest | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | |
| Waist | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 1/4 | 40 1/2 | 41 3/4 | 43 | |
| Seat (hip) | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | |
| Head circumference | 21 1/2 | 21 3/4 | 22 | 22 1/4 | 22 1/2 | 22 3/4 | 22 3/4 | 22 3/4 | 22 3/4 | 23 1/4 | 23 1/2 | 23 1/2 | 23 1/2 | 24 1/4 | 24 1/4 | |
| Neck base | 14 | 14 1/4 | 14 1/2 | 14 3/4 | 15 | 15 1/4 | 15 1/2 | 15 3/4 | 16 | 16 1/4 | 16 1/2 | 16 3/4 | 17 | 17 1/4 | 17 1/2 | |
| Shoulder circumference | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | |
| Armscye | 18 3/4 | 18 3/4 | 17 | 17 3/4 | 17 3/4 | 18 1/4 | 18 1/2 | 18 3/4 | 19 1/4 | 19 1/4 | 19 3/4 | 20 | 20 3/4 | 21 1/2 | 21 1/2 | |
| Upper arm | 11 1/2 | 11 3/4 | 12 | 12 1/4 | 12 3/4 | 13 | 13 1/4 | 13 3/4 | 13 3/4 | 13 3/4 | 14 | 14 1/4 | 14 1/2 | 14 3/4 | 15 | |
| Elbow | 10 3/4 | 11 1/4 | 11 1/4 | 11 1/4 | 11 1/4 | 11 1/4 | 12 | 12 1/4 | 12 3/4 | 12 3/4 | 12 3/4 | 12 3/4 | 13 1/4 | 13 1/4 | 13 1/2 | |
| Wrist | 6 3/4 | 6 3/4 | 7 | 7 1/4 | 7 1/4 | 7 3/4 | 7 1/2 | 7 3/4 | 7 3/4 | 7 3/4 | 8 | 8 1/4 | 8 1/4 | 8 3/4 | 8 3/4 | |
| Thigh | 20 3/4 | 21 1/4 | 22 | 22 3/4 | 23 1/4 | 23 3/4 | 24 1/2 | 25 1/4 | 25 3/4 | 26 3/4 | 27 | 27 3/4 | 28 1/4 | 28 3/4 | 29 1/2 | |
| Knee | 14 1/2 | 14 3/4 | 15 | 15 1/4 | 15 1/2 | 15 3/4 | 16 | 16 1/4 | 16 1/2 | 16 3/4 | 17 | 17 1/4 | 17 1/2 | 17 3/4 | 18 | |
| Calf | 13 1/2 | 13 3/4 | 14 | 14 1/4 | 14 1/2 | 14 3/4 | 15 | 15 1/4 | 15 1/2 | 15 3/4 | 16 | 16 1/4 | 16 1/2 | 16 3/4 | 17 | |
| Ankle | 8 1/2 | 8 3/4 | 9 | 9 1/4 | 9 1/2 | 9 3/4 | 10 | 10 1/4 | 10 1/2 | 10 3/4 | 11 | 11 1/4 | 11 1/2 | 11 3/4 | 12 | |
| Trunk (total trunk, torso) | 59 1/4 | 60 3/4 | 61 1/2 | 62 1/2 | 63 1/2 | 64 1/2 | 65 1/2 | 66 3/4 | 66 3/4 | 67 3/4 | 68 1/4 | 68 3/4 | 69 3/4 | 70 1/4 | 70 3/4 | |
| Total crotch | 24 1/2 | 25 1/4 | 25 3/4 | 26 3/4 | 27 | 27 1/2 | 28 | 28 1/2 | 29 | 29 1/2 | 30 | 30 1/2 | 31 | 31 1/2 | 32 | |
| | Vertical Measurements (in.) | | | | | | | | | | | | | | | |
| Sizes | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | |
| Stature | 67 3/4 | 68 1/2 | 68 1/2 | 69 1/4 | 69 3/4 | 69 3/4 | 70 1/4 | 70 3/4 | 70 3/4 | 70 3/4 | 71 1/4 | 71 1/4 | 71 3/4 | 71 1/2 | 71 3/4 | |
| Cervicale height | 58 3/4 | 58 1/4 | 59 | 59 1/4 | 59 3/4 | 60 1/4 | 60 1/2 | 60 1/4 | 60 1/4 | 60 3/4 | 61 1/4 | 61 1/4 | 61 1/2 | 61 3/4 | 61 3/4 | |
| Head height, including neck | 9 3/4 | 9 3/4 | 9 1/2 | 9 3/4 | 9 3/4 | 9 1/4 | 9 3/4 | 9 3/4 | 9 3/4 | 9 3/4 | 9 3/4 | 9 3/4 | 9 3/4 | 9 3/4 | 9 3/4 | |
| Waist height | 41 3/4 | 41 3/4 | 42 | 42 3/4 | 42 1/2 | 42 3/4 | 43 | 43 1/4 | 43 1/4 | 43 3/4 | 43 1/2 | 43 3/4 | 43 3/4 | 43 3/4 | 43 3/4 | |
| Armscye depth | 4 1/4 | 5 | 5 1/4 | 5 1/4 | 5 1/4 | 5 1/4 | 5 1/4 | 5 1/4 | 5 1/4 | 5 1/4 | 5 1/4 | 5 1/4 | 5 1/4 | 5 1/4 | 5 1/4 | |
| Arm inseam | 19 | 19 | 19 | 18 3/4 | 18 3/4 | 18 3/4 | 18 3/4 | 18 3/4 | 18 3/4 | 18 3/4 | 18 1/2 | 18 3/4 | 18 3/4 | 18 3/4 | 18 1/4 | |
| Crotch height (inseam) | 32 1/4 | 32 1/4 | 32 1/4 | 32 3/4 | 32 3/4 | 32 3/4 | 32 3/4 | 32 3/4 | 32 3/4 | 32 3/4 | 32 3/4 | 32 3/4 | 32 3/4 | 32 3/4 | 32 3/4 | |
| Knee height | 17 1/2 | 17 1/2 | 17 3/4 | 17 3/4 | 18 | 18 | 18 1/4 | 18 1/4 | 18 1/4 | 18 1/4 | 18 1/4 | 18 3/4 | 18 3/4 | 18 1/2 | 18 1/2 | |
| Ankle height | 2 1/2 | 2 1/2 | 2 1/4 | 2 1/4 | 2 3/4 | 2 3/4 | 2 1/2 | 2 1/2 | 2 1/2 | 2 1/2 | 2 1/2 | 2 3/4 | 2 3/4 | 2 1/2 | 2 1/2 | |
| Waist length (cervicale to waist) | 16 3/4 | 16 3/4 | 17 | 17 1/4 | 17 1/4 | 17 3/4 | 17 1/2 | 17 3/4 | 17 3/4 | 17 3/4 | 17 3/4 | 17 3/4 | 17 3/4 | 17 3/4 | 17 3/4 | |
| True rise | 9 1/2 | 9 3/4 | 9 3/4 | 10 | 10 1/4 | 10 3/4 | 10 3/4 | 10 3/4 | 10 3/4 | 10 3/4 | 11 | 11 1/4 | 11 1/4 | 11 1/2 | 11 3/4 | |
| | Width and Length (in.) | | | | | | | | | | | | | | | |
| Sizes | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | |
| Across shoulder (point to point) | 16 1/2 | 16 5/8 | 16 3/4 | 16 7/8 | 17 | 17 1/4 | 17 1/2 | 17 3/4 | 18 | 18 1/4 | 18 1/2 | 18 3/4 | 19 | 19 1/4 | 19 1/2 | |
| Across chest 4 in. down | 15 | 15 1/4 | 15 1/2 | 15 3/4 | 16 | 16 1/4 | 16 1/2 | 16 3/4 | 17 | 17 1/4 | 17 1/2 | 17 3/4 | 18 | 18 1/4 | 18 1/2 | |
| Across back 5 in. down | 15 1/2 | 15 3/4 | 16 | 16 1/4 | 16 1/2 | 16 3/4 | 17 | 17 1/4 | 17 1/2 | 17 3/4 | 18 | 18 1/4 | 18 1/2 | 18 3/4 | 19 | |
| Shoulder slope degrees | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | |
| Cervicale to wrist | 32 | 32 1/4 | 32 1/4 | 32 3/4 | 32 3/4 | 33 1/4 | 33 1/4 | 33 1/4 | 33 1/4 | 34 | 34 1/4 | 34 3/4 | 34 3/4 | 34 3/4 | 34 3/4 | |
| Hand and foot width | 3 1/4 | 3 3/4 | 3 1/2 | 3 5/8 | 3 3/4 | 3 7/8 | 4 | 4 1/4 | 4 1/4 | 4 1/4 | 4 1/4 | 4 1/4 | 4 1/4 | 4 1/4 | 4 1/4 | |
| Hand length | 7 1/4 | 7 1/4 | 7 1/4 | 7 1/4 | 7 1/4 | 7 1/4 | 7 1/4 | 7 1/4 | 7 1/4 | 7 1/4 | 7 1/4 | 7 1/4 | 7 1/4 | 7 1/4 | 8 | |
| Foot length | 8 1/4 | 9 | 9 | 9 1/2 | 10 | 10 | 10 1/2 | 10 1/2 | 10 1/2 | 10 1/2 | 11 | 11 | 11 | 11 | 11 1/2 | |

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TABLE 4 New ASTM Men's Measurement Table

| Weight (Approximate pounds) | XXL - 2XL (50-53) | | | | | XXXL - 3XL (54-57) | | | | XXXXL - 4XL (58-60) | | | |
|-----------------------------------|-------------------|----------|----------|--------|----------|--------------------|---------|---------|--------|---------------------|----------|----------|--|
| | 250 | 260 | 270 | 280 | 300 | 315 | 320 | 330 | 345 | 350 | 360 | 370 | |
| Girth Measurements (in.) | | | | | | | | | | | | | |
| Sizes | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | |
| Chest | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | |
| Waist | 44 1/4 | 45 1/2 | 46 3/4 | 48 | 49 1/2 | 51 | 52 1/2 | 54 | 56 | 58 | 60 | 62 | |
| Seat (hip) | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | |
| Head circumference | 24 7/16 | 24 3/4 | 24 13/16 | 25 | 25 1/4 | 25 1/2 | 25 5/8 | 25 3/4 | 25 7/8 | 26 1/8 | 26 1/4 | 26 1/2 | |
| Neck base | 17 3/4 | 18 | 18 1/4 | 18 1/2 | 18 3/4 | 19 | 19 1/4 | 19 1/2 | 19 3/4 | 20 | 20 1/4 | 20 1/2 | |
| Shoulder circumference | 55 | 56 | 57 | 58 | 58 1/2 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | |
| Armscye | 20 1/16 | 21 1/8 | 21 1/4 | 21 3/8 | 22 1/4 | 22 1/2 | 22 5/8 | 23 | 23 1/4 | 23 1/2 | 23 5/8 | 24 1/4 | |
| Upper arm | 15 3/4 | 15 3/4 | 15 3/4 | 16 | 16 1/4 | 16 1/2 | 16 3/4 | 17 | 17 1/4 | 17 1/2 | 17 3/4 | 18 | |
| Elbow | 13 1/16 | 13 1/8 | 13 1/4 | 14 1/4 | 14 1/2 | 14 3/4 | 14 5/8 | 15 | 15 1/4 | 15 1/2 | 15 3/4 | 15 3/4 | |
| Wrist | 8 3/4 | 8 3/4 | 8 3/4 | 9 | 9 1/4 | 9 1/2 | 9 3/4 | 9 3/4 | 9 3/4 | 9 3/4 | 9 3/4 | 10 | |
| Thigh | 30 1/2 | 30 3/4 | 31 1/4 | 32 | 32 1/4 | 33 1/4 | 33 1/2 | 34 1/2 | 35 1/4 | 35 3/4 | 36 3/4 | 37 | |
| Knee | 18 3/4 | 18 1/2 | 18 3/4 | 19 | 19 1/4 | 19 1/2 | 19 3/4 | 20 | 20 1/4 | 20 1/2 | 20 3/4 | 21 | |
| Calf | 17 3/4 | 17 1/2 | 17 3/4 | 18 | 18 1/4 | 18 1/2 | 18 3/4 | 19 | 19 1/4 | 19 1/2 | 19 3/4 | 20 | |
| Ankle | 12 3/4 | 12 1/2 | 12 3/4 | 13 | 13 1/4 | 13 1/2 | 13 3/4 | 14 | 14 1/4 | 14 1/2 | 14 3/4 | 15 | |
| Trunk (total trunk, torso) | 71 1/16 | 71 1/8 | 72 1/16 | 73 1/2 | 74 3/8 | 75 1/4 | 75 1/2 | 76 3/4 | 77 1/8 | 78 1/4 | 79 1/8 | 80 1/2 | |
| Total crotch | 32 1/2 | 33 | 33 1/2 | 34 | 34 1/2 | 35 | 35 1/2 | 36 | 36 1/2 | 37 1/4 | 37 1/2 | 38 1/2 | |
| Vertical Measurements (in.) | | | | | | | | | | | | | |
| Sizes | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | |
| Stature | 71 1/8 | 71 3/4 | 71 7/8 | 72 | 72 1/4 | 72 3/8 | 72 1/2 | 72 5/8 | 73 | 73 1/8 | 73 1/4 | 73 1/2 | |
| Cervicale height | 61 1/16 | 61 3/8 | 61 1/2 | 62 | 62 1/8 | 62 1/4 | 62 1/2 | 62 3/4 | 62 5/8 | 63 | 63 1/4 | 63 1/2 | |
| Head height including neck | 9 1/16 | 10 | 10 | 10 | 10 1/16 | 10 1/8 | 10 1/4 | 10 1/2 | 10 3/8 | 10 3/4 | 10 1/2 | 10 1/4 | |
| Waist height | 43 3/4 | 43 13/16 | 43 7/8 | 44 | 44 1/4 | 44 1/2 | 44 3/4 | 44 3/4 | 44 3/4 | 44 3/4 | 44 3/4 | 44 13/16 | |
| Armscye depth | 6 3/16 | 6 3/8 | 6 1/2 | 6 5/8 | 6 3/4 | 6 7/8 | 6 15/16 | 6 15/16 | 7 | 7 1/4 | 7 1/4 | 7 3/8 | |
| Arm inseam | 18 1/2 | 18 1/2 | 18 1/2 | 18 1/2 | 18 | 18 | 18 | 18 | 17 3/4 | 17 3/4 | 17 3/4 | 17 3/4 | |
| Crotch height (inseam) | 31 1/4 | 31 1/8 | 31 3/4 | 31 3/4 | 31 3/4 | 31 3/4 | 31 3/4 | 31 1/2 | 31 3/4 | 31 3/4 | 31 1/4 | 31 1/4 | |
| Knee height | 18 3/4 | 18 3/4 | 18 3/4 | 18 3/4 | 19 | 19 | 19 | 19 | 19 1/4 | 19 1/4 | 19 1/4 | 19 1/4 | |
| Ankle height | 2 3/4 | 2 3/4 | 2 3/4 | 2 3/4 | 2 3/4 | 2 3/4 | 2 3/4 | 2 3/4 | 3 | 3 | 3 | 3 | |
| Waist length (cervicale to waist) | 17 13/16 | 17 13/16 | 18 | 18 | 18 1/16 | 18 1/8 | 18 1/4 | 18 3/8 | 18 1/2 | 18 1/4 | 18 1/4 | 18 1/4 | |
| True rise | 11 3/8 | 12 | 12 1/4 | 12 1/4 | 12 3/8 | 12 1/2 | 12 3/4 | 13 | 13 1/4 | 13 3/8 | 13 1/2 | 13 3/4 | |
| Width and Length (in.) | | | | | | | | | | | | | |
| Sizes | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | |
| Across shoulder (point to point) | 19 3/4 | 20 | 20 1/4 | 20 1/2 | 20 13/16 | 20 3/4 | 21 1/16 | 21 1/4 | 21 1/8 | 21 1/4 | 21 13/16 | 22 | |
| Across chest 4 in. down | 18 3/4 | 19 | 19 1/4 | 19 1/2 | 19 3/4 | 20 | 20 1/4 | 20 3/4 | 20 3/4 | 21 | 21 1/4 | 21 1/2 | |
| Across back 5 in. down | 19 1/4 | 19 1/2 | 19 3/4 | 20 | 20 1/4 | 20 1/2 | 20 3/4 | 21 | 21 1/4 | 22 | 22 3/4 | 22 1/2 | |
| Shoulder slope degrees | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | |
| Cervicale to wrist | 35 1/4 | 35 1/4 | 35 1/8 | 35 1/4 | 35 13/16 | 36 | 36 1/8 | 36 3/8 | 36 1/2 | 36 3/4 | 36 13/16 | 37 1/4 | |
| Hand and foot width | 4 3/4 | 4 3/4 | 4 3/4 | 4 3/4 | 4 1/2 | 4 1/2 | 4 3/4 | 4 3/4 | 5 | 5 | 5 | 5 | |
| Hand length | 8 | 8 | 8 | 8 1/4 | 8 1/4 | 8 1/4 | 8 1/4 | 8 1/4 | 8 1/2 | 8 1/2 | 8 1/2 | 8 1/2 | |
| Foot length | 11 1/2 | 11 1/2 | 11 1/2 | 12 | 12 | 12 | 12 | 12 1/2 | 12 1/2 | 12 1/2 | 13 | 13 | |

1068

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Men's Underwear Survey

This submission is *not* anonymous

This survey is intended for U.S. male residents, ages 18-65. Please take the time to answer all questions as accurately as possible. Only 1 submission per person. Thank You.

| | Jockey | Hanes | Fruit of the Loom | Calvin Klein | Tommy Hilfiger | Polo Ralph Lauren | Other |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. Which brands of Men's UNDERPANTS do you wear (Check all that apply) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Which brands of Men's UNDERSHIRTS do you wear (Check all that apply) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

3. What styles of underpants do you wear on a regular basis (Check all that apply)?

- Briefs
- Boxers
- Boxer Briefs
- Bikinis
- Other

4. What styles of undershirts do you wear on a regular basis (Check all that apply)?

- Tank
- V-Neck T-Shirt
- Crew Neck T-Shirt

5. How often do you use size charts on packages to select undergarments for purchase?

- Always
- Sometimes
- Not sure
- Rarely
- Never

6. What size men's underpants do you wear?

- Small: 28-30
- Medium: 32-34
- Large: 36-38
- XLarge: 40-42
- 2XLarge: 44-46

3XLarge or larger

7. What size men's undershirts do you wear?

Small: 34-36

Medium: 38-40

Large: 42-44

XLarge: 46-48

2XLarge: 50-52

3XLarge or larger

In questions 8-33, skip the questions that DO NOT apply to styles of underwear that are normally worn.

| Describe the fit at the following locations for BOXERS ONLY: | 1= Tight | 2 | 3 | 4 | 5= Loose |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 8. Waistband | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 9. Leg opening | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 10. Hips | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 11. Seat | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Describe the fit at the following locations for BOXER BRIEFS ONLY: | 1= Tight | 2 | 3 | 4 | 5= Loose |
| 12. Waistband | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 13. Leg opening | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 14. Hips | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 15. Seat | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Describe the fit at the following locations for BRIEFS ONLY: | 1= Tight | 2 | 3 | 4 | 5= Loose |
| 16. Waistband | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 17. Leg opening | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 18. Hips | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 19. Seat | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

| | | | | | | |
|---|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|--------------------------|
| Describe the fit at the following locations for BIKINIS ONLY: | 1= Tight | 2 | 3 | 4 | 5= Loose | |
| 20. Waistband | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| 21. Leg opening | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| 22. Hips | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| 23. Seat | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Describe the fit at the following locations for CREW NECK TEES ONLY: | 1= Tight | 2 | 3 | 4 | 5= Loose | |
| 24. Neck | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| 25. Upper Arms & Shoulders | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| 26. Chest | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| 27. Abdomen | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Describe the fit at the following locations for TANKS ONLY: | 1= Tight | 2 | 3 | 4 | 5= Loose | |
| 28. Chest | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| 29. Abdomen | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Describe the fit at the following locations for V-NECK TEES ONLY: | 1=Tight | 2 | 3 | 4 | 5=Loose | |
| 30. Neck | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | |
| 31. Upper Arms & Shoulder | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | |
| 32. Chest | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | |
| 33. Waist | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | |
| What areas of the following styles of underpants are you most satisfied with in regards to fit? | Waistband | Seat | Hips | Thighs | None | N/A |
| 34. Briefs | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 35. Boxers | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 36. Boxer Briefs | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

| | | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 37. Bikinis | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| What areas on the following styles of underpants are you most dissatisfied with in regards to fit? | Waistband | Seat | Hips | Thighs | None | N/A |
| 38. Briefs | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 39. Boxers | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 40. Boxer Briefs | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 41. Bikinis | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| What areas on the following styles of undershirts are you most satisfied with in regards to fit? | Neck | Upper Arms & Shoulder | Chest | Waist | None | N/A |
| 42. Crew Neck Tee | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 43. Tank | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 44. V-Neck Tee | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| What areas on the following styles of undershirts are you most dissatisfied with in regards to fit? | Neck | Upper Arms & Shoulder | Chest | Waist | None | N/A |
| 45. Crew Neck Tee | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 46. Tank | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 47. V-Neck Tee | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

| | | | | | | | | | | | |
|----------------------------|----------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Demographics | | | | | | 18-25 | 26-35 | 36-45 | 46-55 | 56-65 | |
| 48. Age group | | | | | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| | | | | | | Black | White | Asian | Hispanic | Native American | Other |
| 49. Ethnicity | | | | | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | Professional/Office Worker | Technical/Craftsperson | Service Worker | Entertainer | Construction/Landscap | Athlete | Homemaker | Retired | Student | Other | |
| 50. Occupation | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | |
| Weight measured in pounds. | | | | | | <97 | 97-119 | 120-149 | 150-199 | 200-249 | >250 |
| 51. Weight | | | | | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

52. Enter the abbreviation of the state in which you currently live. (Ex. Minnesota MN, Delaware DE)