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competitive female bodybuilders and their contest scores**

Gottfried, Rebecca Gail, M.A.

San Jose State University, 1990

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**A COMPARISON OF ANTHROPOMETRIC MEASUREMENTS FROM
COMPETITIVE FEMALE BODYBUILDERS AND THEIR CONTEST SCORES**

**A Thesis
Presented to
The Faculty of the Department of Human Performance
San Jose State University**

**In Partial Fulfillment
of the Requirements for the Degree
Master of Arts**

**by
Rebecca Gottfried
May 1990**

APPROVED FOR THE DEPARTMENT OF HUMAN PERFORMANCE

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ABSTRACT

A COMPARISON OF ANTHROPOMETRIC MEASUREMENTS FROM COMPETITIVE FEMALE BODYBUILDERS AND THEIR CONTEST SCORES

by R. G. Gottfried

Selected physiological characteristics of twenty-seven competitive female bodybuilders were examined in relation to scores awarded to them in bodybuilding contests by two qualified competition judges. Judges' scores and anthropometric measures of muscularity (fat-free weight, mesomorphy, and proportionality of muscle mass) were analyzed using correlational and multiple regression analyses. According to California north district National Physique Committee judging guidelines, the amount of muscularity each competitor has is fairly important in determining success in competition. However, no significant relationship was found between the measures of muscularity and judges' scores. The reasons for this finding may have been due to the following: (1) California north district National Physique Committee scoring systems based on relative scores not absolute scores may have influenced judges' scores; and (2) the homogeneity in measures of muscularity attenuated the range of variability in these measures which may have affected the results.

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CHAPTER 1

INTRODUCTION

The concept of an ideal female physique for the competitive female bodybuilder has been enmeshed in controversy since the sport's inception. Female bodybuilding competitions have their origins in the bathing beauty contests (Thomas, Wennerstrom, Jentz, Semple, & Napfiliotis, 1983). By the late 1940's, a contingent of the bathing beauty contestants had begun to redefine the nature of the beauty contest. These women were said to have been weight-toned rather than weight-trained, and were sometimes referred to as the "barbelles" (Stockton, 1947). Yet, only by indirect or artful methods were they able to participate in men's physique contests. Consequently, the women participating were considered to be only a part of the men's contest. In the late 1970's, competitive female bodybuilding began to evolve as a separate entity. The change from beauty contest to physique contest occurred not because of a disapproval of the beauty contest, but because some women had begun to use a more stringent training modality. These women wanted to be recognized and rewarded for the new standard of physical beauty they had achieved through diligent weight training (Thomas et al., 1983).

From the progression of the beauty contest to the physique contest, the controversy that evolved centered on the issue of muscular development. The question focused on whether it was acceptable for a female to maximize her potential for success in competition through muscular

development. Today, both the controversy and the evolutionary process of competitive female bodybuilding continue. Not only has the commitment of the female bodybuilder towards stricter, more progressive training modes continued and led to heightened muscular development, but also participation in the sport has increased (Giel, 1988).

Title IX of the Education Amendment Act of 1972 and other legal events provided increased opportunities for women to participate in athletic competitions (Protzman, 1980). This led to increased participation among women in various types of sports including the sport of competitive female bodybuilding. According to Freedson, Mihevic, Loucks, and Girandola (1983), "in recent years body building has achieved widespread popularity" (p. 85). Additionally, bodybuilding competitions are not only common sport events in many cities, but also have been the focus of several major sports and television programs (Freedson et al., 1983). However, the beauty contest is still a more popular event compared to female bodybuilding contests. Major national television networks cover beauty contests, whereas coverage for physique contests are often limited to the independent networks. Yet, according to the National Physique Committee (an organization for competitive bodybuilders), 7,000 women currently compete in bodybuilding (Giel, 1988). Unfortunately, even though involvement of women in the sport of competitive bodybuilding has grown, data on this group of athletes is limited.

The experimental research that has been done involving competitive female bodybuilders has focused on the comparison of the physiological parameters of this group of athletes and male bodybuilders, other types of

female athletes competing in other events, and sedentary females (Elliot, Goldberg, Kuehl, & Catlin, 1987; Freedson et al., 1983; Heyward, Sandoval, & Coville, 1989; Giel, 1988; Powell, 1986; Woods, 1985). To date, no comprehensive study has been done on the physical parameters of female competitive bodybuilders in comparison to how well they do in competition.

Statement of the Problem

In bodybuilding competitions, competitors compete in the following three rounds: symmetry, presentation of the muscle groups, and muscularity. However, written assessments (scores) are only made in one of the three rounds of the competition, the muscularity round (B. O'Brien, personal communication, May 27, 1989). With this in mind, "bodybuilders are concerned with physique rather than with strength; they lift weights to assiduously sculpt their muscles" (Giel, 1988, p. 165). Therefore, critical to the sport is heightened muscular development. However, is heightened muscular definition related to success? To examine this question, regression analysis and correlation analysis between anthropometric measures of muscularity (fat-free weight, second component of somatotype - mesomorphy, and proportionality of muscle mass) and competitive scores were used to determine if those characteristics of competitive female bodybuilders were related to success in competition.

Statement of the Purpose

The purpose of this study was to examine the anthropometric measurements of competitive female bodybuilders and compare those

measurements to the scores awarded to them at bodybuilding competitions by qualified contest judges.

Research Hypothesis

The scores awarded by contest judges will correlate with the physical characteristics (anthropometric measures) of competitive female bodybuilders. An alpha level of .05 was selected to determine whether or not there was a significant correlation.

Definitions

The following terms are defined below for the purpose of this study.

Anthropometric measurements. Measures that evaluate and quantify the major structural components (muscle, bone, fat) of the body (McArdle, Katch, & Katch, 1986). Skinfold thickness, trunk and limb diameters, and trunk and limb circumferences are the three basic types of anthropometric measures. The data collected from these measures are converted mathematically to values that estimate body composition characteristics.

Bodybuilding. Strength training for physique enhancement versus muscular strength. In addition, muscles are developed to a high degree of hypertrophy (muscular growth due to enlargement of the muscle fibers) (Thomas et al., 1983).

Bodybuilding competition rounds. Three rounds specified by the National Physique Committee (NPC) are designed to display form and definition of the muscles (W. Sprague, personal communication, November

general assessment, (2) presentation/individual posing routines, and (3) muscular development. However, of the three rounds only the muscular development round is used for the basis of judges' scores (B. O'Brien, personal communication, May 27, 1989).

Bodybuilding competitions. Competitions sanctioned by the NPC are divided into two sections: pre-judging and the evening show. The assessment rounds occur in the morning during the pre-judging section of the competition which is open to the public. The evening show consists of the top five finalists from each weight class which include lightweight, middleweight, and heavyweight categories. If necessary, final judging assessments are made at the evening show. These final assessments are made if the tabulation of the scores from the pre-judging assessments reveals ties between competitors.

Bone diameter (breadth). A measurement that assesses the skeletal frame component (trunk and limb) of the body (Katch & Katch, 1984).

Circumference (girth). A measurement that includes bone, muscle, and fat of specific trunk and limb sites (Woods, 1985).

Ectomorphy. The third component of the somatotype system which refers to relative linearity of physique, partially based on height/weight ratios (Carter, 1972).

Endomorphy. The first component of the somatotype system refers to the relative fatness and leanness of the body (Carter, 1972).

Intraclass reliability coefficient. An estimate of reliability reflecting how consistent scores are of the same performance (Kirkendall, Gruber, & Johnson, 1987).

Judges' objectivity. The agreement between two or more independent scorers, raters, or judges evaluating the same performance (Safrit, 1973).

Judges' scores. Muscular development is the round of assessment used for the basis of NPC judges' scores (B. O'Brien, personal communication, May 27, 1989). The guidelines for scoring at the district level are that the judges are to assess symmetry and shape of the competitor's physique, muscular development, hardness of the muscles, presentation of the muscle groups, and skintone (skin color). At the state and national level the guidelines for judging are different (W. Sprague, personal communication, November 17, 1988). With respect to the district guidelines, the scores awarded to the competitors are based on each judge's personal individual assessment. The scores from each judge are tabulated; the high score and the low score are thrown out. The competitor with the lowest summed score wins the competition (W. Sprague, personal communication, November 17, 1988).

Mesomorphy. The second component in the somatotype system which refers to relative musculo-skeletal development per unit of height; thought of as relative lean body mass (Carter, 1972).

Phantom stratagem. The scaling of some standard measure according to a specified dimensional relationship. The scaling of measures expresses deviations from the phantom model in terms of standard scores based on a given hypothetical human population. Due to the fact that the phantom stratagem essentially scales all data to a common standard and expresses deviations as standard scores, it is possible to compare different items within and between samples (Ross & Ward, 1984).

Proportionality. The dimensional relationship of size, quantity or degree of one body part to another or to the whole body. Quantification of the relationship requires the use of a reference unisex human model called the phantom (Ross & Ward, 1984).

Skinfold thickness. A measure of subcutaneous fat and skin at selected sites on the body based on the fact that a relationship exists between subcutaneous fat, internal fat, and body density (McArdle, Katch, & Katch, 1986). Measures are mathematically converted to values estimating body density which can be used to estimate percent body fat, lean body mass and/or fat-free weight.

Somatotype. A description of morphological conformation (body form/structure). It is expressed in a three-numeral rating always recorded in the same order. Each numeral represents evaluation of one of the three primary components of physique which describe individual variations in form and structure of the body (Carter, 1972).

Delimitations

This study was delimited to National Physique Committee district sanctioned bodybuilding competitions in the northern California district. The subjects were female competitors who entered these competitions. The subjects included light, middle, and heavyweight competitors.

Limitations

The following limitations existed due to the fact that the study took place at NPC California north district bodybuilding competitions. (1) The

number of volunteer subjects was limited. (2) Competitors who volunteered may not have been similar to those who did not volunteer. (3) Pre-contest procedures such as dietary habits or ergogenic aids used by the competitors to gain definition and/or bulk, could not be controlled. (4) The accuracy of the anthropometric measures taken were limited by the reliability of the instruments and the reliability of the measurers. (5) The reliability of the scores among the judges could not be controlled (B. Shifflett, personal communication September 15, 1988).

Significance

The results of this study are potentially significant in several different ways. First, as stated by Giel (1988), information concerning competitive female bodybuilders has been insufficient. Due to the increased participation of women in this sport along with the controversy concerning what the ideal female physique should be, there has been a need to examine and perhaps identify some of the issues concerning this evolving sport. This need has been expressed by not only female competitors, but also by judges (Certo, 1988; Thomas et al., 1983; Zwingle, 1984). Furthermore, to date, no research study has been conducted examining the physical characteristics of competitive female bodybuilders in relation to the scores of the judges who evaluate bodybuilders in competition. To this researcher's knowledge no similar study exists for competitive male bodybuilders, either. Therefore, the results of this study may fill a gap in the literature concerning the sport of competitive female bodybuilding. Secondly, the results of this study may guide the athlete in training by providing information on the

relative importance of muscularity for success in competition. Finally, revision of judging guidelines may be facilitated.

Summary

The controversy and the evolution of muscular femininity has been a part of competitive female bodybuilding since the sport's beginnings in bathing beauty contests. These issues are still apparent today for two reasons. First, female bodybuilders have continued their commitment towards maximizing muscular development by way of progressive training modalities. However, the extent to which a woman can physically maximize muscular development has not been clearly defined (Thomas et al., 1983; Zwingle, 1984). Secondly, even though participation has increased due to the legal events that brought increased opportunities to women in all sports, national television coverage still focuses more on the female beauty contest versus the female bodybuilding contest. Furthermore, involvement of women in competitive bodybuilding being so recent, the research on this group of athletes has been scarce (Giel, 1988). Consequently, there is a need to broaden the base of knowledge concerning competitive female bodybuilders. The intent of this research project was to provide more information to not only the scientific community, but also to competitive bodybuilders. The purpose of this research project was to assess the physical characteristics of competitive female bodybuilders and compare those measures to the scores awarded to them by contest judges at bodybuilding contests. The problem thus lies in determining the relationship between judges' scores and anthropometric measurements of muscularity.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

To date, published research on a comparison of the physical characteristics of competitive female bodybuilders with scores awarded to them by competition judges, has not been conducted. Furthermore, the general information that has been reported on competitive female bodybuilders has been very limited. Consequently, related literature that includes the history of the female bodybuilder, the physiological characteristics of competitive female bodybuilders, the measurement of physical characteristics via anthropometry, somatotyping and proportionality for physique classification, and the judging of gymnastic competitions has been discussed in this review.

History of the Female Bodybuilder

The female physique athlete, according to Thomas et al. (1983), has had to overcome much scrutiny and controversy concerning the aesthetics of muscular femininity. The emergence of the female physique athlete from bathing beauty contestants occurred due to more arduous weight training modalities being employed. Women found that they had created a break in the tradition of bathing beauty contests which expressed a new aesthetic of femininity. This break or change from tradition was meant to widen the continuum along which women could identify themselves and still be

perceived as valued and beautiful (Thomas et al., 1983). However, what ensued was a socio-political-cultural manipulation of the meaning of muscular femininity.

According to Thomas et al. (1983) with regard to the female physique athlete, muscles are meant to be developed. Bodybuilding in itself means developing the muscle to a high degree of hypertrophy. Therefore, the focus of the book by Thomas et al. (1983) was an exploration, if not a definite statement, on the inevitability and the desirability of high level muscle development for the female physique athlete. The authors believe that this matter-of-fact occurrence needs to be recognized and rewarded not only by the contest judges, but also by society.

Erla Zwingle (1984) supported the ideas put forth by Thomas et al. (1983). According to Zwingle (1984), the controversy over the muscular woman has affected all those involved with the sport: competitors, judges, and fans. This is due to the fact that people can not agree on what a female bodybuilder should look like. Several sports have a component of aesthetics associated with it (i.e., gymnastics and diving). However, Zwingle (1984) states that, " bodybuilding is based on aesthetics; the sport exists only to show the beauty of the human form " (p. 35). Consequently, based on these beliefs, the concept of female muscularity should not be controversial. However, it is far less accepted than male muscularity.

The concept of the muscular male bodybuilder has been relatively uncontroversial (Zwingle, 1984). A muscular male bodybuilder has had to face only slight public scrutiny because, according to Giel (1988), strength sports (bodybuilding, weightlifting, powerlifting) have been traditionally

viewed as masculine sports. In addition, increased muscular development (hypertrophy) and/or strength resulting from participation in strength sports have also been viewed as masculine trait, not as a component of fitness. Consequently, similar to the thoughts of Thomas et al. (1983) and Zwingle (1984), Giel (1988) states that women involved in any of the strength sports have had to overcome more societal taboos than men.

Physiological Characteristics of Competitive Female Bodybuilders

In general, bodybuilders are athletes who lift weights to improve the shape and form of their physiques. They arduously weight train to develop muscle size and/or definition. Additionally, weight training in combination with aerobic training and dietary restrictions are used to minimize body fat levels (Woods, 1985). Consequently, bodybuilders are not concerned only with improvements in strength, but also with improvements in physique.

The earliest comprehensive study on competitive female bodybuilders was conducted by Freedson et al. in 1983. These researchers evaluated the body composition of ten competitive female bodybuilders, and 57 active women (control group) to the reference woman as described by Behnke and Wilmore (1974). The evaluation included measurements of percent body fat and lean body mass (via hydrostatic weighing), bone diameters, circumferences, and skinfolds. The major finding was that the lean body mass of competitive female bodybuilders was 3.2 kg higher than the Behnke and Wilmore reference woman (Freedson et al., 1983). The female bodybuilders' lean to fat ratio was 6.9, which was 2.5 times higher than the reference woman and 15 percent higher than other competitive female

athletes. Freedson et al. also found that in comparison to the reference woman, female bodybuilders were 4 cm shorter and 4.8 kg lighter. Furthermore, circumference measures were larger in the upper trunk and smaller in the lower trunk when compared to 57 college age women. However, the diameter measurements (biacromion, chest, biiliac, bitrochanter, knee, ankle, elbow, and wrist) were similar to those of sedentary and active women not engaged in heavy weight training.

Woods (1985), in her masters thesis on the physical characteristics of female bodybuilders, described competitive female bodybuilders who had weight trained for a longer period of time than in previous experimental research. The conclusions that were drawn from this study were that the female bodybuilders had less total body fat and more skeletal muscle mass than the control group of untrained young women. Additionally, muscular hypertrophy (high level muscular development) was more evident in the female bodybuilders. Consequently, the bodybuilders were found to have different external body form (somatotype) than the control group.

According to Giel (1988), in her report on women's weight lifting (a type of strength sport differing slightly from power lifting and bodybuilding), the unpublished data by Stone and Stossel revealed that as expected, percent body fat (determined by hydrostatic weighing) was lower in weight lifters than controls. The data also indicated that the circumference measurements were greater at every site except the waist in female weight lifters when compared to the controls.

Bodybuilders have been known to use anabolic-androgenic steroids (Elliot et al., 1988). Consequently, the measurements taken in the

previously mentioned research studies may have been exaggerated due to the physiological effects of steroid use. Therefore, Elliot et al. (1988) examined the characteristics of steroid-free competitive male and female bodybuilders. Their results were consistent with the results of the other studies on competitive female bodybuilders. The authors found that both the male and female bodybuilders had lower percentages of body fat (delimited to hydrostatic weighing and skinfold measures) when compared to sedentary controls and runners.

Anthropometry

The evaluation of body composition allows for the quantification of the major structural components of the body which include muscle, bone, and fat (McArdle et al., 1986). The quantification of body composition can be accurately measured through laboratory methods such as hydrostatic weighing (Wilmore & Behnke, 1970). However, these methods are complex and time consuming. Consequently, laboratory methods are not always practical for assessing a large number of subjects or when assessments are made in the field. Therefore, anthropometric measurements (skinfold, muscle circumference, and bone diameter) are often used for the measurement and determination of body composition (Jackson, Pollock, & Gettman, 1978).

Wilmore, Girandola, and Moody (1970), suggested that the ability to accurately predict body composition through the use of anthropometric measurements has not been repeatedly demonstrated. The authors also stated that the assumption that hydrostatic weighing and anthropometric

measurements are highly correlated has not been established. Therefore, Wilmore et al. evaluated the predictive validity of estimating body composition from anthropometric measurements on a sample of 23 women (14-18 years old) and 55 men (17-55 years old). Additionally, the study evaluated the validity of the anthropometric measurements with regard to assessing changes in body composition resulting from physical training. The results of the evaluations indicated that the various anthropometric measurements had accurate relative validity when compared to hydrostatic weighing, but the absolute values were inconsistent. However, the authors noted that the absolute values were probably inconsistent due to the extreme age range of the subjects. Lastly, to evaluate changes in body composition due to physical training, the most accurate technique for assessment, according to Wilmore et al. was hydrostatic weighing.

In another study by Wilmore and Behnke (1970), estimation of body composition using anthropometric measures in prediction equations was found to be accurate. However, accuracy was limited by the degree of similarity between the reference or criterion sample from which the equations were derived and the sample of subjects in the study.

Katch and Katch (1980) examined measurement and prediction errors in body composition assessment. Their findings are consistent with the conclusions stated by Wilmore et al. (1970) and Wilmore & Behnke (1970). According to Katch and Katch (1980), there are inherent inconsistencies in the predictive validity of both hydrostatic weighing and anthropometric measurements. The inconsistencies are a result of population specific equations that are used to predict body composition. Consequently,

application of these population specific equations appears not to be valid or usable on different segments of the population (Katch & Katch, 1980). The authors believe that researchers need to acknowledge the limitations and assumptions associated with the assessment of body composition in order to improve the situation. In conclusion, Katch and Katch state that perhaps there are no solutions to predicting body composition with a high degree of accuracy. However, with continued research the validity of predicting body composition will be improved.

Fry, Cisar, and Housh (1986) examined the accuracy of a number of prediction equations in estimating body density in competitive male bodybuilders ($n = 12$). According to the authors, many anthropometric equations have been developed to estimate body composition in various populations. Therefore, Fry et al. determined from the 20 equations that they examined, which equations best estimated the body composition of male competitive bodybuilders. Eleven equations were determined to have acceptable validity. However, the prediction equation that was most appropriate for estimating body composition of male bodybuilders was the Lohman equation. The authors suggested that the Lohman equation along with the other equations with valid predictability, can be used on other athletes who have similar characteristics to the male competitive bodybuilder. Similar characteristics include 12.4 percent and lower body fat levels, plus somatotype ratings of <3 endomorph, >5 mesomorph, and <2 ectomorph (Fry et al.).

Unlike their male counterparts, female bodybuilders do not have a population specific prediction equation for estimating body density.

According to Pollock and Jackson (1984), several research studies have developed and/or have used population specific equations for female athletes. Population specific equations used for estimating body density from skinfold measures are affected by differences in age, gender, and degree of fatness. These equations assume that hydrostatically determined body density is linearly related to skinfold thickness. However, Jackson (1984) has shown that the aforementioned relationship is curvilinear rather than linear. Consequently, the linear equations only predict accurately at the mean of the population from which the data were collected. Furthermore, a population specific equation needs to be used with subjects representative of the population from which the equation was derived. Otherwise, these equations will over estimate body fat for leaner groups and underestimate body fat for fatter groups. Therefore, Jackson, Pollock, and Ward (1980) developed a generalized quadratic equation that minimizes the prediction error at the extremes of a distribution. Consequently, the advantage of the generalized equations are that they are valid over a wider range of subjects, and are less affected by variations in fatness, age, and the nonlinear relationship between body density and subcutaneous fat (Pollock & Jackson, 1984).

Generalized equations were used in a study by Elliot et al. (1987) on steroid-free competitive male and female bodybuilders. The authors noted that the body density measures collected from these equations were not significantly different when compared to the data collected from hydrostatic weighing of the same group of subjects.

Somatotyping

As previously stated, the evaluation of body composition through anthropometry allows for quantification of the structural components of the body. Even though this method provides accurate data concerning physical characteristics of the body, it does not evaluate total body form (Carter, 1970). Assessment of total body form is of importance as it lends itself to identifying behavioral, functional, and health aspects of the body. For example, through the identifications of body form, predictions are made toward determining susceptibility to disease or potential for physical performance (Carter, Ross, Duquet, & Aubry, 1983). The technique for evaluating and identifying total body form is called somatotyping.

There are several somatotyping techniques that have been used to assess total body form. Somatotyping methods that have been employed are height/weight ratios, photographs, somatograms, and anthropometry. These have been used separately or in conjunction with each other. Previous studies on competitive female bodybuilders have used somatograms to assess total body form. Somatograms (also referred to as body profiles) are graphic representations of body part circumferences that provide a quantitative assessment of body shape relative to a reference person (Behnke & Wilmore, 1974).

On the other hand, the Heath-Carter somatotype method uses anthropometry to estimate somatotype. This method has been found to be more effective than other methods. For example, anthropometric measurements limit the subjective element of using photographs to assess somatotype. Furthermore, anthropometric measurements are more precise

for assessing change in the somatotype components of endomorphy, mesomorphy, and ectomorphy (Carter, 1972). To this researcher's knowledge no study has been done on the somatotypes of competitive female bodybuilders using the Heath-Carter somatotype method.

Proportionality

Proportionality assesses structural/functional relationships as variances in body mass to body dimension (Ross, Ward, Leahy, & Day, 1982). To evaluate this relationship, measures of length, diameter, circumference, and skinfold values are used. These measures are mathematically converted to represent fat, skeletal, muscle, and residual masses. However, proportional assessments can only be made relative to a representative value. Therefore, measures of length, diameter, circumference, and skinfold are quantified by use of the phantom stratagem.

The phantom stratagem is basically a calculation device which converts raw data to a common value (Ross et al., 1982). However, it also provides (1) a model to compare differences within and between individuals or samples and (2) estimations of proportion of body masses (skeletal, fat, muscle, and residual) independent of total body mass. The phantom has been applied to describe proportionality in not only athletes, but also in children, genetic syndromology (symptoms grouped together characteristic of a specific condition) studies, and in normal and abnormal growth patterns (Ross et al.).

The practical application of proportionality measures in competitive female bodybuilders is to provide information regarding proportional

differences in the competitors with respect to muscularity. For instance, a taller and/or heavier competitor may not necessarily have more muscle mass than a shorter and/or lighter competitor due to variations in muscle, fat, skeletal, and residual masses between the two competitors.

Proportionality values for muscle mass can account for and quantitatively represent differences in muscularity relative to body size. The importance of assessing muscular differences not confounded by other body characteristics in competitors is due to the fact that the degree of muscularity is not only a guideline for judging competitions, it is also the round of competition in which the competitors are evaluated.

Judging Gymnastic Competitions

Much has been said about the bias that occurs in sports officiating (Ansorge & Scheer, 1988). Coaches and athletes have been known to state their opinions regarding their dissatisfaction with the way a contest or game was judged or officiated. According to Ansorge and Scheer, the effects of biased officiating have been most noticable in sports where officials award points to the athletes performance based on a combination of objective and subjective criteria. Sports that have had to rely on objective and subjective judgments of performance are gymnastics, figure skating, boxing, diving, and competitive bodybuilding. However, little has been documented to explain the nature and extent of biased officiating/judging (Ansorge & Scheer, 1988).

According to Landers (1970), in sports that involve artistic elements, the use of human observers (judges, officials) to determine performance

scores can not be avoided. Landers continued that more research is needed to determine the factors that influence the reliability of the judges' scores. Therefore, Landers' review of the research on gymnastics judging suggested that although scoring systems and approaches to judging can be objectified, the social/psychological influences on a judge need to be considered. Such social/psychological influences include: judges' expectations of the performer's ability; how judges are affected by pressures to conform; the judges' institutional or national-political affiliation; and the judges' beliefs and attitudes concerning certain personal characteristics of performers (Landers).

In another review of gymnastics literature, Scheer (1973) stated that most gymnastic authorities express the need for not only standardized objective judging, but also for a rating system to qualify the judges. However, one study in the review suggested that in trying to objectify judging, judges might become so technically adept that they might not be able to recognize a great gymnastic routine when they saw one (Scheer,1973).

Scheer and Ansorge (1975) examined the effects of naturally induced judges' expectations on evaluation of gymnastic performances. Unknown to the judges, edited videotape performances were used for evaluation. Scheer and Ansorge found that when gymnasts are placed in a certain order within the team they are scored differently. This is due to the fact that the gymnasts are ranked and compete in order from poorest to best. Consequently, the natural expectations of the judges affect the scores of the gymnasts. According to Scheer and Ansorge, this occurs even when the

gymnasts are randomly ordered. They also noted that naturally induced expectations are not found just in gymnastic judges. For example, the effects of expectations are also found in evaluation of academic performance and research. In conclusion, Scheer and Ansorge stated that it seems possible that a relationship exists between the expectations and evaluations for various types of performances, whether they be athletic, academic, or research related performances.

Based on the previous discussion, social/psychological influences on judges may also be apparent in female bodybuilding competitions. Competition scores may be influenced by the judges' beliefs, attitudes, and expectations concerning personal characteristics of the female bodybuilders. This is due to the fact that the controversy in defining the ideal female physique through assessment of muscular development has become an issue with the female competitors, the judges, and the fans (Zwingle, 1894). According to Tanny (1990), " Trying to second-guess what the judges will be looking for each and every year is one of life's mysteries....the trend changes from year to year, from more muscular to more feminine to more muscular... " (p. 227). Furthermore, bodybuilding judges, like gymnastic judges, may display biases when scoring a bodybuilding routine. According to Thirer and Greer (1978) in their article on competitive bodybuilding, " in a closely-contested event charisma and audience reaction may be a deciding factor with a panel of judges " (p. 192). Therefore, bodybuilding judges may also be influenced by social/psychological factors and performance expectations similar to gymnastics judges (Landers, 1970; Scheer et al., 1975).

Summary

This review of literature suggested that competitive female bodybuilding has been and still is a controversial issue with respect to the concept of an ideal female physique.

The physiological parameters of competitive female bodybuilders are characterized by low body fat levels, increased lean body mass, and greater circumference measurements when compared to Behnke and Wilmore's reference woman, sedentary women, and other female athletes (Elliot et al., 1987; Freedson et al., 1983; Giel, 1988; Woods, 1985).

The ability to assess the physical characteristics of competitive female bodybuilders from anthropometric measurements may have certain limitations with respect to predictive validity (Katch et al., 1980; Wilmore et al., 1970; Wilmore & Behnke, 1970). However, in a recent study, the generalized quadratic equation developed by Jackson et al. (1980) was found to be valid for assessing body composition in male and female competitive bodybuilders (Elliot et al., 1987).

The evaluation of body composition through anthropometry provides accurate data on physical characteristics of the body. However, it does not evaluate total body form. The Heath-Carter somatotype method is a technique used to assess total body form. Assessment of total body form is useful for evaluation and prediction of behavioral, functional, and health aspects of the body (Carter, 1972). Additionally, proportionality is another method used for assessment of body composition. Proportionality provides information concerning the variances in body mass to body dimension (size, structure, and magnitude) (Ross & Ward, 1984).

Lastly, the evaluation of sport performance when based on objective and subjective criteria which require the judging of performance by human observation, may be subject to judging bias. This bias may be a result of social psychological factors and performance expectations which can influence the accuracy of a judge's score (Landers, 1970; Scheer, 1973; Scheer & Ansorge, 1975).

CHAPTER 3

METHODS

Introduction

Previous data that have been gathered on competitive female bodybuilders have been primarily restricted to examining the athletes' physiological and psychological characteristics and/or nutritional status. With this in mind, the intent of the researcher was to add to and broaden the base of knowledge on the competitive female bodybuilder. To accomplish this, a study was designed to examine anthropometric measures of muscularity of competitive female bodybuilders, and to compare those measures of muscularity to the scores awarded to them by contest judges.

This chapter contains the methods that were used in this research study. Included in the chapter are the following sections: subjects, instrumentation, procedures, and analysis.

Subjects

The subjects ($n = 37$) were female bodybuilders who entered three California north district National Physique Committee bodybuilding competitions. The subjects were classified in either the light, middle, and heavy weight classes. All of the female competitors were informed of all testing procedures on the day of competition prior to competing. A consent form, approved by the San Jose State University Institutional Human Subjects Review Board was obtained from the competitors who volunteered

to participate in the study.

In addition, those competitors who participated in the study received a body composition analysis of their percent body fat, somatotype, and proportionality of muscle mass (see Appendix C).

Instrumentation

Anthropometric measurements were obtained to determine the female bodybuilders' fat-free weight, mesomorphy, and proportionality of muscle mass. The techniques for measurement of skinfold sites used in this study were described by Keys (1956) and Lohman, Roche, and Martorell (1988). Lange calipers were used to measure skinfold thicknesses at the tricep, subscapula, suprailium, thigh, and calf. Two measures at each site were taken. Additional measurements were made if a difference greater than 0.5 mm existed between the first two values. The average of measures taken per site that were within 0.5 mm of each other were used as the representative score (Behnke & Wilmore, 1974). The generalized equation from Jackson, Pollock, and Ward (1980) was used in this study to estimate body density based on three skinfold values (triceps, thigh, suprailium) and age. The body density estimate derived from the generalized equation was then used to calculate percentage of body fat and fat-free weight (one of the three independent variables used in this study). As described by McArdle, Katch, and Katch (1986), the formula to calculate fat-free weight (FFW) is the following:

$FFW = \text{body weight (BW)} - \text{fat weight (FW)};$

$FW = BW \times \text{percent body fat (\%BF)};$

$\%BF = (495/\text{density}) - 450$ (Siri, 1956).

The procedure for measuring skinfold thickness was to wipe the measuring site clean with rubbing alcohol, a piece of gauze, and/or a towel. This prevented slippage of the caliper arms on the skinfold due to oil and sweat on the subjects' bodies. To measure the skinfold sites, the skin and subcutaneous fat was pulled away from the muscle tissue by using the thumb and forefinger. A constant pressure of 10g/mm was exerted by the pincer arms of the Lange caliper to the skin. A measurement was read from the caliper two seconds after the pressure was released (Lohman, Roche, & Martorell, 1988).

Procedures recommended by Carter (1972) and Lohman et al. (1988) were used to assess breadth and circumference measures. Breadths of the elbow and knee were measured with a broad-blade metal anthropometer to the nearest 0.1 cm. The caliper arms of the anthropometer were positioned at the medial and lateral epicondyles of the elbow and of the knee. Pressure was applied to the caliper arms so that the soft tissue at the bony landmarks was compressed. A reading from the anthropometer was made when the caliper arms became stable (no further decrease in measurement reading as pressure was applied). Three measures were taken per site.

Circumference measures of the bicep (relaxed and flexed), chest, thigh, calf, and forearm were made by using a flexible non-stretchable fiberglass tape measure (Creative Health Products). The tape was placed at right angles to the length of the body part and parallel to the floor. The

tension applied to the tape by the measurer was to hold the tape around the body part without indenting the skin. This technique was used in order to not compress the subcutaneous adipose tissue (Lohman et al., 1988). Circumferences were measured to the nearest 0.1 cm and one measure was made per site.

The data collected from the measures of tricep, subscapula, suprailium, and calf skinfolds; elbow and knee breadths; and bicep (relaxed and flexed), forearm, chest, thigh, and calf circumferences were used in the calculations of somatotype and proportionality as described by Carter (1972) and Hebbelinck, Ross, Carter, and Borms (1980), respectively.

Somatotype was determined using the anthropometric rating method described by Heath and Carter (1967). The decision to use this method was based on the facts that (1) anthropometric measurements are easy to duplicate by other investigators, (2) the method does not require photographs which can be time consuming when this method is used in the field (de Garay, Levine, & Carter, 1974), and (3) this method has been used by other researchers in their assessment of the body composition of athletes (Carter, 1970; de Garay, Levine, & Carter, 1974; Elliot et al., 1987; Pipes, 1979).

A minimum of seven measures are needed to assess body somatotype for mesomorph (Carter, 1972). These include tricep and calf skinfold sites, bicep (flexed) and calf circumference measures, elbow and knee breadth measures, plus height.

Instrumentation used to measure height was a wall scale constructed from a yardstick that was placed on the wall 36 inches up from the point of

contact of the wall to the floor. Furthermore, a hand-held triangle ruler was used as a guide and held at a right angle to the yardstick to provide an accurate measure of height to the nearest 0.25 inch. To measure height the subject stood with her back against the wall and was assessed as an erect body length from the soles of her feet to the vertex of her head (Carter, 1972).

Measures of body weight were used in the calculation of fat-free weight. Therefore, weight was assessed using a physicians' scale. Weight was measured to the nearest 0.25 pound. For the pilot study and one bodybuilding competition the scale was calibrated.

To assess proportionality (fat, skeletal, muscle, and residual masses), skinfold, circumference, breadth, and length measurements are needed (Ross et al., 1982). However, given the purposes of this study only a subset of these measures was needed to estimate muscle mass. The subset indicators used included chest, thigh, calf, bicep (relaxed), and forearm (maximum) circumferences; tricep, subscapular, thigh, and calf skinfolds; and height. The general formula, for the subset of variables, that provided estimates of proportionality (muscle mass independent of total body mass) was described by Ross et al. (1982).

Procedures

Pilot study. In order to ensure the reliability and validity of the three researchers using anthropometric instruments to collect measures from competitive female bodybuilders, a pilot study was conducted. The purpose of the pilot study was to not only establish reliability and validity of the

researchers, but to also establish a protocol for collection of the anthropometric data.

The subjects ($n = 30$) for the pilot study were female students participating in aerobic dance classes at San Jose State University. Prior to consent, all subjects were informed of testing procedures and given an explanation of the study. A consent form approved by the Institutional Review Board was obtained from the aerobic dancers who volunteered to participate in the pilot study. In addition, all those who participated in the pilot study received a personal body composition analysis for their percent body fat and somatotype (see Appendix D).

The data for the pilot study were collected by rotating subjects through six anthropometric measurement stations one and a half times. Each measurement station had one of the three previously described anthropometric instruments: circumference tape, skinfold caliper, and an anthropometer for breadths (a wall scale for height and physicians' scale for weight were also used at this measurement station). The subjects moved from one measurement station to another to be measured.

Three researchers and three expert measurers (each at one of the three measurement stations) used one of the three anthropometric instruments. An expert measurer was defined as having completed an instrumentation course for exercise physiology/biomechanics and/or having measured a minimum of fifty subjects. One researcher and one expert used the Lange skinfold caliper, the second researcher and second expert used a flexible non-stretchable tape measure for circumferences, and the third researcher and third expert used the broad-blade metal anthropometer to measure

breadths. In addition, the third researcher and third expert also measured height and weight. The researcher and expert who assessed skinfold thickness were each assisted by a scorer who recorded the measurement data on a collection form. All other measurements made were recorded by each researcher and expert on separate collection forms (see Appendix E). Each subject was measured twice by the researchers and a third time by the experts. It took approximately 30 minutes per subject to complete the measurement procedures during the pilot study.

No protocol changes were found to be necessary after the pilot study had been completed.

Collection of data at bodybuilding competitions. Bodybuilding competitions are divided into two sections: pre-judging and evening show. The data collection for this study occurred following the pre-judging section of three north district National Physique Committee competitions. Prior to the pre-judging, all competitors must check and weigh in with the head judge. At this time, the researcher informed all of the female competitors of the testing procedures.

Following the pre-judging assessment rounds, the competitors who wanted to participate in the study signed the informed consent form and data collection commenced.

The procedure in which the data was collected (based on the pilot study) was (1) each subject started at the circumference station then (2) moved to the skinfold measurement station and (3) finished at the breadth plus height and weight station. Therefore, each subject rotated through each of the three measurement stations one time. Approximately 15

minutes per subject was required to complete the measurement procedures.

The data were collected by three researchers. One researcher used the Lange skinfold caliper, the second researcher used a flexible non-stretchable tape measure for circumferences, and the third used the broad-blade anthropometer for breadths. In addition, the researcher who collected the breadth data also measured height and weight. All techniques used for measurements made were those previously described except for, the measurement of weight. The physicians' scales used to assess weight were provided by the contest promoters at each contest. Therefore, to ensure valid measures across weights the scales were calibrated at twenty-five, fifty, and one-hundred pounds using barbell weight plates. Weight was measured to the nearest 0.25 pound. Due to contest organization, weight was only able to be obtained by the above mentioned procedure for one contest. All other measures of weight were taken by contest officials. These measures of weight were later obtained from the competitors score sheets.

At bodybuilding competitions, the various groups of weight classes finish their pre-judging assessment rounds in shifts. Therefore, all competitors did not finish at the same time. This allowed time for the researchers to obtain the anthropometric measurements. All measurements taken were recorded on data collection sheets by each researcher (see Appendix E). However, skinfold measures were recorded by a scorer assisting the researcher using the skinfold calipers.

The judges' scores from two bodybuilding competitions were collected for each female competitor from the contest promoters. Scores from the

third round of competition (the muscularity round) were used to evaluate and rank the competitors (B. O'Brien, personal communication, May 27, 1989). These scores were used as the dependent variable for analysis.

Analysis

Pilot study. Reliability and validity of the three researchers was established by the following methods: (1) thirty subjects were used; (2) each subject was measured twice by each researcher for each anthropometric measurement; (3) reliability of the three researchers was established by use of an intraclass R; (4) the subjects were measured a third time by three expert anthropometric measurers from which the values of the experts were correlated with the first measurement values of the researchers in order to establish validity.

Bodybuilding competitions. The data collected from the anthropometric measurements (independent variables) and the scores for the muscular assessment round (dependent variable) given by the contest judges for each female competitor, were analyzed by use of correlation. This helped to determine whether the judging process was assessing the physiological measures of muscularity (fat-free weight, mesomorphy, and proportionality of muscle mass). Additionally, a multiple regression analysis with fat-free weight, mesomorphy, and proportionality of muscle mass as independent variables and judges' scores as the dependent variable was used to determine which measures were best able to predict competitive scores. Power was also estimated. To examine the objectivity of the judges' scores an Intraclass R was calculated on their scores (B.

Shifflett, personal communication, September 15, 1988).

Summary

The methods used for this research project were the following: (1) a pilot study was conducted to ensure the reliability and validity among the measurers and establish an order in which to collect the data; (2) subjects were the competitive female bodybuilders who had entered California north district National Physique Committee bodybuilding competitions; (3) the physical characteristics of the female bodybuilders were assessed by taking anthropometric measurements of skinfold, circumference, breadth, height and weight to determine fat-free weight, mesomorphy, and proportionality of muscle mass; (4) the physical assessments of this group of athletes were compared to the competition scores awarded to them by the contest judges using multiple regression and correlational analyses.

CHAPTER IV

RESULTS

Introduction

Selected physiological characteristics of competitive female bodybuilders were examined in relation to scores awarded to them in bodybuilding contests by qualified competition judges. Judges' scores and measures of muscularity were analyzed using correlational and multiple regression analyses. An alpha level of .05 was selected to determine whether or not there was a significant regression. Additional descriptive statistics for demographic and physiological measures were also examined.

Pilot Study Results

Methodology for data collection was established through a pilot study. Results indicated that all procedures used were acceptable. Estimates of reliability ranged from .80 to .99 and estimates of validity ranged from .73 to .99 (see Table 1).

Bodybuilding Competition Results

Descriptive Statistics. A total of 37 competitive female bodybuilders who had entered three California north district National Physique Committee bodybuilding competitions were the subjects in this study. One of the goals determined at the onset of the study was that each of the competitors needed to be judged by a minimum of the same two judges.

Table 1

Pilot study results - Estimates of reliability and validity for three researchers using selected anthropometric instruments to measure circumferences, skinfolds, breadths, and height

	Reliability	Validity
Researcher 1		
<u>Circumferences</u>		
Arm (relaxed)	.99	.98
Arm (flexed)	.99	.97
Chest	.97	.96
Thigh	.98	.95
Calf	.85	.99
Researcher 2		
<u>Skinfolds</u>		
Tricep	.98	.95
Subscapula	.96	.94
Suprailium	.98	.93
Thigh	.96	.94
Calf	.96	.99
Researcher 3		
<u>Breadths</u>		
Elbow	.80	.83
Knee	.80	.73
<u>Height</u>	.99	.99
<u>Weight</u>	.99	.99

This was necessary in order to examine objectivity. Consequently, scores were used from only two competitions from which both judges were the same. In addition, ten of the subjects were excluded from the study due to the fact that they were not judged by the same two judges as the rest of the group. Therefore, twenty-two subjects were used from one competition and five subjects were used from another competition. Table 2 presents the individual and group descriptive characteristics of the subjects ($n = 27$). The age of the subjects ranged from 17 to 61 years, $\bar{M} = 31$. The mean height and weight were 163.4 cm and 54.37 kg, respectively. These values are similar to the reference woman from which height is equal to 163.83 cm and weight is equal to 56.82 kg (Behnke & Wilmore, 1974). Percent body fat, fat-free weight and proportionality of muscle mass were $\bar{M} = 10.7\%$, $\bar{M} = 48.62$ kg, and $\bar{M} = 25.25$ kg, respectively. These values represent low percent body fat and high levels of muscle hypertrophy. Table 3 depicts the individual somatotype values expressed as a three numeral rating. The mean endomorphy, mesomorphy, and ectomorphy ratings for this group of subjects were 1.5 - 4.4 - 3.2. Similar to percent body fat, free-fat weight, and proportionality of muscle mass, this rating represents both relative leanness and relative muscularity of the subjects. Table 4 shows the mean anthropometric measures collected in this study which included circumferences of the chest, bicep (flexed and relaxed), forearm (maximum), thigh, and calf; diameters of the elbow and knee; and skinfolds of the tricep, subscapula, suprailium, thigh, and calf. Table 5 shows each subject's competitive weight class and their competition scores awarded to them by the contest judges.

Table 2

Descriptive Characteristics of Competitive Female Bodybuilders

Subject	Age (yr)	Height (cm)	Weight (kg)	%BF	FFW (kg)	Proportionality of Muscle Mass (kg)
1	29	160.4	50.00	7.1	46.43	22.95
2	23	151.4	47.77	10.6	40.04	20.45
3	29	158.4	45.80	11.7	40.43	21.84
4	26	154.7	49.55	13.9	42.64	22.24
5	35	160.9	50.45	19.6	40.58	21.18
6	34	159.4	50.90	11.4	45.10	23.80
7	32	157.4	51.60	10.7	46.07	25.27
8	36	160.9	52.50	10.4	47.03	24.60
9	37	158.9	47.60	9.3	43.20	23.31
10	43	158.9	49.90	12.5	43.64	22.40
11	18	161.4	53.40	10.7	47.65	23.85
12	24	164.4	55.45	8.8	50.60	26.26
13	27	165.4	56.60	5.5	53.53	28.02
14	31	164.7	53.64	7.6	49.54	27.03
15	20	162.9	54.32	11.3	48.20	24.34
16	23	165.9	55.65	7.3	51.43	26.60
17	27	162.9	56.14	10.6	50.20	25.45
18	33	156.9	56.70	17.9	46.54	22.35
19	33	162.9	54.10	7.5	50.05	26.20
20	29	171.4	59.54	8.8	54.70	28.60
21	41	178.4	62.50	10.1	56.22	30.06
22	32	170.9	57.73	12.8	50.36	26.54
23	19	174.7	67.04	7.8	61.80	31.55
24	37	159.4	57.50	8.9	52.40	25.37
25	37	175.4	58.07	9.1	52.77	28.25
26	61	167.9	60.00	15.3	50.84	26.44
27	17	164.4	56.70	10.7	50.66	26.77
Mean	31	163.4	54.37	10.7	48.62	25.25
SD	9.17	6.42	5.02	3.2	5.1	2.73

Table 3

Somatotype Ratings of Competitive Female Bodybuilders

Subject	Endomorph	- Mesomorph	- Ectomorph
1	0.5	4	3
2	1.5	5	3.5
3	1	4	4
4	2	4.5	2
5	3.5	4	4
6	1.5	4	3
7	2.5	5	2.5
8	1.5	5	3
9	1.5	4	4
10	1.5	4	3
11	1.5	4	4
12	1	5	3
13	0.5	4	4
14	1	5	3.5
15	2.5	4	3
16	1	4	3.5
17	1.5	5	2.5
18	4	5	1.5
19	1	5	3
20	1	4	3.5
21	1	4	4.5
22	2	3	4
23	1	4.5	3
24	1	5	1.5
25	1	4	4.5
26	2	5	3
27	2	5	2.5
Mean	1.6	4.4	3.2
SD	0.82	0.55	0.80

Table 4

Anthropometric Measurements of Twenty-Seven Competitive Female Bodybuilders (Mean $\pm$ SD)

	Mean	SD
<u>Circumferences (cm)</u>		
Chest	86.0	4.04
Thigh	51.0	2.33
Calf	33.8	1.37
Bicep (relaxed)	26.5	1.31
Bicep (flexed)	30.1	1.60
Forearm	24.0	1.03
<u>Diameters (cm)</u>		
Elbow	6.0	0.35
Knee	8.7	0.43
<u>Skinfolds (mm)</u>		
Tricep	6.7	3.18
Subscapula	7.0	2.38
Suprailium	4.3	1.17
Thigh	11.0	4.63
Calf	6.9	2.72

Table 5

Weight Class, Competition and Judges' Scores of Competitive Female Bodybuilders

Subject	Weight Class	Competition A or B	Scores	
	Lightweight (LW) Middleweight (MW) Heavyweight (HW)		Judge 1	Judge 2
1	LW	A	1	1
2	LW	A	3	2
3	LW	B	2	2
4	LW	B	1	1
5	LW	B	4	5
6	LW	B	5	4
7	LW	B	3	3
8	LW	B	2	2
9	LW	B	1	1
10	LW	B	2	2
11	LW	B	2	2
12	MW	A	3	3
13	MW	A	1	1
14	MW	B	3	2
15	MW	B	5	4
16	MW	B	1	1
17	MW	B	2	3
18	MW	B	6	6
19	MW	B	1	1
20	HW	A	2	1
21	HW	B	1	1
22	HW	B	3	3
23	HW	B	1	1
24	HW	B	3	1
25	HW	B	1	2
26	HW	B	4	4
27	HW	B	1	1

Note. A = competition 1; B = competition 2

Multiple Regression and Correlational Analyses. Table 6 summarizes the multiple regression analysis used for the determination of which measures of muscularity (fat-free weight, mesomorphy, proportionality of muscle mass) best predicted competitive judges' scores. No significant regression was found between the independent variables (fat-free weight, mesomorphy, and proportionality of muscle mass) and judges' scores. In fact, only 18% of the variance in judges' scores was accounted for by measures of muscularity. Further analysis of the variables seemed warranted. A stepwise analysis was used to see in what order the variables entered into the regression equation. When variables are entered into a regression equation they are selected in a certain order because of their ability to contribute to the overall prediction. The first variable selected is usually the one that has the highest correlation with the criterion or dependent variable. The following variables chosen are then stepped in with one already chosen to see which variable next contributes most to prediction (Thomas & Nelson, 1985). Stepwise analysis of results indicated that only the proportionality of muscle mass measure accounted for enough of the variance to be useful as a predictor of judges' scores. A multiple regression analysis of just proportionality and judges' scores resulted an $E = 4.40$, $r = .39$, and standard error of estimate equaled 1.36. Additionally, when power was estimated it was .37.

To explore whether physiological measures were inaccurate, the correlations between height and weight; height and percent body fat; and fat-free weight and proportionality of muscle mass were examined. All correlations were above $r = .80$ as would be expected (see Table 7).

Table 6

Multiple Regression Analysis of Judges' Scores and Measures of Muscularity
 (Fat-free Weight, Mesomorphy, and Proportionality of Muscle Mass)

Source	df	Sum of Squares	Mean Squares	F-ratio
Regression	3	8.964	2.988	1.69
Error	23	40.666	1.768	
Total	26	49.630		

Table 7

Correlation Coefficients for Measures of Height and Weight; Height and Percent Body Fat; and Fat-Free Weight and Proportionality of Muscle Mass

Measure	Correlation Coefficient
Height and Weight	.83
Height and Percent body fat	.95
Fat-free weight and Proportionality of muscle mass	.95

However, when each one of these variables was correlated with judges' scores low negative correlations resulted (see Table 8). One exception was the correlation between percent body fat and judges' scores which resulted in $r = .71$, a moderately high relationship (Safrit, 1986).

In hopes of finding a more meaningful relationship between judges' scores and the subjects' physical characteristics an additional multiple regression was performed. The analysis used judges' scores as the

dependent variable however, height, weight, and percent body fat were used as the independent variables. Table 9 shows the analysis which resulted in Table 8

Correlation Coefficients Between Judges' Scores and Measures of Height, Weight, Percent Body Fat, Fat-Free Weight, and Proportionality of Muscle Mass

Measure/Judges' Scores	Correlation Coefficient
Height and scores	-.27
Weight and scores	-.09
Percent body fat and scores	.71
Fat-free weight and scores	-.32
Proportionality of muscle mass and scores	-.39

a significant regression accounting for 53% of the variance.

Reliability. To determine the objectivity of judges' scores an Intraclass R was calculated ($R = .94$). The computed results revealed that consistency between the scores awarded by the two judges was good (see Table 10).

Table 9

Multiple Regression Analysis of Judges' Scores and Measures of Height, Weight, and Percent Body Fat

Source	df	Sum of Squares	Mean Squares	F-ratio
Regression	3	26.474	8.825	8.77*
Error	23	23.156	1.007	
Total	26	49.630		

* $p < .05$

Table 10

Reliability (Objectivity) of Judges' Scores

Source	df	Sum of Squares	Mean Squares	R
Between Groups	1	0.2962963	0.2962963	.94
Within Groups	26	5.703704	0.2193732	
Total	53	105.2593		

Summary

This chapter described the analysis of the data and the results of the statistical calculations used to assess the research hypothesis. Measures of muscularity (fat-free weight, mesomorphy, and proportionality of muscle mass) reflected in anthropometric measures did not highly correlate with scores awarded to competitive female bodybuilders by contest judges. Other anthropometric measures proved to be more highly correlated with judges' scores. These results will serve as the basis for the conclusions to be discussed in the final chapter.

CHAPTER V

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this research study was to measure fat-free weight, the second component of somatotype (mesomorphy), and proportionality of muscle mass for competitive female bodybuilders. These measures of muscularity were then correlated to scores awarded to the competitors by qualified contest judges. The research hypothesis was that the scores awarded to the competitive female bodybuilders by the contest judges would correlate with the competitors' anthropometric measures of muscularity.

Discussion

Body composition of competitive female bodybuilders. Previous studies have indicated that competitive female bodybuilders display both high levels of muscular hypertrophy and low levels of percent body fat (Elliot et al., 1987; Freedson et al., 1983; Heyward et al., 1989; Powell, 1986; Woods, 1985). For example, measures of percent body fat in these studies ranged between 9.5% and 16.8%. The subjects of this study were also relatively lean ($\bar{M}$ % BF = 10.7%) (see Table 2). This value indicates a lower percent body fat than reported in the early studies on competitive female bodybuilders. Freedson et al. (1983) and Elliot et al. (1987) found that the competitive female bodybuilders had a mean percent body fat of 13.2% and 13.7% based on five and seven skinfold sites, respectively. Similarly, Woods

(1985) and Powell (1986) reported a mean percent body fat of 14% (six skinfold sites) and 16.7% (three skinfold sites), respectively. In comparison, this study found a mean percent body fat of 10.7% based on four skinfold sites. It should be noted that even though most of these studies used more skinfold sites than used in the present study, the differences indicated are not due to the number of skinfold sites used. According to Pollock and Jackson (1984), use of more than three skinfold sites to estimate percent body fat does not increase the accuracy of predictive validity. Therefore, differences between degree of leanness of the present study and previous studies mentioned may be due training modalities, state of training (i.e., competitive versus non-competitive state), dietary manipulations used to decrease percent body fat, and/or caliber of athletes used in each study. Lastly, in the most recent published study on competitive female bodybuilders (in both competitive and non-competitive states) Heyward et al. (1989), reported a lower mean percent body fat ($\bar{M}$ = 9.6%, competitive state versus $\bar{M}$ = 16.8 %, non-competitive state) than previously noted. However, percent body fat in this study was estimated from hydrostatic underwater weighing methods. Hydrostatic methods used to estimate percent fat compared to anthropometric methods differ slightly in accuracy when predicting percent body fat. Error for hydrostatic weighing is 2% and anthropometric skinfold measurement error is 3% (C. Christensen, personal communication, March 5, 1990). Consequently, differences in percent body fat between this study and the present study are probably due to methodology.

The subjects in the present study exhibited a high degree of muscular hypertrophy indicated by levels of fat-free weight ($M = 48.62$ kg) (see Table 2). This is slightly higher than the findings of previous studies on competitive female bodybuilders. Freedson et al. (1983) and Woods (1985) reported a mean lean body mass of 46.63 kg and 45.8 kg, respectively. Even though these studies used lean body mass to estimate muscular hypertrophy, lean body mass and fat-free weight values are closely related for the following reasons. First, fat-free weight and lean body mass differ in terminology due to the fact that lean body mass accounts for essential storages of fat found in the central nervous system, around the organs, and marrow of the bones. Fat-free weight is what the body would have devoid of all fat. Second, even though lean body mass and fat-free weight are not synonymous terms, they use the same calculation to arrive at their respective estimates; fat weight (body weight times percent body fat) subtracted from total body weight equals fat-free weight or lean body mass (McArdle et al., 1986).

Other measures of muscular hypertrophy used in this study, proportionality of muscle mass and somatotype/mesomorph, have never been reported for competitive female bodybuilders. However, values for proportionality can be compared to the phantom strategem from which the calculations for proportionality were derived and to other types of athletes. The phantom strategem is a unisex model that can be used as a reference to compare different anthropometric measures within and between subjects. With this in mind, phantom reference values for height, weight, and proportionality of muscle mass are: 170.18 cm, 64.58 kg, and 25.55 kg,

respectively. In comparison, the subjects in the present study were shorter and lighter than the phantom; mean height equaled 163.4 cm and mean weight equaled 54.37 kg (see Table 2). On the other hand, proportionality of muscle mass ($\bar{M}$ = 25.25 kg, see Table 2) was almost equal to the reference value of the phantom (25.55 kg).

Proportionality measures of muscularity have been used to compare various types of Olympic athletes (Ross & Ward, 1984; Ross et al., 1982). Yet, in these studies values were reported as z scores versus centimeters or kilograms (proportionality measures can be calculated to equal z scores or descriptive values). However, there was one study from which descriptive values on female Olympic rowers and female non-rowers were reported (Hebbinck, Ross, Carter, & Borms 1980). The results of this study indicated that female Olympic rowers had a mean height, weight, and proportionality of muscle mass of 174.3 cm, 67.4 kg, and 29.93 kg, respectively. These findings are higher than the means for both female non-rowers and competitive female bodybuilders in the present study. Mean height, weight, and proportionality of muscle mass for female non-rowers was 165.7 cm, 57.5 kg, and 24.48 kg, respectively. Mean height, weight, and proportionality of muscle mass for competitive female bodybuilders was 163.4 cm, 54.37 kg, and 25.25 kg, respectively. The larger values for the female Olympic rowers was probably due the type of body build/somatotype needed for this type of sport and the athletic caliber of the rowers. On the other hand, competitive female bodybuilders had a slightly higher mean value for proportionality of muscle mass ($\bar{M}$ = 25.25 kg) than the female non-rowers ($\bar{M}$ = 24.48 kg). This finding is not as would be expected since the female

non-rowers were used as a general reference for non-athletic comparisons. One would expect to find that female bodybuilders would have much larger values for proportionality of muscle mass when compared to a non-athletic population. A probable reason for this finding is that the female bodybuilders were both shorter ($\bar{M} = 163.4$ cm) and lighter ($\bar{M} = 54.37$ kg) than the female non-rowers ($\bar{M} = 165.7$ cm and $\bar{M} = 57.5$ kg). However, the slightly higher value for proportionality of muscle mass in competitive female bodybuilders compared to female non-rowers is probably training induced. It is interesting to note, that height and weight of competitive female bodybuilders in previous studies had comparable height and weight to the subjects in this study. Freedson et al. (1983) reported a mean height and weight of 160.8 cm and 53.78 kg, respectively; Woods (1985) reported mean height and weight of 160.6 cm and 53.4 kg, respectively; Powell (1986) reported mean height and weight of 164.22 cm and 55.625 kg, respectively; Elliot et al. (1987) reported mean height and weight of 164 cm and 55 kg, respectively; and Heyward et al. (1989) reported mean height and weight of 162.4 cm and 52.3 kg (competitive state)/58.3 kg (non-competitive state), respectively. Therefore, with regard to the present study and other studies of competitive female bodybuilders, not only are competitive female bodybuilders both relatively lean and muscular, they are also relatively short in stature and relatively light in weight.

As previously mentioned, data is not available for comparisons on somatotype of competitive female bodybuilders. However, examining the data from the present study, competitive female bodybuilders have a high ratio of relative mesomorph compared to relative endomorph and relative

ectomorph. The mean endomorph, mesomorph, and ectomorph were 1.6 - 4.4 - 3.2 (see Table 3). The category used to describe this rating is ectomorphic mesomorph (Carter, 1972). This terminology is used because the second component is dominant and the third component is larger than the first component. Ectomorph refers to relative leanness and mesomorph refers to relative muscularity. Additionally, ratings from 1/2 to 21/2 are considered as low values; ratings of 3 to 5 are considered as mid-range values; and 51/2 and up are considered as high values. Therefore, this finding suggests that (as would be expected) competitive female bodybuilders are relatively lean and relatively muscular.

Prediction of judges' scores. As indicated from the results of the study, objective measures of muscularity (fat-free weight, mesomorphy, and proportionality of muscle mass) did not correlate with judges' scores, as only 18% of the variance in scores was accounted for by anthropometric measures of muscularity. Correlational factors need to account for a minimum of 50% of the variance to be of practical value (B. Shifflett, personal communication, January 11, 1990). According to the California north district National Physique Committee, guidelines for judging bodybuilding competitions at the district level are the following: symmetry/shape, muscular development, hardness of the muscles, presentation of the muscle groups, and skin tone. In addition, assessment of the competitors' physique occurs in the third round of competition only. The third round of competition is the muscularity round. With this in mind, according to the guidelines and the third round used for ranking the competitors, the amount of muscularity each competitor has, is fairly

important in determining success in competition. However, judges' scores were not based solely on degree of muscularity of the competitors, other factors seemed important in determining success in competition. What did correlate with the judges' scores were measures of height, weight, and percent body fat. Although still low, 53% of the variance was accounted for. It is interesting to note, that those subjects with the lowest percent body fat also had the highest degree of proportionality of muscle mass and fat-free weight (see Table 2). This is due to the fact that in athletic populations, as a result of training an inverse relationship exist between fat-free weight and percent body fat (McArdle et al. 1986). Low percent body fat usually indicates a high fat-free weight. This can be exemplified from the data which suggested that strong relationships ($r > .80$) were found between measures of height and weight, height and percent body fat, and fat-free weight and proportionality of muscle mass.

Homogeneity of subjects. The measures of muscularity among the subjects were very similar (see Table 2 and 3). Furthermore, the number of subjects used in this study was limited due to the fact that each subject needed to be rated by a minimum of the same two judges in order to examine objectivity. Since muscularity measures were similar and because the number of subjects was limited, there was little variability in the range of muscularity among subjects. Consequently, the homeogenous nature of the measures of muscularity may have attenuated the results due to narrow variability in these measures.

Judges' scores: Relative vs. absolute measures. As previously noted, an important aspect of the judges' guidelines is assessment of the amount

of muscular development a competitor has. At the present time this assessment, judging the amount of muscular development, is a relative measure because it is subjectively based on the muscularity of other competitors in that weight class. Table 5 shows that variation in judges' scores was minimal regardless of weight class, competition and variations in anthropometric measures of muscularity (see Table 2 and 3). This is due to the fact that scores awarded to the competitors are based on each judge's personal individual assessment; they are not scaled to predetermined values (W. Sprague, personal communication, November 17, 1988). For example, if there are six competitors entered in a particular weight class (NPC competitive bodybuilders are divided into competitive categories according to weight) each competitor in that class is rated on a scale of one to six. Likewise, if there are only three competitors entered in a particular weight class they are rated on a scale of one to three. Consequently, a competitor can score a six then three from one contest to another. This can even take place within the same contest if the competitor has entered more than one category due to age. (Most NPC contests are divided into categories by weight. However, there are some contests in which age along with weight are also categories, e.g., teen and master levels). It seems that use of absolute values for assessment would be necessary if there is to be any meaning to the judges' scores when evaluating competitors within or between different contests. Therefore, the subjective rating of muscularity due to relative values for scores may have influenced the results of this study.

Related Discussion

Even though judges' scores were relative versus absolute measures, objectivity between judges' scores was good (see Table 6). Why then, did the results indicate that only 18% of the variance in judges' scores was accounted for by anthropometric measures of muscularity? As mentioned above, the relative nature of judges' scores and the narrow variability in measures of muscularity may have affected the results. However, the possibility also exists that other factors in combination with the relative nature of judges' scores could have potentially influenced the results.

Judging biases. According to Landers (1970) performance by human observation (i.e., gymnastics, diving, ice skating, competitive bodybuilding) may be subject to judging bias. Furthermore, even though scoring systems may be objectified (and according to the data, judges' scores were objective $R = .94$, see Table 10), biases can still occur. This is because performance scores tend to be not just based on objective criteria. Consciously or subconsciously, subjective assessments may also become an integral part of the scoring system. This could be due to the following reasons: (1) Sports requiring human observation as a basis for evaluation often involve artistic elements in performance. Artistic elements in performances are often rated on the basis of aesthetic value. Aesthetic values (and any other type of value) are individual beliefs. In judging sports competition these beliefs can become personal judgements on the performance in question. (2) These aesthetic values may be influenced by social/psychological factors and performance expectations which can influence the accuracy of a judge's score. For example, conformity pressures due to institution,

organization, committee, or even peer group values are a type of social/psychological factor that may influence judges' scores. These factors can consequently affect judges' beliefs and attitudes concerning certain personal characteristics of performers and thus, expectations of the performers' ability (Landers, 1970; Scheer, 1973; Scheer & Ansorge, 1975).

Competitive bodybuilding for both men and women is an example of a sport that involves artistic elements in performance. According to Zwingle (1984), "bodybuilding is based on aesthetics; the sport exists only to show the beauty of the human form" (p. 35). Based on the above discussion, judges' attitudes and values regarding this artistic/aesthetic element in competitive bodybuilding may potentially affect the scores they award. Furthermore, it is also a sport that has been enmeshed in controversy based on societal and bodybuilding organizational conformity pressures concerning the concept of female muscularity or, the socially accepted aesthetics of how much muscle a woman competitor should develop. According to Kane (1987), female muscular development and/or athletic prowess are in direct conflict with socially accepted notions of feminine behavior. Ideally, masculinity and femininity are either viewed as two separable groups or as a continuum (Graydon, 1987). However, the definition of the terms masculine and feminine tend to rely on what males and females look and behave like. Consequently, research has indicated that there is a negative correlation between opinions of attractiveness and attributions of masculine qualities for women athletes (Kane, 1987). Women in classically masculine sports are viewed as being more masculine than women in other sports or women not involved in any sport.

Athletic/muscular femininity. Bodybuilding and strength sports in general have been traditionally viewed as masculine sports. Consequently, increased strength and muscular hypertrophy resulting from these types of training regimes are also viewed as masculine (Giel, 1988). According to Tanny (1990), " Trying to second-guess what the [bodybuilding] judges will be looking for each and every year is one of life's mysteries....the trend changes from year to year, from more muscular to more feminine to more muscular... " (p. 227). Furthermore, according to Tuman (personal communication, August, 1989), " Judges in the sport of competitive female bodybuilding are trying to not judge on the 'masculine look'.... the judges are looking for a 'feminine bodybuilder look, an athletic healthy look. '" With this in mind, muscularity seems to be perceived not only as a masculine trait but also as an unwanted trait for competitive female bodybuilders. Yet, is not the definition of the sport of bodybuilding, physique enhancement through the development of the muscles to a high degree of hypertrophy? Therefore, it seems possible that the judges' scores in the present study may have been partly influenced by social/psychological notions of athletic femininity (which might adversely affect the correlation with objective measures of muscularity) as described by Kane and Graydon and, consequently, possibly subject to judging bias as described by Landers, Sheer and Ansorge, and Scheer. The possibility exists due to the following reasons: (1) for those involved in the sport of competitive bodybuilding (competitors, judges, and fans) an agreement can not be made on how much muscularity a woman can or should develop. An agreement may not be able to be made due to the aesthetic component involved in the sport and the

social/ psychological factors (i.e., conformity pressures concerning the socially acceptable amount of muscle that a female can develop) that may be influencing such a decision. (2) Competitive female bodybuilders' measures of muscularity did not correlate with judges' scores.

Conclusions

Anthropometric measures of the female competitors' muscularity accounted for only 18% of the variance in judges' scores. On the other hand, the competitors' measures of height, weight, and percent body fat proved to account for a greater percent of the variance (53%) in judges' scores. The reasons for these findings based on the results and discussion are likely to be two-fold. First, judges' scores in bodybuilding competitions are relative measures versus absolute measures. For example, a competitor in one contest with high degree of muscularity might do extremely well. However, all things being equal, the same competitor may not score as well from one contest to another even though she still has the same degree of muscularity as the previous contest. Second, homogeneous measures of muscularity may have attenuated the results due to the narrow range in variability in measures of muscularity and the limited number of subjects. Thus, relative assessments that may have influenced judges' scores and the homogeneity in measures of muscularity may have affected the results. Lastly, judges' scores were not and may never be highly correlated to measures of muscularity unless (1) changes in scoring systems for bodybuilding competitions are implemented and (2) fundamental changes in societal perceptions of the competitive female bodybuilder occur.

Recommendations

Future trends. Title IX and other legal events brought women extended opportunities to participate in athletic competitions (Protzman, 1980). However, even though legal events have quantitatively changed sport opportunities for women, attitudes towards the concept of the female athlete have not changed (Cheska, 1981; Colley, Nash, O'Donnell, & Restorick, 1987; Graydon, 1987; Kane, 1987). Changing societal perceptions of the female athlete are absolutely necessary if women are to have appropriate recognition of their athletic ability. If change does not occur, repercussions of this faulty societal notion may be felt throughout the sporting arena. Unfortunately, societal perceptions of the female athlete are being felt in the sport of competitive bodybuilding for women. According to a NPC contest promoter, the number of female competitors has been decreasing in the last five years (V. Allyn, personal communication, May 27, 1990).

Fortunately, according to Cheska (1981), inherent to society is change. With such change, socio-cultural values can also change. However, within the sport of competitive female bodybuilding, future trends that occur due to these changes can only be positive if the physiological effects from training are not only understood but also accepted. Physiologically, women will never be able to naturally develop muscular hypertrophy to the same extent as men (Fleck & Kraemer, 1987; McArdle et al., 1986; Wilmore & Costill, 1988). High degrees of muscular development/hypertrophy are dependent on the hormone testosterone. Testosterone levels in the body promote anabolic tissue building effects. Even though levels of testosterone are on a continuum for both men and women, females, unlike

males lack high levels of testosterone. It has been noted that men have 20 to 30 times more testosterone than women (McArdle et al.,1986).

Therefore, a physiological limitation for muscular hypertrophy exists for women when compared to men. With this in mind, the amount of muscular development that women can or should have in the sport of competitive bodybuilding should not be an issue or controversy, as previously noted. Women in competitive bodybuilding should be able to be judged on their level of muscularity not on their level of muscular femininity. Acceptance and knowledge of physiological potentials by judges, competitors and fans will enable competitive bodybuilders to have a well-rounded and fulfilled athletic experience. Within a well-rounded athletic experience all women (and men) in competitive bodybuilding would be able to develop their physiques to their utmost capabilities. According to Thomas et al. (1983), a change and recognition for what women are and what they can be in competitive bodybuilding will be a release from socio-cultural notions of femininity for all those involved and not involved in the sport. Women engaged in sport will not be more or less feminine due to muscularity/athletic prowess. Women engaged in sport will be recognized and accepted as athletes and for athletic ability because of their muscularity/athletic prowess regardless of gender.

With this in mind, the following recommendations are made:

(1) scoring systems for female bodybuilding competitions at the district level should be based on absolute values versus relative values. For example, each score could be worth a particular numerical value. On a scale of one to ten, a score of one could represent a high degree of muscularity

whereas a ten could represent a low degree of muscularity. The degree of muscularity judged for each subject would need to be based on human observation in order for bodybuilding to be still considered a sport. Without human observation or judging in competitive bodybuilding, the sport would be reduced to a physiological study. However, it would be important to use some physiological measure to help objectify the judging process. An example of a physiological measure could be the estimation of percent body fat and fat-free weight (a measure of muscularity). Percent body fat could be easily measured by electrical impedance test (electrical impedance has been shown to be as accurate as measures of skinfolds for estimates of body fat) at the time that competitors are weighed in at pre-judging. The computerized results of percent body fat from the electrical impedance instrument could then be quickly calculated by a two-step formula to estimate fat-free weight. This measure of muscularity would assist not only the contest judges in scoring, but also the competitor with regard to improving performance level if necessary.

(2) competitive female bodybuilders need to be rated and awarded for gains in muscular development achieved through weight training regimes without reference to what is socio-culturally considered as masculine or feminine. In and of itself, the definition of the sport of competitive bodybuilding is physique enhancement through the development of high levels of muscular hypertrophy. Therefore, the sport of bodybuilding is not about what muscular men and women should look like, it is about what they can potentially develop through muscular hypertrophy training regimes.

(3) rules/scoring systems for judging competitions need to be not only understood by the judges and competitors, but also by the fans. This would improve the competition and increase the interest for all those involved with the sport of bodybuilding. Additionally, an increased understanding of the sport may possibly change socio-cultural notions of the competitive female bodybuilder.

(4) women competitors should continue to maximize their potential to enhance performance level, thereby increasing their ability to have a well-rounded sport experience.

(5) future studies on the sport of competitive bodybuilding could include: an expansion on the present study by use of more subjects and more judges, thereby lessening the possible effect of attenuation; a survey concerning socio-cultural notions of what competitive female bodybuilders should or should not look like distributed to competitors, judges, and fans in hopes of uncovering whether muscular femininity is an issue or not; an analysis of an examination and/or comparison of new and old scoring systems in which contest judges would rate competitors based on those scoring systems.

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Appendix A - Bodybuilding Competition

CONSENT FORM

You are invited to participate in a research study that is investigating fat-free weight, somatotype, and proportionality of competitive female bodybuilders. The results of this study should further our understanding of the physiological characteristics of competitive female bodybuilders on the day of competition.

I understand that

- 1) I will be asked to have physical measurements taken by physical contact of not only the measuring instruments but also, by the investigator using the instrument. The instruments used will be the Lange skinfold calipers which will assess % body fat; the broad-blade metal anthropometer which will measure breadth; and a flexible non-stretchable tape measure which will measure circumference. I will be measured at five sites for skinfolds, two for breadths, and seven for circumferences. In addition, I will be measured for height and weight. I understand that it could take twenty to thirty minutes to complete the measurement process.
- 2) the possible risks of this study are the occurrence that bruises that may result from use of the skinfold and anthropometer measurement instruments. However, bruising is not common.
- 3) the possible benefits of this study to me are that the physical assessments made will provide an indication of what my body composition is with regard to % body fat, fat-free weight, somatotype (whether I am a true or combination of ectomorph, mesomorph, or endomorph), and proportionality (how much muscle mass I have for my frame size).
- 4) any information from this study that can be identified with me will remain confidential as required by law.
- 5) if I decide to participate, I am free to withdraw my consent and discontinue participation at any time without prejudice from the researchers, San Jose State University, or the bodybuilding competition. If I have any questions I am free to ask.
- 6) any complaints regarding this study can be directed to Dr. Jim Bryant, Chairperson of the Department of Human Performance at (408) 924-3010. Concerns with respect to the rights of Human Subjects can be directed to Dr. Serena Stanford at (408) 924-2480.

I HAVE MADE THE DECISION WHETHER OR NOT TO VOLUNTARILY PARTICIPATE. MY SIGNATURE INDICATES THAT I HAVE READ THE INFORMATION PROVIDED ABOVE AND THAT I HAVE DECIDED TO PARTICIPATE.

Date

Subject

Investigator

Appendix B - Pilot Study

CONSENT FORM

You are invited to participate in a pilot study that is investigating reliability and validity of three investigators using anthropometric techniques. The results of this study should further our understanding of measurement techniques with regard to anthropometry.

I understand that

1) I will be asked to have physical measurements taken by physical contact of not only the measuring instruments but also, by the investigator using the instrument. The instruments used will be the Lange skinfold calipers which will assess % body fat; the broad-blade metal anthropometer which will measure breadth; and a flexible non-stretchable tape measure which will measure circumference. I will be measured at five sites for skinfolds, two for breadths, and seven for circumferences. In addition, I will be measured for height and weight. I understand that it could take twenty to thirty minutes to complete the measurement process.

2) the possible risks of this study are the occurrence that bruises that may result from use of the skinfold and anthropometer measurement instruments. However, bruising is not common.

3) the possible benefits of this study to me are that the physical assessments made will provide an indication of what my body composition is with regard to % body fat and somatotype (whether I am a true or combination of ectomorph, mesomorph, or endomorph).

4) any information from this study that can be identified with me will remain confidential as required by law.

5) If I decide to participate, I am free to withdraw my consent and discontinue participation at any time without prejudice from the researchers, San Jose State University, or the bodybuilding competition. If I have any questions I am free to ask.

6) any complaints regarding this study can be directed to Dr. Jim Bryant, Chairperson of the Department of Human Performance at (408) 924-3010. Concerns with respect to the rights of Human Subjects can be directed to Dr. Serena Stanford at (408) 924-2480.

I HAVE MADE THE DECISION WHETHER OR NOT TO VOLUNTARILY PARTICIPATE. MY SIGNATURE INDICATES THAT I HAVE READ THE INFORMATION PROVIDED ABOVE AND THAT I HAVE DECIDED TO PARTICIPATE.

Date

Subject

Investigator

Appendix C

Dear Competitive female bodybuilder,

The results of your body composition analysis have been computed from the master's thesis study that you most graciously volunteered to participate in at the 1989 _____ bodybuilding competition.

The following values are your body composition analysis for percent body fat, somatotype, and proportionality.

PERCENT BODY FAT: _____

College-aged women have been typically reported to have an average of 25% bodyfat. However, in two published studies on competitive female bodybuilders, an average of 13.2% and 13.5% bodyfat have been reported.

SOMATOTYPE: _____

Somatotype is represented by three hyphenated numbers with each number representing endomorph (relative fatness), mesomorph (relative muscularity), and ectomorph (relative linearity) which are always recorded in this order. For example, 4-5-3 represents mesomorph (5) as being the strongest component, with endomorph (4) secondary, and ectomorph (3) the weakest component. A 6-2-2 shows endomorph as the strongest component, yet low but equal values for mesomorph and ectomorph. Endomorph values typically range from 1/2 -14; mesomorph values typically range from 1-10; and ectomorph values typically range from 1/2-9. In general, ratings from 1/2 to 2 1/2 are regarded as low values; ratings of 3 to 5 are mid-range values; and 5 1/2 and up are high values.

PROPORTIONALITY of MUSCLE MASS: _____

Proportionality can be used to look for trends among sects or types of people/athletes and is compared to "phantom specifications" which is a unisex reference human. The phantom specifications for muscle mass is 56.5 lbs. at the reference height of 5 ft. 7 in. To date, proportionality assessment of muscle mass has not been used in application to study competitive female bodybuilders.

Thanks once again for participating in this master's thesis study which has helped us to gain further understanding of the physiological characteristics of competitive female bodybuilders on the day of competition.

Sincerely,

Rebecca Gottfried
HuP graduate student, Exercise Physiology
San Jose State University

Appendix D

Dear Aerobic dance exerciser,

The results of your body composition analysis have been computed from the pilot study that you most graciously volunteered to participate in last spring semester.

The following values represent an average of three different or sometimes the same scores, resulting from the same body composition equation (remember how many times you were measured at the same body site?). With this in mind, the following values are your body composition analysis for percent body fat and somatotype.

PERCENT BODY FAT: _____

College-aged women have been typically reported to have an average of 25% bodyfat.

SOMATOTYPE: _____

Somatotype is represented by three hyphenated numbers with each number representing endomorph (relative fatness), mesomorph (relative muscularity), and ectomorph (relative linearity) which are always recorded in this order. For example, 4-5-3 represents mesomorph (5) as being the strongest component, with endomorph (4) secondary, and ectomorph (3) the weakest component. A 6-2-2 shows endomorph as the strongest component, yet low but equal values for mesomorph and ectomorph. Endomorph values typically range from 1/2 -14; mesomorph values typically range from 1-10; and ectomorph values typically range from 1/2-9. In general, ratings from 1/2 to 2 1/2 are regarded as low values; ratings of 3 to 5 are mid-range values; and 5 1/2 and up are high values.

Thanks once again for participating in this pilot study which has helped us to gain further understanding of measurement techniques with regards to anthropometry.

Sincerely,

Rebecca Gottfried
HuP graduate student, Exercise Physiology
San Jose State University

Appendix E

DATA COLLECTION FORM

CONTESTANT # _____

HEIGHT (cm) _____

WEIGHT (kg) _____

MEASURE

BREADTH

(cm)

ELBOW

KNEE

DATA COLLECTION FORM

CONTESTANT # _____

AGE _____

MEASURE	SKINFOLD (mm)		
	1	2	3
TRICEP			
SUBSCAPULA			
SUPRAILUM			
THIGH			
CALF			

DATA COLLECTION FORM

CONTESTANT # _____

MEASURE	CIRCUMFERENCE (cm)
CHEST	
ARM (RELAXED)	
ARM (FLEXED)	
FOREARM (MAXIMUM)	
THIGH	
CALF	