Comparison of Anthropometric Measures of Competitive Bodybuilders to Judges' Scores and a Comparison of Judges' Scores

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Dissertation submitted to the Faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

In Education, Curriculum, and Instruction

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August 8, 2001

KEY WORDS: bodybuilding, judging, anthropometrics, bodyfat, athletes, reliability

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Abstract

This research compared physical characteristics of bodybuilders to judges' rankings, and compared the judges' rankings across three levels of judges: Elite, Trained, and Untrained. Twenty-nine male and nine female bodybuilding athletes consented to anthropometric and circumference measurements. The independent variables in this study were bodyfat, fat-free weight, and proportionality of muscle. Three groups of judges ranked male and female athletes in the Open, Novice, Collegiate, and Masters divisions. The measurements of proportionality of muscle, bodyfat, girths, and fat-free weight were analyzed using simple and multiple regression. The judges' rankings in each class were compared using reliability coefficients, correlation, repeated measures analysis of variance, and the generalized theory for inter-rater reliability. There were significant correlations between the Elite judges' rankings and bodyfat in the Men's Open lightweight class. The Trained and Elite judges' rankings were significantly correlated with bodyfat in the Women's Novice class. Fat-free weight was significantly correlated with the Untrained and Elite judges' rankings in the Women's Novice division. Proportionality of muscle was significantly correlated with the Elite and Trained judges' rankings in the Men's Open lightweight class. Elite and Trained judges' rankings were significantly correlated with bodyfat and proportionality of muscle. All three groups of judges' were significantly correlated with the Overall rankings. The Trained judges' rankings were more correlated and more reliable with the Elite judges. The inter-rater reliability scores were higher for the Elite and Trained judges than for the Untrained judges. When fat-free weight was substituted for body weight in the calculation of proportionality of muscle, prediction of ranking was enhanced. The education session led to a significant disparity in judges' rankings between Trained and Untrained judges.

Bodyfat appears to be a better selection variable when comparing physical measurements to judges' rankings in women. Proportionality of muscle is a better selection variable in predicting judges' rankings in men. Prediction models developed from this investigation need further testing.

ACKNOWLEDGEMENTS

I would like to take this time to thank God for giving me the strength, knowledge, and wisdom to complete this research project. God receives all the praise and all the glory, and through Him all things are possible.

I would also like to give thanks to my Mom and Dad for giving me life, and providing me with what they had over the years. Both of them left school in Junior High, so this is for you, Randolph P. Gaines and Emma Lou Gaines. I also give thanks to Mrs. Fannie Cauthorne who passed with cancer early in the 1990's. She raised me from ages 11-14 when things were hard in my family, and it was then that I started making honor roll in school. She, like my parents, taught me respect, discipline, morals, and love of life. She made me realize very early that education would be more important since outdoor labor was not a viable option because of my asthma.

I would also like to thank my Master's Advisor Dr. Don Sebolt, who is no longer here with us but always told me that I could do a PhD. "Rodney, Go work for a couple years and come on back. Through confusing comes learning." I still think Dr. Sebolt is out there somewhere riding his Harley up and down I-81. I also give thanks to Dr. Bos, who helped me tremendously during my thesis writing 5 years ago.

I thank Dr. Redican and Dr. Wojcik for helping me complete the doctoral process. Without them this would have been impossible. Thank you for giving me an opportunity and I will be forever grateful to you. I will never forget one hot August day in 1993 when I sought the advice of Dr. Redican about coming back to get my Master's. I resigned from my job, followed his advice, and am very happy with what has happened here. Thanks for your advice and who would have ever thought that this day would come. Thanks Dr. Janet Wojcik for believing in me, and thank you for all your hours of editing and support. You were a key part of my finishing this dissertation, and I am forever grateful for your support. Thanks for all the motivation and setting a good pace to finish this dissertation.

I would like to thank Dr. Fortune for all his help. He has been a great mentor to me someday. I would love to be the type of professor he is. Your classes were fun and educational. Thanks for all the help with the methodology and statistics for this project. I will never forget you, and your classes truly impacted my life. I wish you the best in Mississippi, and please do enjoy your retirement.

I would like to thank Dr. Stratton for all of his years of support. I really enjoyed your sport psychology classes, and thanks for giving me the opportunity to apply for my doctorate. You are someone for whom I have a high level of respect, and thanks for all your help on this project.

I would like to thank Dr. Krouscas for all his support over the past year, and thanks for all the prayers, my brother. Thanks for all your words of wisdom, and thanks for being a scholar and a friend.

I would like to thank Dr. Cross for all his hours of statistics help, and also thanks for being patient with my level of learning. I also would like to thank Dr. Birch in the Statistics department for helping with the analyses of this project. I send a special thanks to Chris McClinch from the English Department and Ann Jones for their editing help.

I would like to thank the subjects and volunteers who gave their precious time for this study. I send a special thanks to the INBF (International Natural Bodybuilding Federation) and WNBF (World Natural Bodybuilding Federation) for allowing me to do research in their organizations.

I would like to thank all the graduate students, friends, and other professors who were crucial to my learning and who were supportive of me.

Special thanks go to Dr. Rebecca S. Nelson for all her years of support, and her encouragement and belief in me. I also would like to give a special thanks to Oliver Washington, Jr. who encouraged me to come to Virginia Tech in 1985 and not to enlist in the Army. He went on to graduate from the Air Force Academy, and is now a Captain in the Air Force. Thank you Oliver. I also send a special thanks to Shirley Reese for her support and encouragement.

I would also like to remember Ludabelle Washington who passed six weeks before this project. She was an inspiration to the Gaines family, and she loved life and always smiled no matter what her situation was. Even though my heart was saddened, I worked on because that’s what she would have wanted.

I give thanks to my brother Wayne and sisters Sharon, Darlene, and Glenda. Thanks for helping our parents raise me, and thanks for teaching me respect & discipline, Thank you for your love. I also give special thanks to Robert Woody, Mr. Allen, and Alfred Rollins. They all taught me the importance of hard work early in life, and they were all role models for me.

I hope I did not forget anyone. Thanks to this University at which I completed my Bachelors in Business Finance in 1989, Masters in Exercise Science in 1996, and now my PhD in 2001. There has been laughter and tears, but it has been a good ride over the last 16 years. The PhD has been the hardest thing in my life to accomplish, even harder than when I won the Mr. Virginia Title as a drug free athlete. I thank God for keeping me healthy while working full time and going to school full time for 3 years. My completion of this project is due to the support of many, and I will never forget them. I am forever thankful, and thank you, God, for all these wonderful people.

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CHAPTER I

INTRODUCTION

Many today think that bodybuilding evolved on the sandy beaches of California in the 1960's and 1970's. There are reports, however, that the Chinese were performing strength training as early as 3600 B.C. Greece in 6th century B.C. reportedly had strongmen, wrestlers, and boxers. In 624 B.C. it was related that the legendary Milo shouldered a young calf until it grew to its full size. Milo developed the theory of progressive resistance training. Some of the first Greek gyms were outdoor arenas, and the Greeks later built enclosed structures similar to today's fitness centers.

To further understand the history/development of bodybuilding it is important to know the basics and history of strength training. There were reports of strength training in India over 5,000 years ago (Stutley & Stutley, 1977). Some of the earlier training methods included people jumping up out of holds to develop their legs. Ancient athletes cut handles into stones, a concept that proved to be the forerunner of today's dumbbells. Discus throwing was another type of brute strength event, and it remains as a popular training method even today. The Romans, who used exercise to become fierce warriors, developed exercise circuit training. The fall of the Roman Empire sent strength training into dormancy for approximately 1400 years. In the 1800s the Germans rediscovered strength training and physical culture by opening up weight lifting clubs (Persis, 1999).

In the 19th century there were reports of Englishman William Buckingham Curtis pressing two 100lb dumbbells overhead at arm's length. Louis Attila was teaching the art of physical culture at studios in Brussels, Belgium studios in the 1800's, and one of his pupils was the great Fredrick Mueller, also known as Eugene Sandow. Sandow was the first person known to use posing for entertainment, and was said to have earned $3600 a week for displaying his physique. Sandow has been known as "The World's Strongest Man." It was in Sandow's time that competitions were first held in which the physical measurements of the competitors were compared to determine the best athlete (Persis, 1999).

In 1859 French professor Edmond Desbonner and other prominent educators were endorsing weight training. Bernard McFadden was a master promoter of bodybuilding competitions in Madison Square Garden beginning in 1903. McFadden contests put more emphasis on how the body looked than how much strength an individual exhibited. Early in the 1900's the first corporate organization emerged known as the Milo Barbell Company. The first publications, Strength Magazine, Body Molding, and the Truth about Weightlifting, were printed in 1911. Mark Berry, who added lifting methodology and various movements, made appearances with his pupil, John Grimek. The start of World War I ended the rise of the Milo Company, and Bob Hoffman bought out Strength Magazine and the Milo Barbell Company. Hoffman changed the magazine's name to Strength and Health, and he renamed the company York Barbell Company. It was in 1936 that Perry Rader first published The Iron Man and it still exists today (Persis, 1999).

Initial bodybuilding competitions required bodybuilders to perform an athletic feat as well as show their physiques. The first Mr. America contest was held in 1939, and it was won by Roland Essmaker. The first real bodybuilding event was held in 1940, and John Grimek won it. It was added on to a powerlifting event, so it was called a bodybuilding contest until 1940. In the 1940's Clarence Ross and Steve Reeves in particular brought attention to the sport of bodybuilding, and Steve Reeves became well known to the public.

Even before this time physique exhibitions were popular additions to Olympic weightlifting contests, and, photo contests were sponsored by physical culture magazines. Charles Atlas was one of the memorable victors of these earlier events. Many of the classical ideals of how bodybuilders were judged have carried over to today's judging of the sport. Earlier athletes were judged on athletic prowess, and as late as 1973 the Amateur Athletic Union (AAU) America required bodybuilders to show intelligence by being scored on how they responded to a question. There has been some controversy over whether bodybuilding is actually a sport, but its addition to the World Games in 1981 helped confirm its place in the sport's realm. (Hatfied, 1984).

In the 1960's the sport was dominated by Dave Draper, Sergio Oliva, Bill Pearl, Franco Columbu, Frank Zane, and Arnold Schwarzenegger. It was in this era that marketability became important to bodybuilders, and there emerged controversies about judging and whether they showed favor for popular athletes. There was much disagreement about the 1972 Mr. Olympia title when Arnold Schwarzenegger defeated Sergio Oliva. There was even more disagreement in the 1980 Mr. Olympia won by Schwarzenegger, and some believed it to be unfairly judged. Schwarzenegger, after a 5-year leave of absence from the sport, returned to defeat all bodybuilders (Schwarzenegger, 1998).

Society has associated anabolic steroid use with anyone who claimed to be a bodybuilder, and that has prevented the sport of bodybuilding from becoming a part of the Olympics. In the early 1980's drug free bodybuilding surfaced, and the World Natural Bodybuilding Federation emerged to give natural athletes a chance to compete professionally. Some bodybuilders have become more marketable than others, and judging the sport became prone to bias. Back in Sandow's time they used to judge physiques by physical measurements, but this has long been discontinued. Bodybuilding, like other sports judged by human observation, is subject to the biases of the panel of judges selected to evaluate the event.

Reports as early as the 1970's investigated competition judging in observing aesthetics (Landers, 1970). Landers reviewed the scoring systems, because the system would require dropping the low and high score, and keeping the middle scores. His investigations showed that there would be no difference in results by counting all scores (Landers, 1970). Valiquette et al. (1997) explored whether gymnasts' body shapes affect judges' scores, to see if judges gave gymnasts with lower body mass index (BMI) higher scores. This study also explored whether judges with higher experience scored lower than judges with less experience. Simulating a competition videotapes of compulsory routines were viewed by 18 judges. The judges were required to rate the aesthetic appeal of the 16 gymnasts' body shape. Body mass index was calculated by height and weight measurements to quantify an individual's size. The results showed a significant main effect of BMI on the judge's perception of gymnasts' body shape scores. Gymnasts with a low BMI received significantly higher perception scores than gymnasts with a medium-high BMI or a high BMI. The effect of judge experience was not significant, but experienced judges recorded lower performance scores than novice judges (Valiquette, 1997).

Competition judges are influenced by a number of outside factors, such as social/psychological influences, political affiliation, personal biases, and expectations (Ansorge & Scheer, 1988). Another study also showed that gymnasts' body types gymnasts affect the judging scores in women gymnastics (Falls & Humphrey, 1978). In many sports the instant replay can overturn bad calls by officials. In bodybuilding, as in other subjectively judged sports, the outcome of the competition relies on the scores of the judges. At the present time there has been no research done with bodybuilding judges.

Problem Statement

Many sports today continue to use old models of officiating and judging. There have been several studies investigating the judging criteria in sports, and searching for better ways to judge sports (Valiquette, 1997; Gottfried, 1990; Fitzgerald, 1979). Bodybuilding currently uses only a ranked system for judging physiques, and judges give no justification for their rankings. There is a need for a more formalized system. At this time, in most judged sports, there are limited criteria for judging, and there are very few measures for confirming judges' scores. If physical anthropometric measurements are correlated with judges' scores, could be a method to help with confirmation. Numerous anthropometric studies have been done on Olympic athletes, weightlifters, boxers, swimmers, track athletes, and wrestlers (Ross, 1982). There is limited anthropometric data on bodybuilders, especially in peak competition, and this study provides descriptive statistics of natural bodybuilders.

One study in 1990 compared anthropometric measurements of female bodybuilders to judges' scores. This study was limited, however, in that there were only two judges evaluated and the investigators looked only at females. Bodybuilding is a male-dominated sport, and more research needs to be performed on males (Gottfried et al., 1990). Bodybuilding competitions are often judged by former competitors or promoters, and there is no formal training required. This study improves on the methods of Valiquette (1997), since it will test the correlation of experienced judges with inexperienced judges.

Purpose Statement

This study compared anthropometric scores of natural competitive bodybuilders to judges' scores, and also examines whether judges' scores differ by the judge's experience when compared to the scores of trained, but inexperienced judges or to a control group of judges with no training or experience. The independent variables in this study included girth, fat-free mass, and proportionality of muscle (symmetry). Since bodybuilding is judged mainly on muscularity and symmetry, these anthropometric measures should correlate with the judge's scores.

Research Hypotheses

The following hypotheses are stated in the null form:

Ho_1: The experienced, trained, and untrained judge rankings will not correlate with bodyfat measures of competitive bodybuilders to validate judges' scores within class divisions and overall division titles.

Ho_2: The experienced, trained, and untrained judge rankings will not correlate with fat-free weight measures of competitive bodybuilders to validate judges' scores within class divisions and overall division titles.

Ho_3: The experienced, trained, and untrained judge rankings will not correlate with proportionality of mass measures of competitive bodybuilders to validate judges' scores within class divisions and overall division titles.

Ho_4: The experienced, trained, and untrained judge rankings will not correlate with bodyfat, proportionality of body mass, and fat free weight measures of competitive bodybuilders to validate judges' scores within class division.

Ho_5: There will be no differences in inter-rater reliability and intra-rater reliability among the experienced, trained, and untrained judges.

Ho_6 There will be no differences in correlation from an education session given to a group of judges.

Definitions

Listed below are terms that will be used throughout this study.

Anthropometric Measurements. The science of measurement applied to the human body and includes height, weight, and selected body and limb girths (Fleck & Marks, 1983).

Body Build The morphology, or the form and structure of the body (Wilmore & Costill, 1994), same as body type.

Bodybuilding. Strength training for physique enhancement as opposed to muscular strength. Strength training with proper nutrition helps to develop extreme hypertrophy (muscular growth due to enlargement of the muscle fibers).

Body Composition. The body's two components, such as fat and nonfat (muscle, tendons, ligaments, and organs).

Bodybuilding Competition Rounds. The International Natural Bodybuilding Federation (INBF) has three rounds, and they specifically assess bodybuilders for muscularity, symmetry, and definition. The three rounds consist of the mandatory, compulsory, and free style posing round. On the amateur level the free style posing round is not judged, but it is on the WNBF (World Natural Bodybuilding Federation) professional round (Downs, 1999).

Bodybuilding Competition. The INBF divides the competition into two portions, the prejudging, in the morning, and finals, in the evening. During the prejudging, all athletes are assessed in their divisions and classes using the mandatory poses. All ranking and scoring of class winners are done during the prejudging, and overall scores are determined in the finals. The finals are an opportunity for all the athletes to display their physiques to music, and it is during the finals that awards are presented. Division winners are determined at the night show (Downs, 1999).

Body Mass Index. Weight/height^2 , a high Body Mass Index (BMI) is associated with greater risk of cardiovascular disease and diabetes.

Bone Diameter (breadth). A measurement that assesses the skeletal frame size (trunk and limb) of the body (Katch & Katch, 1994).

Class. A portion of a division, such as lightweight, middleweight, light-heavyweight, and heavyweight class.

Circumference. A measurement of specific trunk and limb sites that includes bone, muscle, and fat, same as girth.

College Division. A bodybuilder must be a full-time student to compete in this division.

Compulsory Round. Round of posing where the judges directly compare an individual with other competitors in the same weight class or division, usually done in the prejudging.

Division. Is broken into certain categories and gender based, usually men's and women's open, novice, master's, collegiate, teenage, and other special categories. Within each division there maybe several classes. There may be special categories, collegiate, armed forces, couples, etc.

Ectomorphy. The third component of the somatotype system which refers to relative linearity of physique, partially based on height/weight ratios (Carter, 1975).

Endomorphy. The first component of the somatotype system refers to the relative fatness and leanness of the body (Carter, 1975).

Fat-Free Mass. All the body tissue that is not fat.

Free-Style Posing. The part of the posing where bodybuilders combine mandatory, symmetry, and artistic poses to music of their choice. Free style posing has no affect on judges' rankings, because it is often done at the finals, and placing is already calculated.

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

Lean Body Mass. A term used interchangeably with fat-free mass, includes essential fat.

Mandatory Poses. Standardized poses that all athletes present so judges can assess the athletes together.

Master's Division. A division that requires the bodybuilder to be of a certain age to compete, masters 40-49, 50-59, or grandmaster over 60.

Mesomorphy. The relative musculoskeletal development of the body per unit of height (Carter, 1975).

Novice Division. The bodybuilder has to be a first time competitor or never to have placed in the top 3 in any competition.

One-Repetition Maximum. The maximum amount of weight that can be lifted one time for any given strength training exercise.

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).

Relative Body Fat. Or Percent Body Fat, is the percentage of the total body mass that is composed of fat.

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, 1991). 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), which represents the terms endomorphy, mesomorphy, and ectomorphy. 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, 1975).

Symmetry. how balanced the body is to each of its limbs and trunk.

Symmetry Poses. In the symmetry round, semi—relaxed poses from the front, side, and back.

Weight classes. Weight classes vary depending on bodybuilding organization. The INBF defines lightweight men<156 lbs., middleweight 156-176 lbs., Light-heavyweight 176-190 lbs., and Heavyweight >190 lbs. For Women there are two categories: lightweight (<120lbs) and Heavyweight (>120lbs).

Delimitations

The delimitations of the study were:

1) The study was governed by the rules and regulations of the International Natural Bodybuilding Federation (INBF).
2) The subjects in this study were male bodybuilders who registered for this competition. Thus, the sample in this study for the bodybuilders was a convenience sample.
3) The Elite or criterion judges were chosen by rules of the INBF. The judges who received a training session and the control group were all randomly selected volunteers from the population at Virginia Tech, and they all were randomly assigned to training or control.
4) The subjects either competed in the men's open division, novice division, collegiate division, or the master's division. The male open division consisted of lightweight, middleweight, light-heavyweight, and heavyweight classes. The novice division consisted of lightweight and heavyweight classes. The collegiate division consisted of lightweight, middleweight, and heavyweight classes. The master's men over 40 division only had one class.
5) Each judge scored each individual competitor.
6) The independent variables in the study were bodyfat, fat-free mass, and proportionality of muscle.
7) The dependent variable was contest judge rankings.

Limitations

1) A self-selected sample of the bodybuilders were chosen from the bodybuilding population. Information about the competition was mailed out to all the gyms in the MidAtlantic region, and advertised in Natural Bodybuilding and Fitness Magazine. Due to the complexity of getting ready for a bodybuilding competition, it would be extremely difficult and risky to recruit a group of

athletes prior to the competition. The final number of subjects could not be known until almost the day of the contest.

2) A self-selected sample of the criterion or experienced judges was chosen according to the rules and regulations governed by the International Bodybuilding and Fitness Organization. Due to the limited number of judges in the organization, it would be extremely difficult to get a random sample of the criterion judges of the INBF.
3) There were limited subjects in each division of this study. Therefore, results can be considered preliminary at this time.
4) Three of the control group judges were selected on the final day of the competition.

<u>Significance</u>

Currently, only one study correlates physical measurements and assessments of bodybuilders with judges' rankings, and it is limited to female bodybuilders (Gottfried, 1990). This study focused solely on male bodybuilders, however; information on the females was analyzed to help better understand the relationships. All female athletes in the earlier study were judged by only two judges, and the investigator used female athletes from two different competitions. The rankings were not relative to each contest.

The present study contributes to the literature on anthropometry and other physical measurements in natural male bodybuilders. There have been very few studies assessing the physical characteristics of male bodybuilders, and to date there are no studies to relate these physical measurements to judges' rankings.

This study indicated which independent variables (proportionality of muscle, girths, and body fat) are more correlated with the judges' rankings. The study investigated the preliminary development of a quantified judging prediction model for natural bodybuilding. There has been controversy over the present model of judging bodybuilders, and this study will attempt to shed light on a more structured way of assessing the ranks of bodybuilders.

Another significance of this study is the investigation of judges. Normally, most organizations will choose a judge based on popularity, years in the sport, or former professional performance. There is no set criterion in the International Natural Bodybuilding Federation, though experienced judges of the INBF do receive a training manual prior to becoming an INBF judge. The study will also also examine the reliability and objectivity of the INBF or elite, trained, and control judges within each group and across groups of judges.

Finally, this study will investigate different ways of scoring a bodybuilding competition, and it may, in time, change the judging format. A current potential problem is that only rankings are given to athletes, but there are no absolute scores at this time. Results from this study will contribute to developing a scale of absolute scores for amateur and professional bodybuilding.

CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

Many sports have been criticized for years regarding the subjectivity of the judges. Scoring in sports such as diving, gymnastics, figure skating, and bodybuilding is performed by a panel of judges. In competition the athlete is at the discretion of this panel of judges, and especially in the Olympics it is important that these judges be objective. Certain judges in the Olympics have been criticized for bias against certain countries. Other sports, such as football and baseball, rely on visual technology and instant replay to confirm disputed calls by officials and judges.

Bodybuilding is a sport that has received little attention because of steroid abuse in professional and amateur events. Another dilemma with the sport of bodybuilding is criticism of judges. Most judges are not certified in any manner, and they are usually experienced athletes themselves or contest promoters. The INBF (International Natural Bodybuilding Federation) is developing criteria for judges, and the AAU (Amateur Athletic Union) was the first bodybuilding organization to take steps towards a training system for judges (Rieger, 1987).

In bodybuilding, the objectives of the athletes are to develop lean body mass, symmetry, definition, and good posing presentation. There are physiological assessments that may assist bodybuilding judges in their decision making, and there are assessments that allow for measurement of measure body symmetry, muscularity, definition, and lean body mass. Posing is an art form in itself, and there are no concrete measures for posing just as in artistic impression scores in figure skating and gymnastics.

Strength Training in Bodybuilders.

Strength training was not widely practiced until World War II. Soldiers used strength training as a method of conditioning and rehabilitation. Before an athlete competes in bodybuilding he or she usually undergoes years of training and proper nutrition. Strength has been defined in many ways in the literature. Strength in the 1970's was defined as the maximal tension muscles can apply in a single contraction (Clarke, 1973). A more recent definition of strength is the maximal force that a muscle or muscle group can generate at a specified velocity (Dudley & Fleck, 1987). Strength can be further defined as static, dynamic, or explosive strength. Stratic strength is muscle action where no change in the length of the muscle takes place. Dynamic strength refers to all training that requires movement, and is usually typical strength training workout. Explosive or ballistic training is training in a manner to develop power. This type of training consists of plyometric and Olympic weightlifting Wilmore and Costill (1994) defined strength as the maximum force a muscle or muscle group can generate (Wilmore & Costill, 1994).

The skeletal muscles contain fibers that have varying morphological and physiological characteristics. Fibers are distinguished by twitch time, and therefore are named slow-twitch and fast-twitch fibers. A fast twitch motor unit generates force rapidly, returns to a relaxed state rapidly, and has a short twitch time. Slow twitch motor units generate force more slowly than the fast twitch fibers, relax slowly, and have a longer twitch time. The fast twitch fibers are also referred to as Type II fibers, and the slow twitch fibers are known as Type I. The Type I fibers are fatigue resistant and are utilized in aerobic exercise. Type I fibers are limited in the amount of force supply, due to the low levels of actomyosin myofibrillar ATPase activity and low anaerobic power (Castro et al., 1999) Type II motor units fatigue easily, have low aerobic power, generate force rapidly, have high actomyosin myofibrillar ATPase activity, and high anaerobic power. Type II fibers are further broken down into Type IIa and Type IIb fibers. The Type IIa fibers carry aerobic characteristics similar to the Type I fibers in that they have a greater capacity for aerobic oxidative energy supply than the Type IIb fibers. The majority of muscles have a mixture of Type I and Type II fiber types (Castro et al., 1999). Bodybuilders have shown more hypertrophy in the Type I fibers, which may be due to the training volume (Dudley & Murray,1984; Marcinik, Potts, Schlabach, Will, Dawson &. Hurley, 1991; McArdle, Katch & Katch, 1991).

Energy Systems

To understand the training practices of bodybuilders it is essential to review the three energy systems; phosphagen, glycolytic, and oxidative. The phosphagen system supplies ATP to the muscles during short-term, high-intensity activities. The phosphagen systems include activities up to 30 seconds, such as a 100 yd. sprint or one football play. Activities with short endurance will utilize energy stores from the phosphagen system. The fuels that supply energy in this system are ATP and creatine phosphate. This system requires the chemical actions of the enzymes myosin ATPase and creatine kinase. Myosin ATPase catabolizes the hydrolysis of ATP to form ADP and inorganic phosphate (Pi); thus, energy is released. Creatine kinase catalyzes the synthesis of ATP from creatine phosphate (cp) and ADP. The CP supplies a phosphate group that combines with ADP to form ATP. Energy is supplied at a high rate in this system, but there is a limited amount of creatine stored in the muscle. Type II fibers have more phosphagens than Type I fibers. Bodybuilders utilize energy stores from this system, but much of their training relies on energy from glycolysis. Sports with powerful and fast movements rely heavily on the phosphagen system. This system handles all activity between 0-30 seconds (Wilmore & Costill, 1994).

The glycolysis system also supplies ATP through the breakdown of pyruvic acid and lactic acid. This creates lactate and hydrogen ions in the muscle and is a factor leading to muscle fatigue. The substrate pyruvic acid can either be converted into Acetyl CoA or lactic acid. When converted to lactic acid, the metabolism is anaerobic. Anaerobic glycolysis is another name for this system. Glucose or carbohydrates are metabolized in the glycolysis process, but can be metabolized either aerobically or anaerobically. This system takes longer to supply energy than the phosphagen system, but it is readily available once the phosphagen system energy stores are depleted. Anaerobic glycolysis takes place with intense exercise, and it supplies energy to the working muscles during times of extended physical activity. It has been demonstrated that trained athletes can buffer lactic acid and hydrogen ions, and tolerate higher concentrations of these substrates in the blood without fatigue (Gordon. et al., 1994; Kraemer et al., 1987; Kraemer et al., 1995; Brooks et al., 1996). A training effect in athletes is the ability to tolerate acid conditions in the muscle, and this takes place with 6-

8 weeks. A lower pH reduces the muscle's ability to sustain physical activity explaining muscle pain and eventually fatigue. The blood and muscle buffering capacities improve with anaerobic training as hydrogen ions are neutralized into weak acids (Brooks et al., 1996).

The third system is the oxidative system or aerobic system. This system can contribute up to 40 to 60% of the required energy during anaerobic events to continue power output during anaerobic events. This system relies not just on glucose, but largely on breaking down fat for energy. Aerobic systems allow for long bouts of physical activity (Brooks et al., 1996)

Hormonal Responses to Bodybuilding

A hormone provides a signal to the body to elicit a physiological activity. Hormonal responses to exercise are essential to adaptations to strength training. Anabolic hormones, testosterone, insulin, insulin-like growth factors (IGF's), and growth hormone, all influence the development of muscle, bone, and connective tissue. Hormones are essential to regulating the body's functions during rest and exercise (Fry et al., 1998). Trained athletes appear to have more effective mechanisms for the regulation of these metabolic functions. These increased hormonal responses aid the athlete in sustaining high exercise intensities (Baechle & Earle. 2000).

Types of Training

There are three types of contractions in strength training: concentric, eccentric, or isometric. Concentric training shortens the muscles as tension develops and is often referred to as dynamic contractions. Eccentric contractions are also dynamic in nature, but they cause lengthening of the muscle. An example of an eccentric contraction is the lowering phase of the bicep curl. Isometric contractions or static contractions are contractions where there is force produced muscles but no change in joint angle. These three muscle contractions are the main components of the various types of strength training: isotonic, isometric, plyometric, and isokinetic (Clarke, 1973).

Isotonic exercise involves strength training consisting of constant exercise resistance, with varying forces needed to move the tension. Some of the devices used in isotonic training are free weights, barbells, dumbbells, and machine weight stations. Isotonic training utilizes a number of different training concepts. The amount of weight used is a percentage of an individual's one-repetition maximum 1RM, the maximum weight that can be lifted for an exercise. The typical load for isotonic training is 70-80% of the (1RM). In strength training the number of repetitions used in a set varies from 6 to 10, with the number of sets ranging from 3 to 6 sets per exercise, and 2 to 6 sessions per week. The advantages of isotonic strength training are that the training takes place through the entire range of motion of a joint, both concentric and eccentric contractions occur, resistance is progressive, and strength increases with limited repetitions. The disadvantages of isotonic training are that maximal resistance is applied only at the weakest point in the range of motion, training is limited to slow velocities, pain or fatigue at a point in the range of motion is not accommodated, and it is impossible to vary the load as leverage changes occur throughout the range of motion (Clarke, 1973).

Isometric training consists of repeated muscular contractions executed against a fixed or immovable resistance. German scientists demonstrated that isometric training increased strength an average of 5% per week by holding isometric tension for six seconds at two-thirds maximum once-a-day, five days-a-week (Hettinger & Muller. 1953). Tensiometers and dynamometers are modalities used in isometric testing and training. The intensity for isometric training is similar to that in isotonic training. The load is usually 70-80% of maximum. The resistance is applied for 5-10 seconds for 5 to 10 repetitions, 3 to 5 times a week. One set of repetitions is usually as effective as more than one set. The advantage of this type of training is that it can be performed anywhere at anytime. A major disadvantage of isometric training is that muscle strength gains only occur at the specific joint angle or limb position where training took place. Therefore, it plays a minor role in bodybuilding.

The basis of plyometric training is an eccentric muscle contraction followed by a concentric contraction It consists of explosive movements against resistance. Plyometric training usually consists of jumping off steps or boxes, running downhill, or throwing and catching. Plyometrics utilize an external force to stretch muscles and thus store energy in these muscles to be used in a subsequent contraction. Box jumps are an example of this type of training. An individual steps off of a box, and upon hitting the ground the lower extremities are stretched due to the force of gravity, and subsequently shorten as the individual jumps as high as possible. Plyometric training can be performed as a progressive resistance exercise. The load may be varied by making changes to equipment. For example, more loads can be produced on the muscles by increasing the height of the boxes in the box jumps. Repetitions may also be varied. A beginner in plyometric training performs 20 to 50 foot contacts or repetitions per set. Advanced plyometric training consists of 50 to 100 repetitions per set. The foot contacts are broken down into two to three sets per training session. Plyometric training usually takes place two times a week. The advantages of plyometric training are that it adds variety to training and can be very sport or activity specific, and it is velocity specific since training takes place at high rates of speed. The disadvantages of plyometric training are the prevalence of injuries and the lack of feedback to the individual during training (Chu, 1991).

A more recent training method is isokinetic training, and it is a relatively new type of strength training. Isokinetic training consists of repeated muscular contractions at a constant velocity (speed) throughout the full range of motion of a joint. Isokinetic training may include both concentric and eccentric muscle contractions. Isokinetic equipment has a velocity controlling device that keeps the velocity constant no matter how much force is applied by the contracting muscles. A major difference in this type of training is the ability of isokinetic equipment to provide varying, maximally-resistive loads at all positions throughout the range of motion. The resistance always matches the effort of the individual. Isokinetic training may be performed at slow, moderate, or fast velocities. (Moffroid & Whipple, 1970; Coyle et al., 1981). When considering the speed in isokinetic training, one must consider the force-velocity relationship of contracting muscle. Higher velocities of training will result in less applied force or torque; slower velocities of training will result in greater applied force or torque, thus greater resistance. Eccentric training can also be done with isokinetic equipment, and this type of training results in greater resistances. The number of repetitions in isokinetic training generally ranges between 8 and 15, and the number of sets is limited to three. Training frequency is usually three days per week. Significant strength training effects are typically seen after six weeks of training. Isokinetic training is usually done in clinical settings, such as rehabilitation, physical therapy, and research settings. Isokinetic strength training provides optimal loading of a muscle throughout the entire range of motion, provides minimal post-exercise soreness since the contractions are usually concentric, and accommodates pain or weakness at specific points in the range of motion. However, the equipment used is costly and is often found only in a research or clinical setting. For training purposes it is very difficult to manipulate the equipment to include both concentric and eccentric contractions in the training session (Perrin, 1993).

Summary of Strength Training

There are three predominant fiber types: slow twitch, intermediate, and fast twitch fibers. Fibers are classified by twitch time, and also by the force they generate. Slow twitch fibers are utilized mainly during endurance training, and they rely on aerobic substrates for energy. The slow twitch fibers do not generate the force that fast twitch fibers do, but they are resistant to fatigue. Fast twitch fibers are utilized during anaerobic training, and they generate more force than the slow twitch fibers and are more resistant to fatigue. The intermediate fibers have characteristics of both the slow and fast twitch fibers. Slow and fast twitch fibers cannot be transformed from one to the other, but they can take on characteristics of the other due to training methods. Bodybuilders have more hypertrophy of the slow twitch fibers than the fast twitch fibers. There are three types of energy systems: phosphagen system, glycolytic system, and the aerobic system. When preparing for a competition bodybuilding training cuts across all the systems. The muscles are worked through either static, dynamic, or explosive training using isometric, isotonic, concentric, and eccentric contractions.

Bodybuilding Training Concepts

The sport of bodybuilding mainly utilizes the isotonic training modalities, and it involves both concentric and eccentric contractions to provoke muscular development. There are numerous amateur and professional competitions for both men and women. Bodybuilding became very popular in the 1970's, and the sport continues to grow in the new millennium. Workouts are designed to increase balanced muscular size, body symmetry, and muscular definition (Fleck & Kraemer, 1997). The athletes spend considerable time posing and developing posing routines. Bodybuilders are judged on muscular definition, symmetry, and presentation/posing (Rieger, 1987). Cosmetic appearance tanned body, lack of body hair, and use of body oil is also essential to the success of the bodybuilder. Similar to other sports, there are numerous strength-training patterns in competitive bodybuilding. Over a period of time there have been some standards adapted for bodybuilding training. Bodybuilding training which have been noted as one of the most metabolically strenuous programs (Tesch, 1994).

Muscle hypertrophy is a major goal of the bodybuilder. There are two physiological phenomena that bring about muscle development through strength training. First, muscle hypertrophy is an increase in the cross-sectional area of the existing muscle fibers (Baechle & Earle, 2000). Hypertrophy occurs due to an increase in the syntheses of the contractile proteins actin and myosin within the myofibril and an increase in the number of myofibrils within the muscle. The new myofibrils attach to the outside layers of the myofribril, causing an increase in the diameter of the muscle (Goldberg et al., 1975, MacDougall et al., 1980) Hyperplasia is the process by which muscle fibers split, causing an increase in the total number of fibers, thus an increase in the size of the muscle. Many of the studies reporting hyperplasia have been characterized by methodological problems. Hyperplasia has been evident in animal studies, but has not proven itself in human subjects (MacDougal et al., 1980;Tesch & Larson, 1982). Hence, muscle hypertrophy is characterized as the major scientific phenomenon causing muscle enlargement in response to resistance training.

The initial investigations of muscle hypertrophy extend back as early as 1897. An investigator removed the left sartorius muscle of two dogs and then trained them with eight weeks of treadmill running. Before and after training, fiber sizes in the right sartorius were measured. Because of the removal of the left sartorius, the right sartorius compensated. This compensation resulted in a 53% increase in the cross-sectional area of the right sartorius, without any increase in the number of muscle fibers. A majority of the early research was based on limb circumference measurements (Morpurgo et al., 1872). An investigator in the 1940's observed that muscles responded to progressive resistance exercise by increasing in size (Delorme, 1945).

An investigator in 1980 trained the elbow flexors and extensors of subjects for six months. The subjects completed 3 to 4 sets for 6 to 8 maximal repetitions 3 times-a-week. Before and after training, needle biopsies were taken from either the triceps or biceps brachi. The study reported significant muscle hypertrophy in the muscle fibers, and also concluded that heavy resistance training results in a significant increase in the cross-sectional area of the type I and type II fibers. There was, however, a greater degree of hypertrophy in the type II fibers. The greater hypertrophy that occurred in the type II fibers may indicate a greater relative involvement of these fibers in the adaptive response to training. Another investigator had novice subjects train the elbow flexor muscles for six weeks and reported a 5% increase in the cross-sectional area of these muscles (Davies et al., 1988). Another study reported a 15% increase in the quadriceps femoris of subjects following eight weeks of isometric training (Garfinkel & Cafarrelli, 1992). It is apparent from this research that strength-training supports muscle hypertrophy.

There are three types of training programs, and the type of program an individual practices determines the changes in muscle or other physical structures. The three types of exercise pertaining to muscular adaptation are strength, hypertrophy, and aerobic endurance training. The goals of the athlete dictate which program he/she adopts, a practice known as specificity of training (Baechle & Earle, 1989).

Strength training involves high-resistance, near maximal muscle contractions for a small number of repetitions with a complete recovery of rest time between sets. This requires a high intensity and a low amount of repetition for each exercise. Strength training increases the cross-sectional area of the muscle, and it causes a faster growth in the type II fibers than the type I fibers (McDonough & Davies, 1984). There is a higher degree of recruitment and hypertrophy of the type II fibers with strength training than other modes of training (Stone & O’Bryant, 1987). This is essential for athletes training for physical performance, and also is attractive to bodybuilders. Type II motor units produce greater force output and contract with greater velocity than Type I motor units. An initial dominance of type II fibers is an advantage to increasing muscular strength, since their growth results in an increase in lean body mass. This in turn has an effect on strength increases (Dons, Bollerup, Bonde-Peterson, & Hancke, 1979; Sale, MacDougall, Always, & Sutton,1983). Some of the biochemical benefits of strength training include substantial increases in muscle glycogen, creatine phosphate, and adenosine triphosphate stores (Karlsson, Nordesjo, Jorfeldt, and Saltin, 1972). Strength training also increases the glycolytic enzymes myokinase and creatine kinase, and the result of higher substrates demands additional enzymatic activity to speed reactions so that energy stores can be used efficiently (Constable et al., 1987;Dudley & Djamil, 1985). Strength training at higher intensities would also be attractive to bodybuilders, since there is hypertrophy of the type II fibers.

A bodybuilding program consists of moderate loads of weight, which allows the athlete to perform more repetitions than in a strength-training program. The resistance is often carried to muscular failure (Baechle & Earle, 2000). The training program consists of 6 to 12 repetitions per set with rest intervals between sets short in duration, between 30-90 seconds. The bodybuilder begins the next set before total recovery is reached. Another typical training pattern of bodybuilders is to perform 12 to 20 sets on one single bodypart in one training session. The bodybuilder, unlike powerlifters and strength trainers, has a higher training volume consisting of moderate intensities as based on the 1-RM. Research has demonstrated that this is the optimal training regimen for increasing muscle girth (Tesch & Larsson, 1982).

Research on bodybuilders has indicated that these athletes show a larger absolute amount of collagen and other noncontractile connective tissue that adds to overall muscle size (MacDougall, Sale, Elder, & Sutton. 1980). Research has also indicated that bodybuilders have a lower percentage of type IIa fibers than other anaerobic athletes, but a larger number of type I fibers. Their characteristics are similar to those found in aerobic endurance athletes (Dudley & Murray,198; McArdle, Katch & Katch, 1991). The biochemical adaptations to hypertrophy training resemble the effects of strength training. There is hypertrophy in the type II fibers in bodybuilding type training or hypertrophy programs. There are still unexplained benefits from creatine phosphate in strength training or bodybuilding. It is thought that increased creatine phosphate raises the total output past the 20 to 30 second duration, and this is attractive to the higher-repetition and lower-resistance bodybuilding training programs (MacDougall, Ward, Sale, & Sutton, 1977)

Bodybuilding programs consist of more volume (volume= repetitions x sets x the weight) than other resistance training programs (Fleck & Kraemer, 1997; Baechle & Earle, 2000). Most athletes believe that muscle gains may be optimized by working many different exercises at various angles. This type of training is thought to enhance the symmetrical appearance of the hypertrophied muscle. The majority of bodybuilding programs progress from working large muscle groups in the beginning of the workout to small muscle groups. It is typical for bodybuilders to use a split routine, such as splitting the body parts to be trained over a 4-7 day training period. This type of split routine enables the bodybuilder to train with large volumes. Bodybuilders have many different training strategies, and a common training system is super-setting or working two different exercises one after the other with no rest in between (Fleck & Kraemer, 1997). Bodybuilders usually stay within an 8 to 12 repetition training regimen, often going to muscular failure on each set. Bodybuilders are not judged by how much they can lift, so training at higher intensities of the 1-RM is not typical in a bodybuilder. It is felt that the high volume stress is responsible for the hypertrophy observed in bodybuilding athletes. This type of training causes bodybuilder to have a higher metabolic intensity, which along with diet and aerobic exercise contribute to the low bodyfat prevalent in bodybuilders.

Bodybuilding training differs for off-season (not preparing for competition) or in-season (preparing for competition). The primary systems used in bodybuilding training are super-sets, burn sets, multiple sets, agonist/antagonist orders, tri-sets, cheat systems, isolated exercises, exhaustion sets, and super pump systems. Super-setting can be performed in two ways to intensify training. First, super-sets consist of using several sets of two exercises for the agonist and antagonist muscles of one body part. An example of this program is arm curls for the biceps followed by tricep extensions. A second type is doing two exercises in immediate order working the same muscle group or body part. An example of this type of superset is one set of barbell curls for the biceps followed by a set of seated alternate dumbbell curls to further exercise the biceps. With the burn system, a bodybuilder works an exercise to complete failure, and they continue to do partial repetitions until they can no longer move the weight at all. The athlete normally experiences a burning or ache in the muscle due to lactic acid, and usually 5 to 6 partial repetitions can be performed after muscle failure has been reached. The multiple set system is performed with the same weight and may be set at any number of sets, reps, and weights depending on the outcomes anticipated by the athlete. However, a multiple system with no change over long periods time will lead to boredom and a plateau of strength and hypertrophy gains. The agonist/antagonist system consist of training an opposing muscle group immediately after training the agonist muscle group. A tri-set is what the name implies. A bodybuilder would execute three exercises in a row working the same or different muscle groups with no rest. An example of this program would be completing a set of squats followed by a set of leg extensions and leg curls. The cheat system of training is also what it implies, and it is often done by bodybuilders to push pass a sticking point. The athlete arches or changes body position to gain extra mechanical leverage; therefore, he/she can lift more weight than normal. There is a higher chance of injury when executing this method. This system has been shown to be effective for increasing strength gains (Fleck & Kraemer, 1997). The isolated exercise system devotes an entire training program to a single exercise, such as doing only bench presses on Monday. This system has been under scrutiny, and has been shown to result in overtraining if not changed after six weeks of training. The super pump system has the premise that bodybuilders should perform 15 to 18 sets for each body part per training session in order to achieve the muscular development needed. The bodybuilder performs 1 to 3 exercises on the same body part in a given session, and there are only 15 second rest intervals between each set. This system has been shown effective in smaller muscle groups, but there is perhaps not enough recovery time for larger muscle groups (Fleck & Kraemer, 1997). There are many different training strategies in bodybuilding, but these are some of the more common ones.

Strength gains are primarily due to muscle hypertrophy and adaptations in the neuromuscular system. The majority of strength gains that occur early in a training program are not accompanied by muscle hypertrophy (Moritani & deVries, 1979). These early strength gains are due to neuromuscular adaptations: increased neural drive to the muscle, increased synchronization of the motor unit contractions, increased activation of the contractile apparatus, and inhibition of the protective mechanisms of the muscles, such as the Golgi tendon reflex (Fleck & Kraemer, 1997).

Aerobic Training

Cardiovascular endurance training has been one of the least understood components of a total training program for athletes (Wilmore & Costill, 1994). There has been limited research with aerobic training in bodybuilders. Cardiorespiratory training is often ignored by many athletes, and it is often avoided by bodybuilders. Many bodybuilders typically have the belief that aerobic training will take away muscle mass (Rippe, Katch, & Katch,1985).

In drug free bodybuilding, cardiovascular training is crucial for lowering bodyfat. One study reported that bodybuilders performed 20 minutes of aerobic exercise 3-5 times a week right before a competition (Elliot, Goldberg, Kuehl, & Catlin, 1987). A second source recommends only 20 to 30 minutes of cardiovascular training a week to sustain low body fat levels (Wolf, 1999). Yet another source states that bodybuilders should only do limited aerobic training limited in the offseason, and it should be a part of a program right before a competition (Hatfield, 1984). More research in the area of cardiovascular training in bodybuilding needs to be done. Athletes who use anabolic steroids and diuretics, which play a major part in developing muscle mass and lowering bodyfat, are part of the reason many bodybuilders do not perform cardiovascular training in their programs.

Summary of Bodybuilding Training

Bodybuilders primarily train with isotonic exercises, and the muscle contractions are both concentric and eccentric in nature. They train to develop body symmetry, muscularity, and defined muscles. Muscles develop either through muscle hypertrophy or muscle hyperplasia, and bodybuilders' muscles grow primarily through hypertrophy, With more hypertrophy in the type I fibers than in the type II fibers. Bodybuilders train with 6-12 repetitions, 30-90 seconds of rest between sets, and 12-20 sets per exercise session. They also use advanced training methods to increase intensity, including super-sets, multiple sets with no rest, cheat systems, and exhaust systems. With these advanced techniques, however, bodybuilders must be careful to avoid overtraining. Bodybuilders will use cardiovascular training to shed bodyfat. Bodybuilders perform 3-5 sessions of cardiovascular exercise a week for 30 minutes. There is a need for more research to follow the cardiovascular training patterns of bodybuilders.

Nutritional Practices of Bodybuilders

There are many nutritional strategies for bodybuilders, and there has been some concern over whether these nutritional practices are safe. Some of the strategies include high protein and low carbohydrate diets, water depletion, low-calorie diets, and mineral depletion of sodium and other major nutrients. The optimum goal of bodybuilders is to increase muscle mass without adding excess bodyfat. Athletes need more nutrients than the general population, and this holds true for the bodybuilder as well (Clark, 1997). The amount of carbohydrates, proteins, fats, and micronutrients will vary for the bodybuilder depending on gender, body size, and goals. Many of the general fitness magazines advertise the need for a lot of protein in the diet, and many of the same magazines push readers to take supplements, such as protein supplements and shakes, carbohydrate drinks, creatine, and other vitamin/mineral products. It is important to remember that a bodybuilder must eat for appearance, and performance is not judged except for posing presentation. Bodybuilders are often compared with other athletes when it comes to nutritional needs.

Bodybuilders consume a high protein diet with moderate amounts of fat and carbohydrate intake in their offseason. In precontest training male bodybuilders have an average daily caloric intake of 2000-2350 kilocalories (kcal) and female bodybuilders have an intake averaging 1300-2300 kcal (Walberg-Rankin, 1995). These diets are typically high in protein and low in fat. Carbohydrate intake was moderate for bodybuilders. Bodybuilders often carbohydrate deplete the week of the competition, as well as several times throughout the precontest phase. This raises another health concern. There is no research showing the long-term effects of carbohydrate depletion. Further, athletes tend to report large increases in energy and fat consumption immediately after the competition (Walberg-Rankin, 1995), and the long term effects of this are unknown.

A case study looked at the diet and exercise strategies of a world-class bodybuilder over an 8-week precompetition training period. (Manore, Thompson, & Russo, 1993). The bodybuilder maintained diet records, and measurements were taken on resting metabolic rate, maximal oxygen uptake blood lipids, and liver enzymes. The athlete performed 2 hours of aerobic exercise and 3 hours of weight training daily for 6 weeks. The average caloric intake was 4,952 kcal/day with 1728 kcal/day coming from a supplement called MCT or medium chain triglycerides. This fat is purported to be easily absorbed by the body, and acts like a carbohydrate rather than a fat. MCT supposedly do not contribute to bodyfat storage like other fats. The diet with no MCT consisted of 76% of calories coming from carbohydrates, 19% from protein, and 5% from fat. The bodybuilder met all Recommended Dietary Allowance (RDA) requirements in micronutrients.

Kleiner et al. (1990) surveyed the diets of championship male and female bodybuilders. Nineteen males and eight female bodybuilders were questioned about their diet intakes and health practices. In this study 20 to 40% failed to answer questions related to drugs. All the subjects used strict fluid restriction prior to and during the show, and many used diuretics to help remove body water to achieve definition. Both men and women consumed three times the RDA for protein. Men consumed about 30% of the recommended RDA for most other nutrients. Women in this study consumed only 36% of the RDA for calcium. This is definitely a health concern, since research on women has linked low calcium diets to osteoporosis and other diseases. Women were also consuming only 75% of their daily recommended zinc. Zinc is essential for tissue development and growth. This study also showed from blood samples that athletes were dehydrated, and had very low levels of glucose. It is evident from this study that nutritional practices of bodybuilders warrant health education. There are obvious deficiencies in essential nutrients and vitamins, and over a long period of time these could be fatal to the athlete (Kleiner et al., 1990).

High amounts of protein are typical in most strength athletes' diets, and bodybuilders are no exception. Many athletes feel that more protein will build more muscle, but literature shows that the most protein needed is 2 g/kg of bodyweight, while the RDA for the general population is 0.8g/kg (Manore & Thompson, 2000). It was reported that the average protein in males was 1.7-2.8g/kg of bodyweight (Walberg-Rankin, 1995). Many bodybuilders are getting far more than what appears to be necessary. Protein intake by bodybuilders varies depending on whether they are in either offseason, precontest, or a couple weeks before their event.

In a case study the dietary strategies of a male bodybuilder were studied as the 25- year old bodybuilder, who weighed 86kg with a height of 170.2 cm, prepared for competition (Steen, 1991). Food records were logged for a 6-month period that captured the off-season, weight reduction phase, and the week of the contest. During the offseason the athlete averaged 4,193 kcal or 49kcal/kg. The athlete averaged 8.7g/kg in carbohydrates, and 2.8g/kg of protein. During the precontest phase, the athlete's calories were reduced down to 3,020 kcal (37 kcal/kg). In precontest dieting the kcal dropped to 6.1g/kg and carbohydrates to 2.7g/kg in protein. The bodybuilder met all RDA requirements in other nutrients. Three weeks before the contest the bodybuilder consumed haddock, rice, or potato every 2 hours, and the athlete took in 4g/kg in protein. The bodybuilder limited food intake to chicken, turkey, tuna packed in water, egg whites, brown rice, pasta, whole grain cereal, vegetarian beans, banana baby food, tea, and water. The foods were broken up to average 5 meals/day. The athlete practiced carbohydrate loading the week before the contest to enhance muscularity. The athlete also reported the use of steroids throughout the training period, and the athlete supplemented with a daily multivitamin/mineral. The bodybuilder also took 60-100 grams of amino acid supplements to meet his requirements for protein (Steen, 1991). Although this is only a case study, this bodybuilder is typical of the practices in bodybuilding. The dietary practices and health practices of bodybuilders are not safe. Long term effects of abundant protein in the diet may be detrimental to health, and steroids are not recommended. Bodybuilding athletes need to be informed about proper nutritional strategies concerning macronutrients and micronutrients. A majority of athletes base their dietary strategies on disreputable advice from other advanced bodybuilders, muscle magazines, and nutrition stores.

Kleiner et al. (1990) investigated the nutritional status of 11 female and 13 male elite bodybuilders at the first drug-tested USA Championship. All subjects were examined through food records they kept leading up to the competition. The percentage of calories from protein, fat, and carbohydrate were 39%, 12%, and 48% for females, and 40%, 11%, and 49% for males. The journals indicated that females took in 0% of their recommended vitamin D, 52% of their calcium, 76% of their zinc, and they were below the RDA for copper and chromium. The females were also low in serum magnesium. About 81% of the females reported cessation of menstrual periods during the contest preparation. The dietary intakes of men were adequate, but the females reported deficiencies in calcium, copper, and chromium. This is an important health implication for female bodybuilders. It is evident that females are deficient here in several key nutrients during the precontest diet. Also, a female developing amenorrhea is a major concern. More research needs to be performed on female bodybuilders and athletes, and health education programs should counsel them on getting the proper nutrients in their diets. Walberg-Rankin et al. (1993) assessed the nutritional and body weight patterns in 6 female bodybuilders right before and after a competition. The female bodybuilders kept dietary records, and 2 of them turned in urine samples to provide information about their menstrual cycle. This study reported that women reported a low-fat, high-carbohydrate diet just before competition. Reports indicated that the subjects doubled energy intake and total grams of fat after the show. This study reported that there was a reduction in reproductive hormone concentrations. Reports have indicated that women have a harder time preparing for competition due to the higher bodyfat, and women also have more concern about gaining weight (Walberg & Johnston, 1991).

Another study investigated the effects of weight training on protein metabolism in men. Many bodybuilders and strength trainers believe that weight training tears down body tissue, and more protein must be consumed to compensate for the lost tissue. This study investigated protein metabolism over a 15 day controlled feeding study. Ammonia and urinary 3-methylhistidine serve as an index of muscle contractile protein catabolism. Urine was analyzed for ammonia, creatinine, 3-methylhistidine and total nitrogen, which are all measuring indices of protein metabolism. This study found that there were no changes in 3-methylhistidine excretion from weight training, and protein metabolism was not altered during this time period. This study was conducted over a two week period, but indicated that weight training in general does not raise the dietary protein needs of the athlete (Hickson, Jr. et al., 1986). There have been contrary findings to this study, however, showing that strength training does increase urinary nitrogen levels after the workout sessions, indicating that protein metabolism is raised (Dohm et al., 1982). This information is extremely important to the bodybuilder, because training practices demand vigorous strength training and cardiovascular workouts. Athletes engaged in resistance training have been recommended to take in 1.5-2.0 g/kg of protein per day (Lemon, 1991). Further research with protein intake needs to be done. The long-term effects of high protein diets could be harmful to an athlete's health.

Many bodybuilders have the perception that any fat in the diet will be converted to fat. The majority of the diets reported are low to moderate in fat consumption (Faber et al., 1986). One major health concern in bodybuilders is that their diets may be deficient in some of the essential fats. Bodybuilder have a tendency to eat more fat once the competition is over, and fat calories are restricted prior to the show (Walberg-Rankin et al., 1993). Carbohydrate intake is considerably lower among bodybuilders. One study reported carbohydrate intakes comprising only 36% of the athletes diet (Faber et al., 1986). Bodybuilders have also altered carbohydrate intake while preparing for competition. A case study reported carbohydrates as high as 78% of the caloric intake two days prior to competition (Steen, 1991). This is an old strategy adapted from marathon runners who deplete carbohydrates, and then "load up" right before a race. It is thought that this method would cause higher glycogen stores in muscles and increase size on the day of competition. Bodybuilders also are known to increase the frequency of meals when preparing for competition. There are reports that bodybuilders consume food every 2 hours (Steen, 1991).

Females usually have deficits in micronutrients during the pre-competition period. Male bodybuilders lack these deficits, and that may be due to a higher calorie diet (Walberg-Rankin, 1995). Most of the deficits occur as the athletes get closer to the competition and limit their variety of food. Another study reported that female bodybuilders were only consuming 67% of the RDA of folate (Lamar-Hilderbrand et al., 1989). Other vitamins in which female bodybuilders have shown deficits are Vitamins C, A, and B12. There have been reports of low calcium intake for female bodybuilder as the contest day approaches (Kleiner et al., 1994). Both male and females have reported calcium deficits in precontest dieting. (Walberg-Rankin et al., 1993). Bodybuilders also restrict water and other fluids prior to competition. Bodybuilders feel that drinking fluids will cause them to bloat and hold water under the skin. One survey indicated that all bodybuilders restrict fluids prior to competition (Kleiner et al., 1990).

Summary of the Nutritional Practices of Bodybuilders

Many of the nutritional practices of bodybuilders deviate from the norm of other athletes. Bodybuilders have been known to eat high protein and low carbohydrate diets. Also, the restriction of fat in the diet has been reported, especially during the precontest phase. The average calorie diet for bodybuilders during precontest phase is 2000-2350 calories for males and 1300-2300 calories for females. The ultimate dietary goal of a bodybuilder is to increase and maintain muscle growth and shed fat with low-calorie, low-fat diet. There are safety concerns for bodybuilders because research has indicated deficiencies in major micronutrients and macronutrients. There have also been reports of very low water intake and fluctuations of key body electrolytes by the bodybuilders. There is concern for the nutritional practices of bodybuilders, and health education is essential for the safety practices of bodybuilders.

Supplementation and Drug Use in Bodybuilders

Bodybuilders have been inundated by supplement companies and other advanced bodybuilders with information extolling the benefits of nutrition supplements. Bodybuilders also utilize supplements and replacement foods to aid in training and contest preparation. Bodybuilders tend to take the advice of other professional or national caliber bodybuilders, and they believe many of the advertisements in muscle magazines. There are over 89 brands of 311 products advertising nutrition and muscle growth supplements, and many claim to enhance development. Only 77.8% of the products listed ingredients, and amino acid were one of the most used ingredients. Bodybuilding athletes often find themselves searching for a more powerful supplement, and eventually may turn to anabolic steroids. Over 624 commercially available supplements are targeted towards bodybuilding athletes, and over 800 different benefits were claimed to take place by ingesting these products (Grunewald & Bailey, 1993).

Amino acids are a very popular supplement of bodybuilders. Arginine, ornithine, and lysine have been claimed to act like natural steroids. These supplements have been promoted to increase muscle growth and act as fat burners. There have been controversial reports concerning the supplementation of arginine, ornithine, and lysine. One study showed a seven-fold increase in growth hormone 90 minutes after oral consumption of 1200mg of arginine and lysine combined (Isadori, 1981). Conversely, another study failed to show an increase in growth hormone in men who were supplementing arginine, ornithine, and lysine (Besset et al., 1982). Walberg-Rankin (1995) points out that there is no good scientific evidence showing that oral arginine and ornithine have an effect on growth hormones and insulin-like growth factors.

A product called boron has been advertised as a natural testosterone booster, and is claimed to enhance weight or muscle gain. A study by Neilson et al. (1987) examined the effects of a 3mg boron supplement on mineral metabolism and hormone levels in postmenopausal women. This study reported that boron supplementation doubled serum testosterone levels in women, but the findings here were not referenced to other population groups. The investigators of this study also did not measure weight or muscle gain (Neilsen et al.1987). In another study young bodybuilders were given boron 2.5mg of for over 7 weeks, and reported an increase in plasma testosterone, lean mass, and strength (Ferrando & Green, 1992).

Some of the supplements have claimed to contain ingredients to promote weight loss and decrease bodyfat. L-Carnitine is involved in the transport of long chained fatty acids through the mitochondrial membrane. The body contains 20 to 25g in an average male, and the majority of the L-carnitine is located in the muscle tissue. It is found naturally in meats and dairy products. The average diet contains 100 to 300mg of carnitine daily (Grunwald et al., 1993). One study reported that carnitine has little effect on resting oxygen consumption in normal subjects, and these subjects ingested 6g/day over a 10-day period (Del Negro et al., 1986). There are reports that L-carnitine has increased the maximal oxygen uptake in endurance athletes (Marconi et al., 1985). There have been studies negating the benefits of L-carnitine, and further research is needed to validate its use as an ergogenic aid (Cerretelli & Marconi, 1990). The supplement choline is another fat burning agent that has been investigated as also an aid in the transport of lipids. It is a component of lecithin in foods, such as egg yolk, liver, meat, and peanuts. There have been no research data supporting choline as a fat-burner (Grunewald et al., 1993).

Chromium supplements have been used widely by bodybuilders and athletes for anabolic purposes. A study of football players supplementing chromium picolinate showed an increase in lean body mass of football players and young men enrolled in weight training classes as compared to a placebo (Evans, 1989). Another study of young college women who received chromium picolinate over a 12 week weight training program demonstrated more lean body mass than a group taking a placebo (Hasten, 1991).

One of the newest supplements that has claims on athletic performance and muscle growth is creatine. It is found naturally in meat products, and the supplement has been reported to increase energy substrate availability. The supplement maintains a high concentration of ATP in the muscle during periods of muscular performance. Creatine is crucial in the early stage of a sprint or all out performance of physical activity. The supplement is supposed to increase creatine phosphate in Type II muscle fibers. One study reported that creatine supplementation decreased ATP degradation, and at the same time increased the work output during two 30-second bouts of isokinetic cycling (Casey et al., 1996). Creatine is supplemented in the form of creatine monohydrate, since the phosphorylated creatine will not pass through cell membranes. A regular diet contains about 1 gram of creatine per day. There are reports showing that 20g/day of creatine can raise muscle creatine phosphate by 20%, and further increase performance by 5 to 7% (Birch, et al., 1994;Greenhaff et al., 1997). This level of creatine is the same amount that would be found in a 10lb uncooked steak. It has been reported that 20g/day of creatine causes more creatine storage in muscle tissues (Hultman et al., 1996). There are no reported risks of creatine supplementation, but more research needs to be conducted to find out the effects of long term use.

Another supplement made popular in the late 1990's and in 2000 is androstenedione. This supplement was used by professional baseball player Mark McGwire, whose record-breaking season in 1998 brought attention to this over-the-counter steroid-enhancing drug. Androstenedione is one of the major androgens produced by the ovaries in females, the testes in males, and the adrenal glands in both sexes. The hepatic enzymes transfer the adrenal output of the hormone to ether estrogens or testosterone. Testosterone and androstenedione are the principal androgens of the testes. The supplement androstenedione can increase endogenous testosterone levels in the body only if a luteinizing hormone (LH) is increased (Manore & Thompson, 2000). Androstenedione supplements are known to create anabolic effects by being converted to testosterone in the liver. Supplement distributors combine androstenedione with the herb tribulus terrestris, and this supposedly increases LH production, which increases testosterone production and an increase in protein synthesis. The distributors of this product claim that it improves physical power and mechanical edge by increasing fat-free mass and decreasing body fat. The supplement is also believed to decrease recovery time needed between vigorous workouts. This drug remains attractive to bodybuilders, since it apparently increases muscle mass (Manore & Thompson, 2000). The manufacturers of androstenedione claim that it enhances protein anabolism by increasing testosterone levels up to 337%. There are few studies at this time validating these reports. One study indicated that men consuming 300mg/d of supplemental androstenedione showed no changes in testosterone after an 8 week strength training program (King et al., 1999). If this supplement does increase testosterone, then this should alert health educators and medical personnel. Some of the health implications of excessive testosterone are increased facial and body acne, premature baldness, female-like breast enlargement in males, shrunken testicles, premature closure of growth centers in adolescents, and increased aggressiveness, and violent behavior. Androstenedione in particular causes these problems because it aromatizes easily into estrogen. The drug androstenedione is very expensive, especially when combined with DHEA (dehydroepiandrosterone) as recommended by some manufacturers. The drug is not approved by the Endocrine Society, an international research organization representing 10,000 members in 80 countries who specialize in endocrinology (Manore & Thompson, 2000).

Anabolic steroids have been the dark side of bodybuilding, and have kept the sport out of the Olympics. They are predominantly used by bodybuilders to aid in skeletal muscle enlargement or increase strength. Teenage bodybuilding has been prevalent at the Junior Olympics, but the sport has not received recognition for the Olympics. The FDA reports that over 1 million people are using androgenic-anabolic steroids for nonmedical purposes, and the sales of the drugs have reached $300 million to $500 million a year. The majority of the drugs are imported into the United States (Stehlin., 1987), and their value has increased. The use of anabolic steroids among bodybuilders runs as high as 80%, and it is 50% in other competitive athlete. The American College Health Association, The American Academy of Pediatrics, The American College of Sports Medicine, The National Strength and Conditioning Association, The National Collegiate Athletic Association, The National Football League, International Natural Bodybuilding Federation (INBF), The World Natural Bodybuilding Federation (WNBF), The US Olympic Committee, and the International Olympic Committee condemn anabolic steroid use due to the possibility of health concerns for the athlete (Scott et al., 1990). Another factor is that doses taken are 10, 100, or even 1000 times larger than those prescribed for medical conditions (Scott et al., 1990). Bodybuilders are known to "stack" the drugs by taking several different steroids at the same time. The bodybuilders also will cycle the drugs for several months, and then taper off of the steroids for a few months. It has been reported that the bodybuilders are not only addicted to the physical changes that the drugs give, but they also get a feeling of euphoria and an increased sense of well-being.

In a study of nineteen male and eight female bodybuilders, 40% of the bodybuilders used steroids, and 20% did not answer this survey question. The bodybuilders also practiced fluid restriction and used diuretics, which is a very dangerous combination. The abuse of anabolic steroids by bodybuilders has been well documented (Kleiner et al., 1990).

There are major health concerns when taking anabolic steroids, and health educators need to target bodybuilders and athletes. Drug testing is conducted at some bodybuilding competitions consists of a polygraph and a urine test. Even so the bodybuilders on steroids find ways to mask the drug, and pass the drug test. The use of anabolic steroids continues to rise in young athletes. The drug has been associated with liver diseases and significant reductions in HDL cholesterol. Drug free bodybuilding contests have made a difference, but there are still many federations that do not test for drugs.

Summary of Supplementation and Drug Use in Bodybuilding

Bodybuilders and other athletes rely heavily on meal replacements and supplements. There have also been high reports of anabolic steroid use by bodybuilders. There are over hundreds of different supplements on the market, and there are more claims of their benefits. One of the most heavily marketed supplements are amino acids. The bodybuilding and fitness magazines convince athletes that they need more protein than is scientifically required. There were reports that the amino acids ornithine, arginine, and lysine worked as a testosterone and growth hormone precursor, although further research denied this case. There have also been the fat burners, such as L-carnitine, choline, and ripped fuel which has ephedrine and caffeine. Supposedly, these supplements. burn fat while preserving or even increasing muscle mass. Some of the more current supplements receiving popularity are Androstenedione and DHEA (dehydroepiandrosterone). The WNBF and INBF have banned these over the counter supplements, since they both are precursors for increasing steroids. Health educators also need to work with bodybuilders on supplements. There have been wide reports of steroid abuse by bodybuilders, and it has prevented the recognition of the sport.

Anthropometry

Anthropometry is the measurement of man, living or dead, and consists primarily in the measurement of the dimensions of the body (Carter, 1975). Anthropometry has also been defined as the science of measurement applied to the human body and includes measurements of height, weight, and selected body and limb girths (Fleck & Marks, 1983). The use of anthropometry is a standardized method to compare bodybuilders and other athletes in the areas of muscle, body proportionality, and fat tissue (McArdle et al., 1991). A first area of assessment is body composition. Bodybuilding, unlike performance sports, is characterized by aesthetics and by body dimensions, which can be measured. Tests, such as body fat analysis, somatotyping, girth measurements, height, weight, and proportionality of muscle are all systemized methods to give valuable data to correlate scores with judges. These measurements must be done correctly in order for a test to be valid, reliable, and objective. Validity is the degree to which a test measures the characteristic it intends to measure. Reliability refers to the degree of measurement consistency with repeat testing. The objectivity is the level to which multiple testers agree on the scoring of tests (Baumgartner & Jackson, 1987).

Bodyfat

In bodybuilding, fat free mass is an important component in the assessment of physique. Body composition refers to the relative percentage of fat and nonfat tissues in the body. A body composition measurement estimates the amount of fat-free mass and the percent of body fat. Body composition can be assessed in several possible ways, including hydrostatic weighing, bioelectrical impedance, dual-energy x-ray absorptiometry, air displacement, and skin fold techniques.

Hydrostatic or underwater weighing is considered to be the criterion measure when assessing body fat, and all other measures are compared to this method as a standard. This technique is based on Archimedes principle, that states that a submerged object is buoyed up by a force equal to the volume of the water it displaces. An object weighs less underwater than on land, and the difference between the two is called body density. This technique involves submerging a person in a tank of water, and having the person exhale fully while the physiologist records bodyweight. The submerged weight is compared with total bodyweight to calculate the body volume, body density, and % of body fat. This method separates all body tissue into either a fat weight or fat-free weight. Fat free tissue has a density of 1.1 g/cc, while the density of fat is .9 g/cc. The difference between land weight and underwater weight is used to estimate body volume, and then this measure is further used to estimate body density. The density of the water is also crucial, and it depends on water temperature. A correction of the residual lung volume of the person must also be assessed (Wilmore, 1969). Once the body density is calculated, this value must be converted into body fat percentage. This method remains a criterion measurement, but it is very expensive and time consuming. It may also involve subject discomfort.

Air displacement plethysmography is a technique that uses density to measure body fat percentage. It measures body fat by taking density as the ratio of body weight to body volume. In this method a person is seated in a chamber, and they breathe using plastic tubing. The researchers examine pressure-volume relationship, and body density can be calculated using the same equation used in hydrostatic weighing, the Siri equation (McArdle, Katch, & Katch, 1991). This method is quicker in testing than the hydrostatic weighing, but it is very expensive with systems typically priced at $30,000. It also involves less subject burden.

Bodybuilding success is a combination of muscularity, symmetry, definition, and presentation. The judging of bodybuilding has always been subjective, and at the present time there are no ways to confirm judging scores. Muscularity, definition, and presentation can be measured in the athletes, and these assessments can further be compared to the judges overall ratings to see if there is a correlation. An unpublished study in 1990 made a comparison of anthropometric measurements to judge's scores. Since muscularity, fat-free muscle, and body symmetry can be assessed, these measures should predict bodybuilding success. The study performed by Gottfried (1990) compared anthropometric measurements from competitive female bodybuilders and their contest rankings. Certain physiological characteristics of 27 competitive female bodybuilders were investigated in relation to scores awarded to them in bodybuilding contests by two qualified competition judges. Correlation and multiple regression analyses compared judges' scores with anthropometric measurements such as muscularity, mesomorphy, and proportionality of muscle mass. In this study, no significant relationship was found between the anthropometric measurements and judges' scores. The reasons for these findings may have been due to the relative scoring systems by the bodybuilding organization, and each athlete should have been given an absolute score. For example, a first place finish in the lightweight class is not the same as a first place in a middleweight, or heavyweight class. If all three first place athletes are in one class, the scores granted by the judges are relative only to that class, and not to a criterion score. There are standard measurements on Olympic athletes, and these athletes could serve as a criterion. The goal of most Olympic athletes is performance, but many these athletes train to increase muscularity and definition. There are some characteristics reported on bodybuilding athletes, but there is not a large volume of literature profile (Freedson et al., 1983; Elliot et al., 1987). More research on bodybuilding characteristics would also help standardize expectations in natural bodybuilding, and develop criterion measurements for future competitions.

Success in bodybuilding is mainly determined by three components: muscularity, symmetry, and definition. Presentation or posing is not defined as a judging criterion at the amateur level, but it is a category for professional natural bodybuilding. Posing refers to how well athletes display their physique to the judges and audience. Some bodybuilders look better in some poses than others, and certain poses fit with the strong areas of the athlete's physique. Muscularity refers to the size of the muscles, their shape, definition, and hardness. Symmetry is a measure of the balance of the development and how well the body is put together as a whole. For example, an athlete's muscularity and degree of definition can be measured not only by human observation, but it can be accurately assessed through anthropometric measurement. Definition refers to the leanness of the bodybuilder and how well the muscles are displayed through the skin (Wilmore & Behnke, 1970; McArdle et al., 1991). These measurements include girth and circumference measurements, skin folds which determine subcutaneous fat, breadth measurements (usually of joints), and height/weight measurements.

Somatotyping

There has been interest in classifying the human physique as far back as 460 B.C. Body types are summaries of many characteristics. The concept of somatotyping was first introduced in 1940. Total body form can be evaluated through a method called somatotyping, and there exist several different methods of somatotyping (Ross et al., 1982). A somatotype is a description of present morphological conformation. Somatotype is described in a three-numeral rating, consisting of three sequential numerals, and they are always described in the same order. Each of the three numbers describes individual variations in human morphology and composition. The first component, endomorphy, refers to relative fatness in individual physiques; and can also be referred to as relative leanness.

The endomorphy ratings are evaluations of degree of fatness, which lie on a continuum from the lowest values to the highest values, ½-14. Low ratings in this first component indicate the individual has low non-essential fat, while high ratings signify high degrees on non-essential fat.

The second component is mesomorphy, which represents the relative musculoskeletal development per unit of height, from a scale of 1 to 10. This is an evaluation of musculoskeletal development, which lies on a continuum from lowest to highest degrees recorded. It can also be thought of as lean body mass relative to height. Low second component mesomorphic ratings indicate light skeletal frames with little muscle, and high ratings in this second component, indicate a high degree of muscle. In bodybuilding competition scoring, mesomorphy is very essential in competition judging, since a big part of the score relies on muscularity (Downs, 1999).

The third component, ectomorphy, refers to relative linearity of individual physiques, ½ to 9. This component can be described by $(\text{height/inches})^3$. A low rating in, ectomorphy, indicates a low degrees of linearity, and a high component indicates good linearity. Somatotype readings are given as three successive hyphenated numbers, such as 4-5-3 with the 4 representing endomorph, 5 for mesomorphy, and 3 for ectomorph. Ratings between ½ to 2 ½ are scaled as low ratings. Ratings between 3-5 are considered mid-range values, and 5 ½ and up are considered high values on the component scales. Values above seven are extremely high values (Carter, 1975). Anthropometric measurements are measures that evaluate and quantify the major structural components (muscle, bone, fat) of the body (McArdle et al., 1991). Anthropometrics have proven to be a valid measure of fat-free mass and skin folds, and a technique using proportionality of muscle has proven accurate in using anthropometric measurements to determine total body form (Carter, 1975).

Body composition enables investigators to quantify the major structural components of the body, which include muscle, bone, and fat (McArdle et al., 1991). Wilmore and Behnke (1970) explored the estimation of body composition using anthropometric measures. They found that estimates of body composition using anthropometric measures in prediction equations were accurate, but there were varying degrees of similarity between the reference or criterion sample from which equations were derived (Wilmore & Behnke, 1970). Hydrostatic weighing is the most accurate way of assessing body fat, and Wilmore et al., (1970) looked at the predictive validity of estimating body composition from anthropometric measurements on a sample of 23 women and 55 men. Results of this study indicated that anthropometric measurements had accurate relative validity when compared to hydrostatic weighing, but the absolute values were inconsistent. The age range caused the differences in absolute values. Generalized equations were used in a study of steroid-free competitive male and female bodybuilders. The authors noted that the body density measures were not significantly different from hydrostatic weighing of the same group of subjects (Elliot et al., 1987).

Proportionality of Muscle

Another technique, the proportionality of body muscle, was developed to measure muscle proportionality or the proportionality of muscle to height. This method was developed to provide some conceptual framework to perceive the relation of one body part to another or to the whole body with respect to some magnitude, quantity, or degree to obtain an appreciation of relative size (Ross et al., 1982).

Summary of Anthropometry

Anthropometry is the science of measurement applied to the human body, and includes measurement of height, weight, and other body limb girths. Another area of assessment is body fat testing, and this can be done by hydrostatic weighing, bioelectrical impedance, dual energy x-ray, absorptiometry, air displacement, and skinfold technique. Bodybuilders are evaluated on three major areas: muscularity, symmetry, and definition. With proper posing these three areas are enhanced. Somatotyping is another area of anthropometry that provides a way of assessing and comparing the human physique. Somatotype is a description of morphological confirmation, and it consists of three components: endomorphy, mesomorphy, and ectomorphy. Endomorphy, measures relative fatness or leanness in the human body. Mesomorphy measures the relative muscularity per unit of height. Ectomorphy characterizes the degree of linearity in the human physique. Another assessment that allows comparison of the human physique is proportionality of muscle. This allows us to compare athletes of different heights and weights, and it takes into account the proportionality of how the body fits together. It is the closest formula right now for measuring any type of body symmetry.

Aesthetic Judging of Athletes

In bodybuilding, gymnastics, figure skating, and diving, human observers or judges are necessary to evaluate the sport. More research is needed in all of these sports to increase the reliability, objectivity, and validity of the judge's scores. One investigator determined that judging through human observation can be objectified by considering the social/psychological influences on judges. These influences include expectations of the performer's ability, institutional or national-political affiliation, and a judges beliefs and attitudes concerning certain personal characteristics of performers (Landers,1970). In the 1950's an experiment was conducted where judges were not allowed to judge competitors from their own country, but this practice was not adopted (Fitzgerald, 1979). There were reports of national biases in 1971 English judges scored their ice skaters with higher marks and placing. They ranked their athlete 5th in 1971, and he ended up placing 7th. Later, they ranked him 9th, and he placed 14th (Oundjian, 1972). There have been reports of home judges' scoring higher than visiting judges for the home team, but investigator was unable to generalize whether this was due to expectancy or favoritism (Brown, 1963). Another bias that may influence judges is the reputation of the performer. In this situation judges do not give scores only on what they see. Old competitors receive charity scores based on prior competition or reputation (Paterson, 1967). Certain judges also have reputations for looking for certain athletic, aesthetic, or technically-perfect performances (Richardson, 1957).

In the classroom setting, it has been demonstrated that teacher expectations for academic performance tend to produce the expected performance, and due to this expectation, amateur skaters often perform by number instead of being identified by name and club (Nicolette, 1972). There have been attempts in other sports to send judges to training schools. In these attempts there have been attempts of promoting attendance, and educating judges on medical terminology pertaining to the sport (Brewer, 1971). The classroom setting is an opportunity to share ideas and differences. Judging ability, in gymnastics is determined by three things: (1) assessment by the International Federation of Gymnastics judging examination, (2)the percent of the time that the score or ranking will be make a difference in athlete's placing, and (3) the absolute deviation from the mean score. Judging is specific to the activity being performed. The question has arisen in other sports of who should be allowed to judge: competitive athletes, professionals, officials, and whether a judge should have a minimal skill in that sport (Fitzgerald, 1979). Research has shown that previous competitive experience is of little value in predicting judging performance (Carruthers, 1971).

It has been shown with gymnasts that judges would give higher scores to the athletes who were in better body shape in that they had lower BMI scores, and the more experienced judges scored competitions lower than newer judges. Valiquette (1997) explored whether gymnasts body shape affects judges' scores. Videotapes of compulsory routines were viewed by 18 judges simulating a competition. The judges were required to rate aesthetic appeal of the 16 gymnasts' body shapes. Body mass index (weight in kg/height in meters squared) was calculated by the height and weight measurements to quantify body shape. There was a significant main effect of BMI on judge's perception of gymnasts' body shape scores. Gymnasts who were in better condition (lower BMI) received higher rankings by officials. Gymnasts with an average to low BMI received significantly higher perception scores than gymnasts with higher BMI scores. The effect of judge experience was not significant, but experienced judges recorded lower performance scores than novice judges (Valiquette, 1997).

Another judging study looked at the effect of the order of competition on scores of Nebraska high school student gymnastic competitors. The competition was divided into three separate rounds, and a two-factor mixed design with judges as a repeated measure, allowed the investigator to consider between judge differences and judge by order interaction, as well as variance due to order. The order of competition had a significant effect on scores. Significant main effects among judges were found in one event, and order effect was significant in two events. These results concluded that for the three rounds a gymnast was at a significant disadvantage if he competed in the first third of the order of competition. This study concluded that judging in Nebraska high school meets should be more objective among judges and that judge discrepancies for order should be minimized (Scheer, 1973).

Bodybuilding, like gymnastics, has varying experience levels of judges, and in bigger competitions judging habits can change as the competition goes on. Head judges may rush through classes or divisions if they are running out of time; hence, athletes competing later in the event may not get the same quality of stage time as those on the stage earlier. It is also important that judges with many years of experience are used, and there should be certification criteria given to judges before the competition to obtain reliability of scores. This will also confirm judging reliability and validity. A rating system is needed to qualify the judges (Leff, 1999).

Another process to help in confirming the objectivity of judging scores is to administer an educational seminar to judges prior to the competition, and give a test to see how reliable the judges' scores are. It is only natural that judges will score an athlete lower or higher, depending on personal beliefs of how a physique should look. Social/psychological influences may also play into judging bias. For example, there is controversy over what a female bodybuilder should look like in competition. Some judges score women lower if in their observation. She does not represent feminine characteristics or if they feel an athlete is on drugs (Zwingle, 1984). Bodybuilding judges, like gymnastic judges, may show biases if they are influenced by crowd reaction or if they personally know the athlete (Landers, 1970). In the sport of figure skating there have been reports of judges being charged with collusion, favoring athletes politically, holding jealousies of athlete's abilities, and accepting bribes (Bird, 1975).

There have been inconsistencies across many sports in judging. Figure skating previously used a method of judging by looking at how well the skaters could perform patterns on the ice. This was back in the 1870's and was a more concrete way of scoring the figures the skaters left on the ice. This was a more quantified and less subjective way of judging the figure skaters than the system currently in uses (Brown, 1959). Just like other subjective sports, judges in skating evaluate athletes based on their own value systems. There was too much personal preference in who is the best athlete instead of looking at the standards required to judge the sport (Cook, 1953). There will likely always be some variation in judges' rankings and scores, and this can't be changed. Many of the subjective sports recommend that judges use good judgment when selecting the best athlete, but the problem with this concept remains in the fact that it is hard to measure good judgment (USFA, 1954). The ideal goal of any organization whose judging relies on subjective evaluation would be to make scores more reliable and objective. Each judge must have the same value system, and must see the same errors as the other judges. They also must rate acceptable performance in the same way. Judges should be appointed only after they have gone through a trial period, and their scores should be in agreement with other trial and official judges. Judges should be evaluated to help maintain the basic standards of judging. In figure skating judges a 20% variation from the best score is allowed by a judge (Cram, 1966).

A similar method of rating judges was proposed in which any calculations falling outside the curve for a normal distribution of scores, after standard deviation was calculated, should be investigated. Differences in judges are expected, but there should be some common ground (Chamberlain, 1950). Another criterion for evaluating judges was to compare the judge's rating with the final score received by an athlete. This system felt that it was essential to select the top places correctly. Each placing received a weight factor and the placing of first, second, and third received more weight than eighth, ninth, and tenth place. This weight factor, together with the square of the judge's difference from the correct place, was the basis for determining the overall performance of a judge. The ending value was then divided by the maximum total subtracted from one, to arrive at a rank correlation coefficient. This rank coefficient enabled investigators to evaluate judging consistency in performance to the actual finishing order of competitors (Hapgood, 1958). A judge's score that is not in agreement with other judges may not be incorrect; the other judges' scores may be out of line. Most competitions score the final placing based on the opinion of all judges. Judges should be evaluated for marks that are clearly deviant from the rest of the group, and if no explanation can be given these judges should be banned from judging (Sterling & Webb, 1969).

In bodybuilding, like many other subjective sports, there has been a lack of validity determined by judges' final decisions. One study in gymnastics took the final scores and averaged the results across 5 other scoring systems to validate the placings. Investigators in this study failed to get expert opinion when computing the composite ultimate criterion (Moore, 1967). At the present time there has been only one study in bodybuilding attempting to validate judges' scores to some other criterion. Another study in gymnastics which validated judging, correlated the judges' rating of filmed gymnastic performances with the scores of experts. The validity established for five of the six panels was approximately .95 and the sixth panel was .75. Another way to increase the reliability and validity of the judges is through having more judges (Godbout, 1974). Another study found that reliability of judging was highly correlated with the type of group that is being judged. The more heterogeneous group of athletes received higher reliability coefficients than the homogeneous group. In National, World, and Olympic sports the competitors are very homogenous in body type and athletic performance, and this makes the skill of judging even more difficult (Gauthier, 1974).

One method to evaluate an individual judge is to correlate individual judges' scores with the final placements of the other judges. This method is sufficient only if the average of all scores is valid. There have been reports of high individual judging scores compared to that of the final placements (Falkner & Liken, 1962). For training purposes, the investigators researched whether there was a correlation between scoring of the live performance of diving and the videotaped replay. Results indicated a high reliability, and judges' scores were more conservative when viewing on television. (Godbout, 1974). For bodybuilding, pictures and video tape recording will not highlight the physique as it appeared on the day of the show. It relies on the quality of the video and pictures. Scores may vary with the angle from which the routine was viewed.

There have been investigations to look at the accuracy of judges. Two types of errors exist, Type A and Type B. Type A is falsely accusing the rater of judging incorrectly when the judge was scoring or ranking up to standard. The Second, Type B error, is where the rater is given credit for judging when he/she is actually reporting wrong scores. This is referred to as the differential accuracy phenomenon (DAP). The DAP is essential in specifying areas of need for improvement of judging (Fitzgerald, 1979).

Another system of judging is to split the duties among the judges. In professional figure skating one judge observes spins and music, another observes the jumping. component, a third judge observes footwork, and a fourth marks for overall impression. Final rank or placement is awarded by totaling all scores (Dean & Dean, 1974). This type of system may be attractive to the sport of bodybuilding, where one judge could focus on the symmetry; another on muscularity, another on posing ability, and yet another on lean mass and definition.

Investigators of sports officiating continue to look for methods to confirm judges' scores, especially in Olympic sports such as gymnastics. In bodybuilding there has been limited resources to train and confirm judges scores (Rieger, 1987; Leff, 1999). Anthropometric methods maybe a way to objectify judges' scores in bodybuilding (Gotfried, 1990; Carter, 1975). There are several ways to estimate body fat, but the three site skin fold method for males and females is comparable to more advanced techniques (Jackson, Pollock, & Ward, 1980). Gymnastics is another sport that has investigated the biases of judge's scores. Research in gymnastics has demonstrated that body shape and body measurements are influential in judges' decisions (Valiquette, 1997).

Any sport in which athletes are judged on performing tasks is open to bias. In sports having a panel of judges to evaluate the athlete's performance, prior routines or competition by an athlete may bias a judge. The previous performance can bias or undermine the judge's response (Brawley, Landers, Miller, & Kearns, 1979). Another investigator feels that a judge will see a situation in a way that fits his assumptions even to the extent of distorting or omitting detail (Brawley et al., 1979). This may also hold true in bodybuilding. Often, bodybuilding judges will tend to score an athlete higher because they knew how they looked previously or they have seen the athlete in better shape so they rank them lower. It is important for judges to score or rank the athletes on what they see in front of them that day. In the sport of figure skating there have been some concerns with how judges use scales. Even though there is a 60-120 point scale, most of the points cluster within 10-12 points from the top (Bird, 1975). There have been suggestions that the judging panel, as a committee, discuss the results of the competition, and award one score (Bird, 1975).

In other sports, there has been bias in judges' scoring their country's athletes (Ansorge & Scheer, 1988). They examined whether the judge scored the gymnast from his or her country higher, lower, or the same as the mean of the remaining judges. The analysis indicated that judges' scores were higher in 122 instances and lower in 12 instances than the scores of other judges on the panel when scoring for their country. The analysis also pointed out that the scores assigned by individual judges to the gymnasts in close competition were lower than the average of the remaining judges on the panels. The results of this study indicate that there are biases in gymnastic judging.

Another study looked at international bias in judgment from the 1984 and 1988 Olympic figure skating performances. They concluded that judges rated skaters from their own country above the average scores of the remaining judges (Whissel et al., 1993). Another investigator looked at whether international bias in gymnastic judging could be due to unconscious influences in the form of exposure or perceptual influences. It is generally assumed that international biases are a result of judges consciously awarding athletes from their politically affiliated countries higher scores than athletes from competing countries. Videotaped gymnastic routines were arranged so that judges were able to view the routines once, twice, or three times. It was hypothesized that those routines seen more would be scored higher and liked better. The following idea was similar to the idea that judges see previous routines from their own country before seeing them at an international competition. The results showed that exposure to at least three presentations did not result in higher preferences for a routine, nor higher scores. Due to these findings there is a lack of evidence supporting the possibility of potentially unconscious influence contributing to international bias. Another investigator examined whether international bias was due to unconscious influences in the form of exposure or perceptual fluency effects. It was felt that the judges rated their athletes higher, but this may not be controlled by the judge's intentions. Investigators showed judges routines three times, so they would become familiar with the athletes. It was hypothesized that familiarity would generate higher scores, but this was not the case. There was no continuous support given to international judges potentially unconscious influence contributing to international bias (Ste-Marie, 1996).

In the sport of bodybuilding the current judging system requires at least five experienced judges for the state and regional shows, and they require seven to nine judges for national level and pro-qualifiers. The system disregards the lowest and highest score, and the sum of the remaining scores are used to rate the athlete. The bodybuilder with the lowest score is declared the winner of that class or division. An investigator in diving competitions found that using all scores did not affect the inter-rater and intra-rater reliability of the ratings (Godbout, 1974). In contrast another study showed that when all five scores for figure skating were averaged they differed from the average obtained when the highest and lowest scores were dropped (Hunsicker & Loken, 1951).

Researchers have found that expert judges were better than novice judges in identifying error (Ste- Marie & Lee, 1991). Another investigator found that expert judges had 27% fewer fixations or deviations than novice judges (Bard et al., 1980).

Summary of Judging Athletes

There are a few sports that rely on judges' ratings: gymnastics, diving, boxing, figure skating, and bodybuilding. Research has indicated that biases exist due to political affiliation, a judge's beliefs and attitude, the reputation of the athlete, the coach's reputation, and other biases. A majority of these sports are still using the same methods to judge that they used 30-40 years ago, even though there have been data to support the biases. There have also been questions about who should be allowed to judge a sport: former athletes, professional athletes, novice officials, etc. There is agreement across sports suggesting that there needs to be more schooling for judges. It was also found that an increased number of judges would enhance the consistency of scoring. Bodybuilding is a sport that looks for body symmetry, proportionality, and muscular definition, and these measurements may be a way to confirm the judges' scores. In bodybuilding, similar to other scoring systems, the highest and the lowest scores are eliminated. There have been reports showing that keeping both the lowest and the highest scores do not affect the overall outcome. More investigations are needed in all subjective sports to help validate judges' rankings.

CHAPTER III

METHODS

Introduction

At the 2001 INBF Mid-Atlantic States and Collegiate Nationals Bodybuilding Championships on April 28, 2001, the anthropometric scores of natural competition bodybuilders were compared to judge's scores. The Elite, experienced, judges' scores were also compared to Trained, but inexperienced, judges' scores on to the control group, Untrained without experience, judges' scores.

Subjects

There were 29 male and 8 female athletes who participated in several divisions: Men's Open, Men's Novice, Men's Collegiate, Men's Master's over 40, Women's Open, Women's College, & Women's Novice divisions. There were 19 in the Men's Open, 3 in the Women's Open, 12 in the Men's Collegiate, 3 in the Women's Collegiate, 4 in the Men's Masters, 10 in the Men's Novice, 5 in the Women's Novice, and 1 Fitness Competitor. Within the Men's Open division there were lightweight, middleweight, light heavyweight, and heavyweight classes. In the Men's Novice division there were a lightweight and heavyweight class. In the Collegiate division there was a Men's lightweight, middleweight, and heavyweight class. In the Men's Master's division there was only one class of competitors. The study was described to all bodybuilders upon check-in. During the check-in, each athlete registered for the competition, weighed in, and took the polygraph test. A separate room was reserved for obtaining the athlete's measurements and informed consent. The study was approved by the Virginia Tech IRB (see application and consents in appendix B). All athletes received information on their bodyfat, and all athletes received a free gym bag and t-shirt for participating in the study.

Judges

There were three groups of judges scoring the athletes. The three groups of judges were the Elite judges, treatment or Trained judges, and the control or Untrained judges. The experienced judges were official judges appointed by the International Natural Bodybuilding and Fitness Organization. These judges have over 5 years of experience in the sport of bodybuilding, and they have all judged prior competitions. The Trained and Untrained judges were recruited from the population of faculty and graduate students at Virginia Tech. The requirements were that the recruited judges could not have any prior experience judging physiques, nor could they have seen any prior competitions. From this population 20 judges were selected, 10 were randomly assigned to the control group and 10 were assigned to the treatment group. The Trained judges went through a 2-hour training session on judging criteria (See Appendix D). All judges completed an informed consent form (Appendix B), which had been previously approved by the Institutional Review Board at Virginia Tech.

Methods

Anthropometrics. All measurements were taken by a certified personal trainer, who familiarized herself through two training sessions and practice with the anthropometers and skinfold calipers. All measurements were taken prior to the competition. Anthropometric measurements were gathered on male and female bodybuilders to compute fat-free weight, mesomorphy, and proportionality of muscle. The bodybuilding show was divided into two sections; the pre-judging and the evening show. The majority of the anthropometric data was collected 48 hours prior to competition. All athletes' data were collected before the start of the prejudging at registration. Athletes rotated among the polygrapher, the personal trainers who were doing the assessment, and the registration table. All athletes had to sign an informed consent form before any measurements could be taken. After signing the informed consent, height and weight measurements were taken, followed by the breadth measurements on the elbow and knee, the skin folds on all areas, and finally the girth circumference measurements. It took 10-15 minutes to assess each athlete fully. The data were collected by two assistants, one did all the measurements and the other recorded. The instruments used were non-stretchable tape, large skinfold caliper, broad-blade anthropometer for breadths, and a balance scale that had a height bar. All instruments were calibrated before the assessments took place.

Skinfolds. In this study skin folds were taken using Lange skin fold calipers, since this method of assessing body fat does not differ significantly from the criterion method of underwater weighing (Elliot et al., 1987). The techniques for measurement of skinfold sites used in this study were from Keys (1956) and Lohman, Roche, and Martorell (1988). Three measurements were taken at each site, and an average was calculated. Skinfolds were repeated if there were large discrepancies of more than 1 mm (Behkne & Wilmore, 1974).

It is essential that the location of the skin fold measurement be accurately determined. Most researchers will mark the site for measurement, and this guarantees that the calipers will be placed in the same position each time. A constant pressure of 10g/mm was submitted by the pincer arms of the Lange caliper to the skin, and measurements were read 2 seconds after the pressure was released (Lohman, Roche, & Martorell, 1998). All skin fold measurements were taken on the right side of the body for convention. The subject's skin was gently pinched, and the skin fold lifted away from the underlying muscle in order to measure it. When measuring skin folds, fingers were placed perpendicular to the skin fold approximately 1 cm from the caliper head placement. The skin fold should be gently pinched between the thumb and the first two fingers and lifted away from the underlying tissues. The jaws of the caliper were placed at the measurement site perpendicular to the skin fold. The jaws of the caliper should be halfway between the bottom and top of the fold. At least 15 seconds should elapse before taking another measure in the same location. If the second measurement varies by more than 1 mm, the measurement must be taken a third time. Too many measurements will lead to compression of the skin fold and a mean should be used across each location. The Lange and Harpenden calipers are the most widely used calipers for assessing body fat, and skin fold calipers should be calibrated occasionally. Both generalized and population specific equations for estimating bodyfat have been developed (Jackson and Pollock, 1985; Jackson et al., 1980).

All of the skinfolds were used in both a three site and seven site skinfold formula, and the scores were averaged. The skinfolds were also used in computing somatotype ratings. The most common skin folds are the abdominal, triceps, chest, midaxillary, sub scapular, suprailliac, and thigh. The abdominal measurement fold is taken 2cm to the right and left of the umbilicus. The head of the calipers should not protrude into the abdomen. The triceps measurement is found by measuring the vertical fold over the belly of the triceps muscle in a relaxed arm. The specific site is the posterior midline of the upper arm, half the distance between the acromion (tip of the shoulder) and olecranon (elbow) processes. The chest site is taken one half or one-third the distance between the anterior axillary line and the nipple for men and women, respectively. The measurement should be a diagonal fold along the natural line of the skin. The midaxillary measure is a vertical fold taken at the level of the xiphoid process on the midaxillary line. The subscapular is a skin fold located 2 cm below the inferior angle of the scapula at a 45 degree angle. The suprailliac fold should be taken in line with the natural angle of the iliac crest. The measurement should be taken along the anterior axillary line just above the iliac crest. Finally, the thigh fold is a vertical fold over the quadriceps muscles on the midline of the thigh. The location for this site is half the distance between the top of the patella (kneecap) and the inguinal crease (where the hip flexes) (Lohman et al., 1988). The protocol used for this study is be the three-site skin fold method for males (chest, abdominal, and thigh), and research has shown that this method correlates higher with criterion methods such as hydrostatic weighing (Pollock et al., 1980).

Joint Breadths. Breadth and circumference(girth) measurements were used to assess body fat or body proportions. Procedures and techniques for these measurements were taken from Carter (1975) and Lohman et al. (1988). Circumference or girth measurements were taken with a flexible non-stretchable tape measure. The major drawback of girth measurements is that the measurement does not distinguish between fat and non-fat components of the body. A large girth measurement accompanied by low body fat is an advantage in bodybuilding; whereas a large girth measurement with high amounts of body fat is not. Breadths of the knee and the elbow were taken with a broad-blade 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. There were 2 measurements taken at each site, and a third if there were discrepancies a third measurement was taken.

All measurements are taken perpendicular to the torso or limb. The following are standards of anthropometry for girth measurements:

1) Waist- at the narrowest part of the torso between the xiphoid process and the umbilicus.
2) Abdomen - at 1 in. above the umbilicus.
3) Right calf- at the point of maximal circumference between the knee and ankle.
4) The hips-at the maximal protrusion of the buttocks above the gluteals with the heels together.
5) Chest- at the nipple level in males and at maximum circumference in females.
6) Right upper arm - at the point of maximal circumference with the elbow fully extended, palm up, and arm abducted parallel with the floor (Baechle & Earle, 2000).
7) Height- with a radiometer attached to a scale
8) Weight - measured with a certified balance scale, and the athlete should be weighed with minimal clothing (Baechle & Earle, 2000).
9) Joint breadths - measurements will be taken on the knee and elbow joint condyles.

Somatotyping There are several somatotyping techniques that can be used to assess total body form. Some of the methods are height/weight ratios, photographs, somatograms, and anthropometry. Somatograms are graphic representations of body part circumferences that provide a quantitative assessment of body shape relative to a reference person (Behnke & Wilmore, 1974). The Heath-Carter somatotype method uses anthropometry to estimate somatotype, and that is the protocol followed here. (Carter, 1975).

Somatotyping reveals three known components about the physique, endomorphy, mesomorphy, and ectomorphy. In order to do anthropometric measurements for somatotyping the following equipment is needed: skinfold calipers, sliding calipers or anthropmeters, flexible tape, and stadiometer. See Appendix C for the somatotype rating form.

To calculate the Somatotypes, the following steps were taken:

A) First Component (Endomorphy) Rating:

1. Record pertinent identification data in the top section of the rating form.
2. Record the measurements from each of the four skinfolds.
3. Sum the triceps, subscapular, and suprailliac skinfolds and record in the box opposite total skinfolds.
4. Circle the closest value in the Total Skinfolds scale to the right. The scale reads vertically from low to high in columns, and horizontally left to right in rows. The rows, “lower limit” and “upper limit” are to provide exact boundaries for each column and these values should only be circled when the TOTAL SKINFOLDS are within a few millimeters of the limit. In most cases the value in the row “midpoint” is circled)
5. Circle the value in the row First Component which is directly under the column circled in number four above.

B) Second Component (Mesomorphy) rating. (Steps 6-12)

6. Record the height (in.) and the humerus and femur diameters in the boxes. Before recording the biceps and calf girths in their respective boxes, the corrections for skinfold must be made. To do this, subtract the triceps skinfold (convert to cm. First by dividing by 10 from the biceps girth, and subtract the calf skinfold (convert to cm.) from the calf girth.
7. Mark the point of the subject’s height on the height scale which is directly to the right. (Note: Regard the height row as a continuous scale).
8. For each bone diameter and girth circle the figure which is nearest the measurement. (Note: If the measurement falls

exactly mid-way between two-values, circle the lower value. Because the largest girths and diameters have been recorded the conservative procedure is used.)

9. Now, work only with columns, not numerical values. Find the column, or space between the columns, that is the average of the column deviations for the diameters and girths only (not height). To do this:
   a. Consider as the zero column the first column containing a circled figure.
   b. From this zero column, add the total number of columns you must travel horizontally to reach each of the other three circled numbers.
   c. Divide this total by four.
   d. Take this number and starting at the zero column, count this number of columns to the right and place a mark (e.g. asterisk) at this point (regardless of where it falls).
10. Still considering columns only, count horizontally the number of columns you must travel from the asterisk to the marked height.
11. From the number 4 in the row marked SECOND COMPONENT move this number of columns to the right or left, depending upon the direction of the asterisk from the height marker. (If the asterisk is to the right of the height marker, and to the right of the height marker, move that number of columns to the right of number 4, and if the asterisk is to the left, move left. Because the columns in this row are in half-unit increments, number of columns and half-unit increments (or decrements) are equivalent.)
12. Circle the closest SECOND COMPONENT value determined in 11 above. (If the point is exactly mid-way between two

rating points, circle the value closest to the 4 on the scale. This regression toward the 4 is the conservative approach, and is less likely to produce extreme ratings.)

C. Third Component (Ectomorphy) rating. (Steps 13-16)

13. Record the weight (lb.)
14. Refer to the monograph to find the height-weight ratio (H.W.R., or height/ cube root of weight). Record the H.W.R. in the box.
15. Circle the closest value in the H.W.R. scale. (See Note in number 4 above.)
16. Locate the THIRD COMPONENT value below the of the circled H.W.R. and circle it.
17. Record the circled values obtained above in the appropriate column the row labeled Anthropometric Somatotype
18. The person calculating the rating should sign to the right.

<u>Proportionality/Body Symmetry</u>

Proportionality of muscle, also referred to as body symmetry, evaluates structural/functional relationships as variances in body mass to body dimension. A compilation of length, diameter, circumference, and skin fold values are used, and these measures are mathematically converted to represent fat, skeletal, muscle, and residual masses. Measures of length, diameter, circumference and skin folds can be quantified by a technique called the phantom stratagem. The phantom stratagem is used to convert raw data of different anthropometric measurements to one common raw value. It is beneficial in comparing differences within and between individuals or samples, and it estimates proportions of total body masses, skeletal, fat, muscle, and residual, independent of total body mass. In bodybuilding proportionality measures can provide information on differences in competitors with regards to muscularity. For instance, a taller, heavier competitor may not necessarily have more muscle compared to a shorter, lighter competitor. Proportionality of muscle figures can explain differences in muscularity relative to body size (Ross et al., 1982). The formula for proportionality of body mass or muscle (pkg) is: pkg= $kg(170/h)^3$ and for the adjusted proportionality of body mass or muscle is: Adjusted pkg=$ffw(170/h)^3$, where ffw equals fat-free weight.

Judging Education

Judges were selected from a group of volunteers, and the judges were randomly assigned to either a trained group or untrained group. The Elite INBF judges were selected months in advance by the promoter and the organization. The judges selected for the treatment received a judging training session. At the first meeting all judges were invited to a brief about the competition, and informed consent forms were signed (Appendix B). All trained judges were given the INBF judge's manual, and much of the information was discussed in the session.

All judges selected for the Trained group received a 30-minute instruction session on proper judging etiquette, human anatomy, and somatotypes. Each judge scored previous competitions on video, and had to justify in how the athletes placed. Results of the previous competition were given, and open discussion too place between the judges receiving the training session. The Untrained group of judges was given instruction on how to use the forms. They were not given any set criteria.

All judges were required to report to the school auditorium 30 minutes prior to the start of the prejudging. All judges signed an informed consent the morning of the show, and they were briefed on how to use the forms. The trained and untrained groups of judges had seats directly behind the experienced judges. All judging sheets were collected after the prejudging and finals. The judges were instructed not to communicate with each other, and not to look at another judges' scoring sheet. Judges were briefed on the order of the show, and they were also, at that time, given the order of events for the finals.

Research Design

The study was a descriptive and correlational study examining the anthropometrics measurements of bodybuilding athletes and judges' rankings, and used regression to predict bodybuilding success from anthropometric variables. Descriptive data were gathered on each athlete's anthropometrics measures of height, weight, girth measurements, age, body fat, and breadth measurements. The means, standard deviations, and variance of each division of male and female competitors were calculated. Correlations between anthropometric measures and judges' scores were made using multiple regression analysis to see if independent variables, body fat, proportionality of muscle, and fat-free mass were correlated with judges' scores. The control group of judges, Untrained, consisted of individuals who had never judged a bodybuilding competition, there was a minimum of 5 judges in each of the groups. A treatment set of judges, Trained, consisted of a set of judges who received an education instruction, consisting of watching and scoring previous competitions, understanding of body types, and a question/answer period (Please see Appendix D for training outline).

<u>Measurement</u>

The dependent variable was judges' scores, and the independent variables were body fat, proportionality of muscle, and fat-free mass. Multiple regression was used to determine if these variables were significantly correlated with the dependent variable, judges' scores. All measurement were taken by qualified professionals with degree in Health/Sport Science, and all measurements were taken with a calibrated weight scale, calipers, flexible tape, and anthropometers. All instruments are valid instruments for assessing anthropometry (Carter, 1975; Ross et al., 1982). The Elite, Trained, and Untrained judges were compared, and the judges were tested for reliability. At the present time there are no instruments to test the reliability of the judges.

<u>Analysis</u>

All data were analyzed the SPSS Graduate Pack 10.1 for Windows. Descriptive statistics were conducted on all bodybuilder's somatotypes, bodyfats, circumferences, fat free weight, and proportionality of muscle. Reliability analysis was conducted on skinfold measurements. A test of multicollinearity was run between the independent variables, fat-free weight, bodyfat, and proportionality of muscle. Bivariate and multiple regression were used to analyze the correlations and relationships of the independent variables to the Elite, Trained, and Untrained judges' rankings in the various bodybuilding divisions and classes. Reliability and correlational analyses were run to examine the reliability and objectivity of the Elite, Trained, and Untrained judging panels. Correlations of the predictions scores were compared to the final placings. By means of the Generalizability Theory repeated measures ANOVA was conducted to compute the interrater reliability of the three judging panels. Bivariate and multiple regressions were tested at an alpha of .05 and all correlations were tested at .01.

CHAPTER IV

RESULTS AND DISCUSSION

Introduction

The anthropometric and body measurements were compared with judges' rankings to investigate whether there was a relationship between physical characteristics and judges' rankings. The comparison of body measurements and judges' scores were analyzed using SPSS 10.0, and the statistical analyses used were correlation, reliability analysis, simple, and multiple linear regression. The G-theory or Generalizability Theory was used to analyze the objectivity of the judges' scores and compute reliability within each judging group for each class. An alpha of .05 was used in the comparisons of body measurements and descriptive statistics were calculated on the bodybuilders.

Bodybuilding Results

There were a total of 37 bodybuilders in the entire study, and there was one female fitness competitor. There were 29 male bodybuilders, and 8 females in the study. Two of the male bodybuilders gave height and weight measurements, but did not want to give the other measurements. There were 5 Elite judges appointed by the INBF, 10 Trained judges, and 8 other judges selected as an Untrained group. The Trained judges received the INBF judging manual and a two-hour seminar on judging (Appendix D). The competition was sanctioned by the International Bodybuilding Federation (INBF), which is an amateur affiliate organization of the World Natural Bodybuilding Federation. All athletes signed informed consent forms and waivers. The competition was drug free, which meant all athletes went through a 30 minute polygraph and screening, and they were all required to sign a banned substance list stating that they had not used any of those banned substances.

Descriptive Statistics

All measurements were performed by the same certified trainer, and reliability of skinfold measurements can be seen in Table 1 for males and Table 2 for females

(Appendix A). There were 3 skin folds taken on each individual, and the measurements were averaged. The reliability of the measurements were all .97 or better, with the exception of the female's chest measurements which was .86. The trainer was certified through the American Council on Exercise (ACE), and she attended a practice session and took practice measurements prior to the event.

The circumference and breadth measurements are found in Tables 3 and 4. Descriptive statistics of the physical characteristics of male and female bodybuilders are reported in Tables 5 and 6. The mean age of the males was 28 years, and the mean age of the females was 31 years. The ages in both competitions ranged from 20 to 50 in the male bodybuilders and 22 to 45 in the female bodybuilders. The mean height of the male bodybuilders was 170.33 cm, and the mean weight of the males was 74.61kg. The mean height of the female bodybuilders was 161.22 cm and the mean weight of the females was 54.88kg. The percent bodyfat (BF), fat-free weight (FFW), and proportionality of muscle (PM) for male bodybuilders were M= 6.4% $\pm$ 1.83 SD, 70.16 $\pm$ 5.76kg, and 74.84 $\pm$ 5.82kg for males, respectively. The percent bodyfat (BF), fat-free weight (FFW), and proportionality of muscle mass (PM) for females were 13.59% $\pm$ 1.62 SD , 47.67 $\pm$ 5.2, and 64.73 $\pm$ 4.22.

Somatotypes

Somatotypes were also computed on all bodybuilders in the study, and this data is summarized in Tables 7 and 8. The scores are reported in the order of endomorphy, mesomorphy, and ectomorphy. The mean scores for the male bodybuilders in this study were 1.3-6.5-1.1. The somatotypes for the females were 2.2-3.7- 4.5.

Bivariate Regression

The independent variables bodyfat, fat free weight, and proportionality of muscle are analyzed in this section using bivariate regression. Table 9 shows the correlation of bodyfat in bodybuilders to the Elite, Trained, and Untrained judges' rankings. There was a significant correlation between the Elite judges and bodyfat in the Men's Open light heavyweight class. There was also a significant correlation between the Elite judges and bodyfat in the Women's Novice group.

The variable, fat-free weight, was analyzed to see if there was a relationship between fat-free weight and judges' rankings. Table 10 shows this analysis, and the only findings were in the Women's Novice Division for Elite and Untrained judges; rankings were significantly correlated with fat-free weight.

The variable, proportionality of muscle, was analyzed to examine the relationship between the proportionality of muscle and judges' rankings. Table 11 shows this relationship, and results indicate that the Elite and Trained judges' rankings are significantly correlated with proportionality of muscle in the Men's Open Lightweight Class. The proportionality of muscle is significantly correlated with the Untrained judges' rankings in the Men's Open Light Heavyweight class. The proportionality of muscle is significantly correlated with the Elite and Trained judges' rankings in the Men's Novice Heavyweight Class.

In this study an adjusted proportionality of or muscle was also explored where fat-free mass substituted for body mass in the equation developed by Ross et al, (1982), and the results are shown in Table 12. The adjusted proportionality of muscle is significantly correlated with the Elite and Trained judges' Rankings in the Lightweight Class. The adjusted proportionality of muscle is significantly correlated with the Untrained judges' Rankings in the Men's Open Light Heavyweight Class.

Bivariate regression was also conducted the Men's Open Overall Class. Results of this analysis are found in Table 13. Bivariate regressions were run with fat-free weight, bodyfat, proportionality of muscle, and adjusted proportionality of muscle. Results indicated that there was no significance reported between fat free weight and bodyfat when compared to the Elite, Trained, and Untrained judges' Ranking in the Men's Open Overall Class. There was a significant relation with proportionality of muscle and the Untrained judges in the Men's Open Overall Class. There was a significant relationship at .05 with the adjusted proportionality of muscle and Elite judges' ranking in the Men's Open Overall Class. Bivariate regression analysis was conducted in the Overall College Male division. The results are displayed in Table 14. There were no significant relations with the variables, bodyfat, fat-free weight, and proportionality of muscle when compared to the Elite, Trained, and Untrained judges' rankings in the Overall College Male Class.

A bivariate regression was used to examine the Women's College Division. The results are reported in Table 15. Regression examined the variables, bodyfat, fat-free weight, and proportionality of muscle. The independent variable, bodyfat significantly correlated with the Elite, Trained, and Untrained judges' rankings. There were no significant findings with proportionality of muscle and fat-free weight due to small sample size.

Multiple regression was used to analyze the relationship of the variables bodyfat, fat free weight, and proportionality of muscle with the Elite, Trained, and Untrained judges' rankings. Results of these analyses are in Tables 16 and Table 17. Table 16 shows adjusted proportionality of muscle, while Table 17 used the traditional proportionality of muscle formula. With the adjusted proportionality the Elite, Trained, and Untrained judges' rankings were significantly related to bodyfat and proportionality. The Trained group had significant coefficients with adjusted proportionality, fat-free weight, and bodyfat. Table 17 reports similar findings with the traditional proportionality of muscle. It should be noted that there was a small sample size for this study. Tables 18 and 19 report the results of multicollinearity of the independent variables bodyfat, fat-free weight, and proportionality of muscle. The results indicated that fat-free weight and proportionality of muscle are highly correlated, and this may explain why fat-free weight fails to contribute significantly to explaining variance similar to proportionality of muscle.

Multiple regression analyses were conducted on the Men's Open Lightweight Class. The Trained judges' rankings were significantly correlated with the variables proportionality of muscle, fat-free weight, and bodyfat. Ironically, this was not the case with the Elite judges. These results are reported in Tables 20, 21, 22, and 23. In tables 20 and 21there is a significant relationship of Adjusted proportionality and the Trained Judges' rankings in the Men's Open Lightweight Class. Similar findings are observed in Tables 22 and 23. The Elite Judges' rankings are significantly correlated with adjusted proportionality of muscle. In Tables 24 and 25 the Trained Judges' rankings are significantly correlated with proportionality of muscle and bodyfat. In Tables 26 and 27 the Elite Judges' rankings are significantly correlated with proportionality of muscle in the Men's Open Lightweight Class. In Tables 28 and 29 there is no significant correlation between the Untrained Judges' rankings and adjusted proportionality of muscle. In Tables 30 and 31 there is no significant correlation between the Untrained judges' rankings and the proportionality of muscle. The best predictor for the Trained judges was the proportionality of body mass formula. Tables 24, 25, 26, and 27 show ANOVA Tables and correlation coefficients for the use of in the prediction model. Again, Trained judges' rankings were significantly correlated with the variables adjusted proportionality and bodyfat. There were no significant findings with the Elite judges' rankings in the Men's Open Lightweight Class. Tables 28, 29, 30, and 31 report on the Untrained judges' rankings with the variables proportionality of muscle, fat-free weight, and bodyfat. There were no significant findings between the variables and the Untrained judges' ranking by multiple regression analyses.

Results in Table 32 shows the overall reliability when all three panels of judges' rankings are combined. The highest reliability is 1.0 and the lowest is .33. There was disagreement among the judges when comparing all 3 groups together. Table 33 shows the comparisons of the Elite, Trained, and Untrained judges' reliability scores. Scores in the Men's Open Lightweight Class were fairly close when comparing the trained and untrained to the elite judges. The Trained group was more consistent with the elite scores in the Men's Open Middleweight, Open Light Heavyweight, College Men heavyweight, Novice Men Lightweight, Men's Masters and Overall Open male The Untrained group had better reliability scores in the College Men Lightweight, College Men Middleweight, Novice Men's Heavyweight, Women's Novice, and Women's College Division.

Tables 33 reports similar results of the correlations of the three groups of judges. All three groups are significantly correlated with each other in the Men's Open Lightweight Class. The Untrained group is not significant to the Elite judges' rankings in the Men's Open Middleweight Class. There were no significant findings in correlation in the Men's Open Light Heavyweight Class. All three groups were significantly correlated with each other in ranking in the Collegiate Men's Lightweight Class. The Untrained group was significantly correlated with the Elite group in judging the Collegiate Middleweight Class, while the trained group was not. There were no significant correlations in the Novice Men Lightweight or Heavyweight Classes, and Women's Novice Division. There were significant correlations in all group comparisons when analyzing the Men's Masters, Overall Open, Overall College, and Women's College Divisions.

Table 34 reports the consistency of the Trained, Untrained, and the Elite judges' rankings. In the Men's Open Lightweight division both the Trained and Untrained judges showed reliability above .9 when compared with the Elite judges' rankings. The Trained judges' rankings were more consistent with the Elite judges' rankings in the Men's Open Middleweight, Men's Light-Heavyweight, College Men Heavyweight, Women's Novice, Men's Masters, and Overall Open Men. Both the Trained and Untrained groups showed reliabilities of .8 with the Elite judges' rankings in the Women's College division, Overall College, Men's Masters, Women's Novice, College Men Lightweight, and Open Men Lightweight classes. The reliability among judges was notably inconsistent in the Men's Novice Lightweight.

The inter-rater reliability results are reported in Table 35. The inter-rater reliability was calculated using repeated measures through methods of the Generalizability Theory. The inter-rater reliability of the three panel judges was high for rankings the Men's Open Lightweight Class. The reliability was lower for the three panels in that the Elite, Trained, and Untrained judges reported .74, .21, and .86, respectively. The Trained judges had a higher agreement with the final placements than the Untrained panel of judges.

Tables 36, 37, 38, 39, and 40 all show prediction scores when using the different formulas in the model. There is a large variance in the scores. Finally, Table 41 indicates how well each judge compares with the final placements. The Elite judges correlate best with the scores, the Trained judges are second, and the Untrained judges are third.

Table 42 shows prediction of rank using the Men's Lightweight formula. Tables 43, 44, and 45 all show a comparison of final placing with scores predicted using the model. In Table 43 the Men's Open Lightweight formula is applied to each class to assist in the prediction of the rankings. The formula failed to predict accurately in the Lightweight, Middleweight, Light-Heavyweight, and College Middleweight Classes. In Table 44 the Men's Overall prediction formula also misplaced several athletes. In Table

45 the Women's Novice Formula accurately predicted a perfect correlation in all women's classes.

Discussion of Descriptive Data

The female height and weight values are similar to previous research done on female bodybuilders (Tables 5 and 6), and other reports have shown similar mean values of 163.4 cm in height and 54.37 kg in weight (Behnke & Wilmore, 1974; Elliot et al., 1987; Freedson et al., 1983; Gottfried, 1990; Heywood et. al, 1989). Height and weight reports of male bodybuilders have had a mean value of 86.1kg and this is 10kg heavier than in this competition (Heywood et. al, 1989). One study reported mean weights in the competition for male bodybuilders of 76kg ± 6SD, which is slightly lower than values found in this study (Eliot et al., 1987). Several other studies of male bodybuilders report similar results in weight as the investigators reported lean weight of 82.4kg and 81.4kg, respectively (Katch et al., 1980). The competition here was drug free which may explain the lower bodyweight. Another study reported that there is not much difference in bodybuilding profiles between bodybuilders taking drugs and drug free athletes (Elliot et. al, 1987; Kleiner et al., 1990). There were more lightweight and middleweight competitors in this competition than heavyweight competitors, and there has been an increase in lightweight and middleweight male competitors in natural competitions. Ten years ago there were not a lot of drug free competitions, and athletes may have felt the need to take anabolic steroids and diuretics in order to be competitive.

In a study where there was no drug testing the mean report on male bodyfat was 6% and 9.8% in females (Kleiner et al., 1990). In a study reporting on drug-free male and female characteristics, a mean bodyfat of 14% was reported for females and 7.2% for males (Elliot et al., 1987). Gottfried (1990) reported female bodybuilders at 10.7% bodyfat, and this is lower than we found in this study. Bodyfat in this study was 6.4% for males and 13.59% for females. Different methods of skinfold testing exist, but prior research shows that three-site skinfold and seven site skinfolds are not different (Pollock & Jackson, 1984). There may be several reasons why the bodyfat in this study varied from other studies. This contest required all athletes to take a polygraph test, and research done on bodybuilding competitions with no drug testing report leaner athletes

(Gottfried, 1990;Heywood et al., 1989; Kleiner et al., 1990). Other differences may result from the type of competition. This contest was a regional competition, and some of the earlier data involved only national level athletes, and who are more muscular and defined.

Other studies on male bodybuilders have reported fat free weight in the ranges of 74.6kg and 80.8kg. (Behnke & Wilmore, 1974; Pipes, 1978;Tanner, 1964). Heywood et al. (1992) reported mean lean body masses of 82.7 kg for males and 48.5 for females. Similar fat-free weight was reported as 74kg in a previous study (Katch et al., 1980) The levels of bodyfat in this study were lower than other studies reporting on female bodybuilders in competition Another study reported lean bodyweight of 81.1kg for males and 47.4kg for females. One study reported female's fat-free weight an of 46.63kg (Freedson et al., 1983). In a similar study Gottfried (1990) reported female athletes with a fat-free weight of 48.62kg, and results of females in this study reported 47.64kg. In the literature the terms fat-free weight and lean body mass are used interchangeably, but the terms are different. Fat-free weight means without any fat, and lean body mass relates to fat-free weight along with the fat in the organs (Baumgartner & Jackson, 1987)

The formula for proportionality of muscle developed by Ross et al. in 1982 does not take into account fat-free weight using instead total body mass. The formula developed by Ross is $PKG=w(170/h)^3$. The proportionality of body mass formula was modified by replacing w or total body weight in kg with FFW or fat-free weight: $PKG= FFW(170/h)^3$. This adjustment makes the proportionality more relative to bodybuilding. Proportionality has been used to make comparisons between Olympic athletes (Ross et al., 1982; Ross & Ward, 1984). The proportionality values in this study were comparable to Olympic weightlifters. The proportionality values reported for male Olympic weightlifters were 82.4 pkg (Carter et al., 1983). The adjusted proportionality of muscle using the phantom strategem reports lower values for both males and females, but give a higher correlation with the judges' scores. The adjusted proportionality of muscle explains more because it takes into account body proportionality of weight, body symmetry as it relates to pounds, bodyfat, and also fat free weight.

Somatotypes were also computed on all bodybuilders in the study (Tables 7 and 8). The scores are reported in the order of endomorphy, mesomorphy, and ectomorphy. The mean scores for the male bodybuilders in this study were 1.4-6.5-1.2. The somatotypes for the females were 2.2-3.7-4.5. Scores from a previous study in females reported somatotypes of 1.6-4.4-3.2. There was a small sample size here with females, and the ectomorph score was higher than the mesomorph. Reports of .5 to 2.5 are considered low values, 3 to 5 scores in somatotypes are middle level, and 5.5 and up are considered high values. The findings here suggest that male bodybuilders are very muscular and lean. Female mean scores suggest that the bodybuilders in this study were fairly muscular and lean.

<u>Discussions of Comparisons of Physical Characteristics and Judges's Scores</u>

Table 9 shows the bivariate regression analyses of bodyfat and its ability to predict judges' ranking. There were significant correlations between the Elite judges' rankings in the Open Men's Light-Heavyweight Class. The Trained and Untrained judges fail to show significance when relating to the various divisions, though there were trends (.11-.14) in the Men's Open Lightweight Class. Many of the sample sizes across the classes were small, which resulted in low significant correlations between the bodybuilders and judges' rankings when analyzing bodyfat as a predictor. The findings here indicate that Elite judges' rankings are more correlated with bodyfat, but due to the number of correlation comparisons, the two findings of significance could be chance. Bodyfat was significant in the Women's Novice Classes with the Elite judges' rankings, and it was close to significant in the Trained and Untrained judges' comparisons, .068 and .094 respectively. Bodyfat appears to be a significant predictor in women's rankings.

Table 10 summarizes the relationship between judges' rankings and fat-free weight. The only significant findings were in the Women's Novice Class. Both the Elite judges' and the Untrained judges' rankings were significantly correlated with fat-free weight. This may have occurred due to chance since there were a number of correlations. One of the major areas for bodybuilding judges to rank athletes is based on the muscularity round. Fat-free weight is important, but consideration must be given to the amount of weight and the proportionality of muscle. A bodybuilder may have a great deal of fat-free weight, but may lack proportionality based on physique size.

Tables 11 and 12 summarize the relations between judges' rankings and proportionality of body muscle. This variable reported the most significant findings. In the Men's Open Lightweight Class the variable proportionality of muscle significantly correlates with the rankings of the Elite and Trained judges. In the Men's Open Light-Heavyweight Class the Untrained judges significantly correlate with proportionality of muscle. There were also significant findings in the Men's Novice Heavyweight Class, and the proportionality of muscle was significantly correlated with the Elite and Trained judges' rankings. These findings possibly confirm that some experience and education is needed for judges. The adjusted proportionality accounted for a higher variance, and further research should be conducted to test this new formula.

Bivariate regression analysis was performed on the Men's Overall Division(Table 13). There were only four subjects in the overall comparisons: lightweight- winner, middleweight-winner, Light-Heavyweight winner, and heavyweight winner. There were no significant correlations with fat-free weight and bodyfat, but there were trends with proportionality of muscle and adjusted proportionality of muscle. The Untrained group was significant in the proportionality of muscle, and the Elite group was significant in the adjusted proportionality of muscle. These findings confirm that further testing is needed with adjusted proportionality of muscle. The adjusted proportionality of muscle takes into account fat free weight, which is significantly correlated with the proportionality of muscle variable. Both the Trained and Untrained judging panels had close to significant scores in the adjusted proportionality. It is apparent from these findings that the proportionality is a major predictor in male bodybuilding, but because of low sample sizes more research is necessary. Bivariate regression and multiple regression analysis was run on the Men's Open Men Lightweight Class and the Women's Novice Division. There were no significant findings from bivariate regression when correlating the variables, bodyfat, fat free weight, proportionality of muscle, and adjusted proportionality of muscle (Table 14). The p-values are lower for the adjusted proportionality of muscle, but still non-significant

There is a significant relationship between bodyfat and judges' rankings . In this study the lower the bodyfat, the higher the placing in the Women's Novice Division. There were 5 women in this division, with fewer female athletes in the other divisions. The only variable that significantly correlates with the judges' rankings was bodyfat, and the p-values were .037, .002, and .019, respectively, in the Elite, Trained, and Untrained judges' comparisons. It appears that judges are using bodyfat as a major predictor when scoring female bodybuilders. Previous research by Gottfried (1990) also found similar findings for women bodybuilding where bodyfat was highly correlated with judges' rankings. More research on what judges are looking for in the women's physique is needed to confirm the findings in this study.

Results of the multiple regression analysis of physical characteristics and judges' rankings the Men's Overall Division are displayed in Table 16, and adjusted proportionality is used as the dependent variable instead. There were only four males competing for the Overall Title, so statistically it would be unlikely to find significance. Significant findings were reported in this study between Trained and Untrained groups' rankings when regressed on bodyfat and adjusted proportionality of muscle. There were no significant findings in the Untrained group with the independent variables adjusted proportionality of muscle and bodyfat. These findings again confirm that the education session was significant in improving judging ability. Also, with these findings, a prediction model can be developed to predict all the judges' rankings across all the male divisions. The p-values for the Trained group were .007 when regressing adjusted proportionality of muscle and bodyfat to Trained judges' rankings. The p-values for the Elite judges were .017 when regressing adjusted proportionality of muscle and bodyfat to Elite judges' rankings. These findings confirm the validity of physical characteristics to predict judging outcomes; however, the samples were small throughout this investigation of prediction.

In Table 17 results are different when using the proportionality formula by Ross et al. (1982). Only the Trained and Untrained groups are significant when regressing proportionality and bodyfat with judges' rankings, a more important the Elite group is not. It is unclear why these findings are contrary to those using the adjusted proportionality as a variable, but again the old formula only recognizes overall mass instead of fat-free mass. The less trained judges may be weighing more influenced by body size rather than overall quality of the physique. The p-value was low in the Elite group (.195). The Overall Male will almost always consist of 4 athletes.

Tables 22 and 24 report the multiple regression analysis of proportionality of muscle, bodyfat, and fat-free weight on Trained judges' rankings in the Men's Open Lightweight Class. This class was chosen for analysis because it had the most subjects (n=8). The ANOVA data in Table 22 indicate a p-value of .007, which is a significant correlation with the Trained judges. In Table 22 the model is significant with proportionality (p-value=.006), but is not significant when bodyfat is added to the model. The prediction model is not significant when adding fat free mass. Tables 20 shows that the relationship was not strong enough between judges' rankings and the variables proportionality of muscle, bodyfat, and fat free weight. However, just using proportionality of muscle reports a significant correlation as seen in Tables 11 and 12 for Elite judges' score with the Men's Open Lightweight Class. These reports indicate that further investigation is needed as the Trained judges correlate better with the variables than the Elite judges (Tables 20 and 21). The reason for these findings may be that the Trained judges' lack biases. Similar findings are reported in tables 23 and 24, which report the adjusted proportionality of muscle. Table 22 indicates that there is a significant relationship between the Trained judges and the variables adjusted proportionality and bodyfat (p< .007), but the Elite judges fail to reject the null with a p-value of .063 (Table 24 and 25). The variables, adjusted proportionality of muscle and bodyfat are significant together in predicting judges' rankings with the Men's Open Lightweight Class (p<.021). Other research reports that the Novice judges make more errors in scoring and ranking (Bard et al., 1980). The scores of the Elite and Trained judges are very reliable, and the Trained judges' scores correlate higher with the final placings than the Untrained judges. As reported in a gymnastics study the Elite and Trained judges may be looking for different body shapes (Valiquette, 1997). The sample sizes were low in this study, and further investigation should to be done to draw conclusions about the Elite judges. Tables 26-30 report the findings of the Untrained judges' rankings regressed on the independent variables proportionality of muscle, bodyfat, and fat-free weight. There were no significant findings in the untrained group.

These finding confirm that some type of judging criteria or education is needed. The Untrained group were less correlated with the final placings (Table 41).

Discussions of the Judging Reliability and Correlation

Table 32 shows the overall reliability of all judges scores together across all the class and divisions. There was inconsistency in rankings in the Men's Open Middleweight, College Heavyweight Division, and the Novice Lightweight Division. In the Open Middleweight Divisions there were discrepancies with 1st and 2nd place. Both male bodybuilders were similar in physical characteristics, and the judges had different scores for 1st and 2nd place. Reliability scores were higher in the Men's Open Lightweight (.98), College Men lightweight (.99), College Middleweight (.96), Novice Heavyweight (.91), Master's Men (.94), and Women's College (.99) Classes. The objectivity is high in some classes, but there are inconsistencies in others. Overall reliability of all the scores is .89. Any scores that deviate 20% from the final placing are not considered consistent (Cram, 1966).

Table 33 shows the correlations of the Trained and Untrained judges to the Elite judges and to each other. Table 42 shows each individual's correlation with the final placing by the Elite judges. It is evident from tables 33 and 41 the Trained judges correlate closer to the Elite judges. Even though the three groups are significantly correlated at .01, there are differences in the judges' rankings.

Analysis of Judges' rankings

The Elite, Trained, and the Untrained judges all ranked the male and female bodybuilders within their classes and divisions. Tests were conducted to see which judge's groups were significantly correlated with each other at the .05 level. All these results can be seen in Table 33. The sample sizes were small within the classes, so it was possible no significance would be found. All three groups of judges were significantly correlated with each other in the Lightweight Open Men's Class. There seemed to be some difficulty in judging the Men's Open Middleweight Class. None of the judging groups were significantly correlated with one another in either the Middleweight Open or the Light Heavyweight class in the Men's Open Class. There was only one individual in the Men's Open Heavyweight Class, so no correlations were made. In the Men's College division the Elite, Trained, and Untrained judges scores were all significantly correlated with each other. In the Men's College Middleweight Division none of the groups were significantly correlated with each other. In the Men's College Heavyweight Class the Elite and Trained were significantly correlated, but the Untrained group's rankings were not correlated with the Elite and Trained group. There were no significant correlations among the Elite, Trained, and Untrained Men's in Novice Lightweight and Heavyweight classes. The Women's Novice Class had significant correlations between the Trained and Untrained group, but both groups failed to correlate significantly with the Elite group rankings. There were no significant correlations among the judging groups in the Men's Master over 40 category and the ranking of the Overall Men's Champion. There was significant correlation among the judges in the Men's College Overall division. Last, there was a significant correlation among the Elite and Untrained judges in selecting the Women's College Champion. Even though r was .96 between the Elite and Untrained group, it was not high enough because of the small number of subjects (n=3). Correlations were fairly high among the judges, except in the Men's Open Middleweight, College Heavyweight, and the Men's Novice Lightweight Classes. The bodybuilders in these classes were closer in competition; small sample size can cause low correlations. Overall, the correlations were high indicating a low amount of judging bias in these groups. Even though the Men's Open Middleweight and Men's College Heavyweight Classes difficult to judge, the Elite and Trained judges significantly correlated in these classes. This confirms that trained group is performing better than the untrained group of judges. Also, even though there was no significance in the Men's Master's Classes the correlation of the Elite and Trained judges was higher than the correlation of the Elite and Untrained judges. This was also the case in the selection of the Overall Open Male winner, Men's Novice Heavyweight Class, and Men's College Heavyweight Class. There were two classes, Men's Novice Lightweight and Women's Novice, which correlated better with the Untrained judges. In the Women's Novice classes the Untrained group was significantly correlated with the Elite group, but the Trained group was not. This was the only class out of 13 where the Untrained group rankings were significantly correlated with the Elite group.

Table 34 shows the reliability of the three groups of judges. The reliability of the Elite, Trained, and the Untrained are highly reliable as they all are above .9 when making comparisons. In the Men's Open Middleweight Class the reliability score is .99 between the Elite and Trained groups, and the reliability is .19 between the Elite and the Untrained groups. The Men's Open Light-Heavyweight class had similar results. The reliability between the Elite and Trained judges was .92, and the between the Elite and Untrained group judge it was .83. The reliability was low between the Trained and Untrained judges when looking at consistency of the Men's Open Middleweight and Light-heavyweight scores. In the Men's College Lightweight Class the Elite judges had a higher reliability with the Untrained judges (.98) than with the Trained group. The Elite group had higher reliability scores with the trained group in the Men's College Heavyweight Class. In the Men's Novice Lightweight, Novice Heavyweight, Men's Masters, and Overall Open Male, the Elite group has better reliability scores with the Trained group than with the Untrained group. This, along with the information on correlations, points out that some experience and training may be essential for judging bodybuilding competitions.

Inter-rater reliability scores were computed using the Generalizability Theory in Table 35. In the Men's Open Lightweight Men the scores between the Elite, Trained, and Untrained judges reported were .97, .96, and .98, respectively. The inter-rater agreement dropped in the Men's Open Middleweight Class to .85, .738, and .2 in the Elite, Trained, and Untrained groups of judges. In the Men's Open Light-Heavyweight, Men's College Heavyweight, Novice Men Lightweight, Women's Novice, and Men's Masters, the Trained judges reported more within consistency than the Elite group. The Elite group reported higher scores in the Men's Open Lightweight, Men's Open Middleweight, Men's College Middleweight, Novice Men Heavyweight, Overall Men's Open, and Women's College Division. Data indicate there is more agreement and consistency in judging for the Elite and Trained judges than in the Untrained group. Reliability is .8 or better in the Men's Open Men's Lightweight, Men's Open Middleweight, Men's College Lightweight, Men's College Middleweight, Men's Masters, Women's College class, and Overall Male Class. Reliability scores were very low in the Men's Novice Lightweight and Men's Novice Heavyweight classes, .335 and .48. There was a score of .55 in the

Men's Open Middleweight class. The only perfect reliability across all judges was in the Overall College Male Division, where every judge had the same ranking. Even though the Elite and Trained group judges had higher consistencies in a majority of the classes, there is still a lot of inconsistency in the scoring system. Usually, in smaller competitions it should be easier for judges because they have fewer bodybuilders to score.

It is apparent from this research that the education session for the one panel of judges was beneficial in improving their reliability and consistency. Table 41 presents evidence of these findings. The Trained judges' rankings were more correlated to the final placings than the Untrained group, and their scores were also more consistent and correlated with the Elite judges.

Discussion of Prediction Models from Physical Characteristics and Judges' Rankings

Table 36 shows the correlation of the predicted rankings with the final rankings using the lightweight formula from the coefficient table. The formulae are determined from the Elite judges' correlation with adjusted proportionality and bodyfat. The first formula shows the correlation of Elite judges' rankings with adjusted proportionality of muscle and bodyfat. There are perfect correlations in Men's Novice Lightweight and Novice Heavyweight, Men's College Lightweight, and Overall Males. The Lightweight model has low correlations with the Men's Open Light Heavyweight Class, Men's Master's Division, Men's College Middleweight, Men's College heavyweight, and Overall College Male college. Table 37 displays the correlations of Elite judges using the women's novice formula and college formula. The correlations were high for both the Women's Novice and Women's College Classes, .9 and 1.0. Although these models are making predictions that are highly correlated with the final placings, there are some low correlations. More research needs to be conducted to confirm that a model exists. Table 38 displays actual predictions using the LW formula, and Table 39 displays the actual predictions using the women's college formula.

Tables 43, 44, and 45 all show a comparison of final placings with scores predicted using the model. In Table 43 the Men's Open Lightweight formula is applied to each class to assist in the prediction of the rankings. The formula failed to predict accurately in the Lightweight, Middleweight, Light-Heavyweight, and College Middleweight Classes. In Table 44 the Men's Overall prediction formula also misplaced several athletes. In Table 45 the Women's Novice Formula accurately predicted a perfect correlation in all women's classes. The Women's Novice formula in this study works in accordance with the judges' rankings. At times the model is predicting the placings, but there are classes when the model is not working. Using the models it is apparent that judges are making correct decisions for the 2 or 3 placings, with the misplacements usually occurring in lower brackets. This may be due to the fact that judges are spending more time determining the top 3 placings, to the detriment of the other placements. For example, in Table 43 the misplacements using the overall formula are at the 4th and 5th position. In the Men's Open Light-Heavyweight the formula was not correlated with the final placing. The formula also did not predict the 1st place winner correctly in the Men's College Middleweight and Heavyweight classes. The formula was successful in predicting in the Men's Novice Heavyweight Classes and Men's Masters, however in the Master's the 3rd and 4th positions were misplaced.

The overall formula (Table 44) predicted the Men's Open Lightweight placing, except at positions 6 and 7. It correlated with the Men' Middleweight rankings at the 1 and 2 positions, but there were discrepancies in the 3rd-6th places. As with the Lightweight formula, the overall formula did not successfully predict the Men's College Middleweight and Heavyweight. The overall formula was successful in predicting Men's Novice Lightweight, but the formula was unsuccessful in predicting in the Men's Master's.

The formulae are successful in predictions at times, but at other times the prediction formulas are misplacing bodybuilders. Even though there were high correlations among the judges' scores and the physical characteristics, it is apparent that these models need to be tested further. Bodybuilders in this competition were allowed to crossover from the College into either the Novice or the Open Division. Twice, the judges changed the placing of a few athletes. For example, in the Men's College Heavyweight Class one athlete placed ahead of another, but when they competed in the Open the judges reversed the score. More research is needed to confirm the test models.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This investigation compared anthropometric measurements of amateur bodybuilders to judges' rankings, to see if there was a significant relationship. It also examined the consistency of judges, and comparing three levels of judges, Elite, Trained, and Untrained in the areas of consistency and reliability. The independent variables were fat free weight, bodyfat, and proportionality of muscle. It was found that an adjustment to proportionality of muscle to include fat-free weight gave a better explanation of judges' rankings.

Descriptive statistics from this study indicate the bodybuilders in this study are similar in weight and height to those in previous research. Data from bodybuilding contests with no drug testing have reported higher weights and leaner physiques in male and female bodybuilders (Kleiner et al., 1990). Results of this study show that proportionality of muscle and the adjusted proportionality of muscle account for a large portion of the variance when comparing physical characteristics in bodybuilders to judges' rankings. Physical characteristics in this study were more related to elite judges' rankings. The trained judges' rankings were also significantly correlated with physical characteristics. It was also noted that bodyfat was a better predictor of judges' rankings than fat-free weight and proportionality of mass in females. In males the proportionality of muscle better correlated with judges' rankings. Previous investigations also showed that bodyfat was a major predictor in female bodybuilders (Gottfried, 1990). Fat free weight was not significantly related to judge's ranking in the linear or multiple regression comparisons. It was found that fat free weight is significantly correlated to proportionality of muscle, and multicollinearity exists. The best two predictors of judges' rankings were proportionality of muscle and bodyfat in the male bodybuilding competition; however, these findings can only be considered preliminary because of the small sample sizes. Future data is needed to confirm these findings. Future tests are needed for the adjusted proportionality to see if results hold in other population samples.

In comparing judges' scores, the Trained group was more correlated with the Elite judges scores than the Untrained group. It was evident from this study that the training session was successful in helping the Trained judges understand the aesthetic elements of judging bodybuilding competition. The Elite and Trained judges had better within-group reliability than the Untrained group. The Elite group was still superior in reliability, and correlated better with the predictors bodyfat and proportionality of muscle. The Trained group was also significantly correlated with these predictors, but the Untrained group was not. Overall, the Elite, Trained, and Untrained judges averaged together were reliable in most of the divisions. The Trained judges' rankings were very close to the Elite judges' rankings, and this indicates that education of anatomy and physiology, aesthetic elements of bodybuilding posing, and exposure to former competitions through way of video can prepare an untrained individual to judge a high level competition. It must be noted that there were only 38 competitors in this competition, and the judging groups may behave differently with a larger sample.

Overall, there seems to be a relationship between judges' rankings and physical characteristics. It was found that the variables, fat-free weight, girths, and mesomorphy were highly correlated with proportionality of muscle, and can be eliminated through the concept of multicollinearity. It was also found that the proportionality of muscle formula can be altered to improve the relationship of judges' rankings with the physical characteristics of bodybuilders. A training session was an effective treatment for the volunteer judges, and the group receiving the training sessions had better scores of reliability and correlation with the Elite judges. The Elite judges are preferable and until further research is performed should be the criterion group for judging. However, this study showed that a subject totally unfamiliar with judging and with no prior experience can be prepared to judge a bodybuilding contest.

There were some inconsistencies in the competition, which means some biases did occur. The Trained group was more consistent within some categories than the Elite group. This may be due to the Elite judges' pre-conceived opinions of what a physique should look like or prior knowledge of a particular bodybuilder. In some of the categories there is a lot of unexplained variance. The judges are possibly looking for criteria other than muscularity, fat free weight, and bodyfat. Posing is an aspect that is not considered, and also body symmetry could play a large role in explaining the variance. Some bodybuilders have a more attractive shape, that the judges may prefer wide shoulders, small waist, and large legs (Leff, 1999; Valiquette, 1997). This cannot be measured with the current physical characteristics. Even though there were significant correlations between the physical characteristics and the judges' rankings, there are times when the predictors had low correlations with the judges' rankings.

<u>Recommendations for future Research</u>

1) Further research should be conducted with a larger sample size. The largest class was the Lightweight Men, and there were only 8 subjects. The other classes averaged 4-5 subjects. This follow-up study should be performed on a national amateur or even a professional competition. Some of the top bodybuilders participate at these events, and criterion scores could be developed for the future. Also, this would build a regression model to help judges and promoters select the ideal physique for each competition.
2) There is need for developing a more validated scoring system for bodybuilding, which should be tested against the physical characteristics. Ultimately, all bodybuilders should receive an absolute score, and this score should be hypothetically compared to a high-class athlete. Bodybuilders should be compared to the hypothetical perfect physique.
3) Other predictors should be explored to explain more variance in the model. At times the model fits well in the smaller classes. One variable that may help explain more variance is a symmetry variable. Even though the proportionality of muscle examined how proportioned the bodybuilder's weight is to height, there is need for a formula to look at the balance of the limbs and body together. In bodybuilding, judges look for body symmetry and alignment, with a small waist, broad shoulders, and wide muscles in the outer thigh. A formula should be developed to compare this symmetry, similar to that for the proportionality of muscle.
4) A qualitative research project should be performed to ask experienced judges what is the ideal bodybuilding physique. Judges' perceptions can be exposed before the competition through interviews and focus groups. It would be

interesting to know if an education session or certification would help make Elite judges more consistent in scores.

5) There is need for more research on both male and female bodybuilders to gather more data on the physical characteristics of natural bodybuilders, and to thus expand the regression/prediction model. Mock competitions could be conducted, and bodybuilders could be recruited from local gyms. It should be noted that these bodybuilders will not be in top form. The bodybuilders recruited can further be divided into groups allowing the investigator more control over the study. All bodybuilders would give their measurements. In the present study some of the bodybuilders refused, and one of those bodybuilders finished first in one category.
6) It was apparent from this study that an education session helped the Trained group of judges' scores in some classes of the competition be comparable to the scores of the Elite judges. More research is needed to develop a certification for judges and an objectified written judging criterion. Judges need to be accountable for the rankings of the bodybuilders, so a validated scale that describes the physique at different maturity and conditioning levels should be developed. This type of scale will enable judges to give absolute rather than relative scores to bodybuilders.

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APPENDIX A

TABLES

Table 1

Estimates of Reliability for Skinfold Measurements
For Male Bodybuilders

	Reliability
Skinfold Measurements	
Chest	0.98
Triceps	0.97
Subscapular	0.99
Abdomen	0.98
Suprailiac	0.98
MidAxilliary	0.98
Thigh	0.99
Calf	0.98

Table 2

Estimates of Reliability for Skinfold Measurements
For Female Bodybuilders

	Reliability
Skinfold Measurements	
Chest	0.86
Triceps	0.98
Subscapular	0.99
Abdomen	0.99
Suprailliac	0.98
MidAxilliary	0.96
Thigh	0.99
Calf	0.98

Table 3

Anthropometric Measurements of Twenty--nine Competitve Male Bodybuilders (Mean± SD)

	Mean	SD
Circumference (cm)		
Chest	102.03	4.91
Thigh	55	2.78
Bicep (relaxed)	35.55	2.31
Bicep (flexed)	39.29	2.02
Forearm	29.9	1,47
Diameters (cm)		
Elbow	6.8	0.35
Knee	9.08	0.37

SD= Standard Deviation

Table 4

Anthropometric Measurements of nine Female Bodybuilders
(Mean± SD)

Circumference (cm)	Mean	SD
Chest	100.49	5.8495
Thigh	54.15	2.99
Biceps (relaxed)	34.8	1.99
Biceps (flexed)	38.9	1.63
Forearm	29.41	1.5
Diameters (CM)		
Elbow	6.76	0.4274
Knee	9.18	0.3882

Note: SD= Standard Deviation

Table 5

Descriptive Characteristics of Male Bodybuilders

Subject	Age (yr)	Height (cm)	Weight (kg)	%BF	FFW (kg)	pm (mass-kg)	pkg-mg mass-kg
1	20	166	65.91	4.11	63.2	71.01	66.59
2	30	163.25	69.55	6.84	64.79	78.78	71.04
3	25	175.5	87.73	5.26	83.11	79.99	75.19
4	31	174.5	67.61	6.12	63.48	62.72	57.04
5	20	180	83.86	6.8	78.16	70.87	65.13
6	23	162	67.5	4.22	64.65	78.25	73.36
7	22	173.5	78.64	4.68	74.96	74.21	69.79
8	20	168	73.41	5.59	69.3	76.3	70.49
9	35	173	66.36	5.9	62.45	63.17	57.56
10	40	166	72.5	8.76	66.15	78.12	68.68
11	37	173	80.91	7.03	75.22	77.02	70.33
12	22	178.5	75.91	6.9	70.67	65.78	59.8
13	50	174	77.73	12.01	68.4	72.72	61.49
14	34	166	69.2	9.25	62.8	74.57	64.6
15	34	166.5	74.09	5.09	70.32	79.11	73.68
16	24	167	72.27	6.75	67.39	76.48	69.33
17	27	166	77.05	4.04	73.93	83.01	78.66
18	30	160.5	65	6.96	60.47	77.48	69.18
19	20	162	60.23				
20	19	178	73.41	5.84	69.12	64.12	59.05
21	41	171	78.07	8.59	71.36	76.95	68.48
22	28	173	84.66	7.07	78.68	80.59	73.86
23	21	177.8	78.75				
24	24	170	80.68	5.93	75.9	80.94	74.99
25	22	176	82.95	6.98	77.16	74.99	68.68
26	38	166.5	75.68	7.77	69.8	80.81	72.51
27	21	178	76.36	4.14	73.2	66.73	63.11
28	42	169	77.61	6.36	72.67	79.25	72.75
29	24	165	70	4.09	67.13	76.8	72.31
Mean	28.41	170.33	74.61	6.4	70.16	74.84	68.43
SD	8.31	5.64	6.59	1.83	5.76	5.82	5.75

Note: proportionality of body muscle; Adj. Pm=Adjusted Proportionality of muscle;

Table 6

Descriptive characteristics of Competive Female Bodybuilders

Subject	Age (yr)	Height (cm)	Weight (kg)	%BF	FFW (kg)	PM (kg)	Pkg-pm (kg)
1	22	166.5	63.3	14.26	54.27	67.57	57.95
2	21	162	54.77	12.86	47.73	63.48	56.33
3	37	160	50.57	14.42	43.28	60.83	52.07
4	25	161	52.84	11.65	46.68	62.39	55.13
5	22	165.5	60.57	12.46	53.02	65.84	57.64
6	45	152.5	51.14	11.32	45.35	71.05	63.02
7	32	165.5	52.73	12.60	46.09	57.31	50.11
8	34	153	47.27	16.58	39.43	65.04	54.26
9	40	165	60.8	14.19	52.17	66.69	57.24
Mean	30.88	161.22	54.88	13.59	47.67	64.73	55.95
SD	8.81	5.29	5.45	1.62	5.2	4.22	3.98

%BF=Percentage of Bodyfat; FFW=Fat-free Weight;PM=Proportionality of Muscle.

Table 7

Somatotype Ratings of Competitiive Male Bodybuilders

Subject	Endomorphy	Mesomorphy	Ectomorphy
1	0.5	6.7	1.5
2	1.5	6.9	0.5
3	1	6.3	0.5
4	1	5.6	2
5	1.5	6.5	1.5
6	1	6.9	0.5
7	1.5	5.8	1
8	1.5	6.8	1
9	1	5.6	2.5
10	2	7	1
11	1.5	6	1
12	2	6	2.5
13	1.5	6.6	1.5
14	2.5	6.5	1
15	1	7.7	0.5
16	1.5	7.1	1
17	1	7.3	0.5
18	1.5	7.2	1
19	0	0	1.5
20	1.5	4.5	2.5
21	1.5	7.5	1
22	1.5	6.1	0.5
23	0	0	2
24	1	6	0.5
25	2	6.6	1
26	1.5	7.4	0.5
27	1	5.7	2
28	1	6.8	0.5
29	0.5	7.1	1.5
Mean	1.352	6.525	1.161
SD	0.456	0.7257	0.6534

Note: SD=Standard Deviation

Table 8

Somatotype Ratings of Competitiive Female Bodybuilders

Subject	Endomorphy	Mesomorphy	Ectomorphy
1	2.5	3.9	4.5
2	2.5	3.8	4.5
3	2.5	3.8	4.5
4	2	3.2	4.5
5	2	3.3	4.5
6	1	5.1	4.5
7	2	3.5	4.5
8	2.5	2.8	4.5
9	2.5	3.7	4.5
Mean	2.2	3.7	4.5
SD	0.5	0.6	0

Note:SD=Standard Deviation

Table 9

Bivariate Regression Analysis of Judges' Rankings and Bodyfat in Male Bodybuilders

Division	N	r	bo	b1	p-value	
Open-LW-Trained	8	0.57	0.4	1.02	0.14	
Ope LW-Untrained	8	0.6	-0.117	1.148	0.11	
Open-LW-elite	8	0.51	0.673	0.948	0.201	
Open MW-Trained	6	0.22	2.05	0.339	0.721	
Open MW-Untrain	6	0.28	2.421	0.266	0.648	
Open MW-Elite	6	0.19	2.064	0.301	0.757	
Open Lt. Hvy-Trained	3	0.971	-30.664	5.613	0.153	
Open Lt. Hvy-Untrain	3	0.753	-15.942	3.082	0.458	
Open Lt. Hvy-elite	3	1	-33.345	6.074	0.014	sig
College LW-Train	3	0.33	1.035	0.287	0.783	
College LW-Untrain	3	0.49	0.574	0.423	0.67	
CollegeLW-elite	3	0.113	3.429	-0.201	0.928	
College MW-Train	3	0.59	7.926	-1.339	0.596	
College MW-Untrain	3	0.46	6.525	-1.023	0.689	
College MW-Elite	3	0.579	6.524	-0.977	0.63	
College HW-Train	3	0.94	-0.862	0.968	0.059	
College HW-Untrain	3	0.88	0.695	0.612	0.114	
CollegeHW-Elite	3	0.71	-0.133	0.788	0.285	
Novice LW-Train	3	0.913	-2.464	0.816	0.267	
Novice LW-Untrain	3	0.983	-1.181	0.587	0.118	
Novice LW-Elite	3	0.93	-0.442	0.509	0.239	
Novice HW-Train	4	0.285	1.173	0.316	0.715	
Novice HW-Untrain	4	0.55	-0.784	0.693	0.445	
Novice HW-Elite	4	0.195	1.421	0.274	0.805	
Master-Train	4	0.824	-1.118	0.526	0.176	
Master-Untrain	4	0.85	-0.343	0.459	0.351	
Master-Elite	4	0.4	1.724	0.171	0.737	
Women Novice-Train	5	0.85	-5.331	0.578	0.068	sig
Women Novice-Untrain	5	0.81	-6.161	0.651	0.094	
Women Novice-Elite	5	0.95	-8.453	0.812	0.012	sig

Note:N=number of athletes; r=correlation;bo=constant slope; b1=partial slope of bodyfat;

Table 10

Bivariate Regression Analysis of Trained Judges' Rankings and Fat Free Weight in Bodybuilders

Division	N	r	bo	b1	p-valule	
Open-LW-Trained	8	0.594	47.612	-6.78	0.12	
Ope LW-Untrained	8	0.652	54.538	-0.787	0.08	
Open-LW-Elite	8	0.525	44.357	-0.627	0.182	
Open MW-Trained	6	0.366	-23.234	0.371	0.545	
Open MW-Untrained	6	0.319	-10.907	0.201	0.6	
Open MW-Elite	6	0.257	-15.841	0.266	0.677	
Open Lt. Hvy-Trained	3	0.888	-32.367	0.446	0.305	
Open Lt. Hvy-Untrained	3	0.575	-13.797	0.205	0.61	
Open Lt. Hvy-Elite	3	0.966	-37.335	0.511	0.166	
college LW-Trained	3	0.687	19.712	-0.282	0.518	
college LW-Untrained	3	0.805	22.591	-0.328	0.404	
CollegeLW-Elite	3	0.297	18.692	-0.254	0.807	
College MW-Trained	3	0.697	-39.573	0.606	0.509	
College MW-Untrained	3	0.586	-31.704	0.491	0.602	
College MW-Elite	3	0.659	-28.702	0.45	0.565	
College HW-Trained	3	0.161	-1.305	0.02639	0.839	
College HW-Untrained	3	0.18	-2.47	0.0249	0.815	
CollegeHW-Elite	3	0.034	2.39	0.0214	0.966	
Novice LW-Trained	3	0.06	1.11	0.021	0.967	
Novice LW-Untrained	3	0.29	-1.869	0.026	0.915	
Novice LW-Elite	3	0.103	1.226	0.022	0.941	
Novice HW-Trained	4	0.34	10.62	-0.106	0.656	
Novice HW-Untrained	4	0.072	0.733	0.022465	0.928	
Novice HW-Elite	4	0.412	14.71	-0.16	0.588	
Master-Trained	4	0.877	26.82	-0.35	0.105	
Master-Untrained	4	0.497	14.539	-0.167	0.669	
Master-Elite	4	0.903	19.425	-0.239	0.283	
Women Novice-Trained	5	0.793	9.917	-0.151	0.109	
Women Novice-Untrained	5	0.974	13.289	-0.218	0.005	sig.
Women Novice-Elite	5	0.9	13.082	0.214	0.037	sig.

Note: N=subjects; r=correlation; bo=partial slope;b1=partial slope of fat-Free Weight

Table 11

Bivariate Regression Analysis of Trained Judges' Rankings and Proptionality of muscle in Bodybuilders

Division	N	r	bo	b1	p-value	
Open-LW-Trained	8	0.74	22.878	-0.252	0.034	sig.
Ope LW-Untrained	8	0.506	17.704	-0.181	0.2	
Open-LW-elite	8	0.751	22.986	-2.54	0.046	sig.
Open MW-Trained	6	0.474	14.148	-0.137	0.42	
Open MW-Untrain	6	0.373	8.73	-0.02668	0.42	
Open MW-Elite	6	0.554	16.091	0.164	0.333	
Open Lt. Hvy-Trained	3	0.887	-19.14	0.273	0.306	
Open Lt. Hvy-Untrain	3	1	-14.901	0.218	0.001	sig.
Open Lt. Hvy-elite	3	0.295	-3.673	0.101	0.705	
college LW-Train	3	0.671	13.117	-0.147	0.532	
college LW-Untrain	3	0.528	10.683	-0.115	0.646	
CollegeLW-elite	3	0.928	34.542	0.226	0.243	
College MW-Train	3	0.949	10.874	-0.123	0.204	
College MW-Untrain	3	0.985	10.883	-0.123	0.112	
College MW-Elite	3	0.964	9.294	0.0298	0.171	
College HW-Train	3	0.085	0.931	0.915	0.915	
College HW-Untrain	3	0.21	0.28	0.024518	0.79	
CollegeHW-Elite	3	0.295	-3.673	0.101	0.705	
Novice LW-Train	3	0.862	-65.879	0.885	0.338	
Novice LW-Untrain	3	0.722	-35.862	0.495	0.487	
Novice LW-Elite	3	0.839	-38.115	0.528	0.366	
Novice HW-Train	4	0.959	13.304	-0.145	0.041	sig.
Novice HW-Untrain	4	0.809	12.616	-0.138	0.191	
Novice HW-Elite	4	0.955	16.078	0.183	0.045	sig.
Master-Train	4	0.73	25.46	-2.99	0.27	
Master-Untrain	4	0.797	21.8	-2.47	0.413	
Master-Elite	4	0.312	8.7772	0.0276	0.798	
Women Novice-Train	5	0.425	15.868	-2.03	0.476	
Women Novice-Untrain	5	0.584	24.186	-3.29	0.301	
Women Novice-Elite	5	0.22	11.567	-0.133	0.719	

Note: N=number of athletes; r=correlation; bo=constant slope; b1=partial slope of proportionality

Table 12

Bivariate Regression Analysis of Trained Judges' Rankings and Adjusted Proportionality in Bodybuilders

Division	N	r	bo	b1	p-value	
Open-LW-Trained	8	0.898	25.531	-0.316	0.002	sig.
Ope LW-Untrained	8	0.68	21.495	-0.256	0.06	
Open-LW-elite	8	0.848	25.294	-0.313	0.008	sig.
Open MW-Trained	6	0.54	16.344	-0.179	0.343	
Open MW-Untrained	6	0.45	10.164	-0.0292	0.2	
Open MW-Elite	6	0.62	18.479	-0.21	0.258	
Open Lt. Hvy-Trained	3	0.909	-19.253	0.3	0.274	
Open Lt. Hvy-Untrained	3	0.999	-14.566	0.233	0.031	sig.
Open Lt. Hvy-Elite	3	0.796	-17.585	0.276	0.413	
college LW-Trained	3	0.96	19.116	-0.246	0.175	
college LW-Untrained	3	0.99	17.859	-0.228	0.288	
CollegeLW-Elite	3	0.98	38.915	-0.519	0.114	
College MW-Trained	3	0.91	10.789	-0.133	0.271	
College MW-Untrained	3	0.96	10.946	-0.135	0.178	
College MW-Elite	3	0.93	9.27	-0.107	0.237	
College HW-Trained	3	0.183	6.963	0.0546	0.817	
College HW-Untrained	3	0.056	4.143	0.0113	0.944	
CollegeHW-Elite	3	0.05	0.949	2.313	0.0164	
Novice LW-Trained	3	0.897	122.33	-1.742	0.291	
Novice LW-Untrained	3	0.975	89.403	-1.265	0.142	
Novice LW-Elite	3	0.916	77.536	-1.089	0.263	
Novice HW-Trained	4	0.928	11.988	-0.138	0.072	
Novice HW-Untrained	4	0.799	11.56	-0.133	0.201	
Novice HW-Elite	4	0.917	14.33	-0.172	0.083	
Master-Trained	4	0.854	16.98	-0.214	0.146	
Master-Untrained	4	0.894	15.764	-0.192	0.296	
Master-Elite	4	0.479	8.363	-0.081	0.6822	
Women Novice-Trained	5	..854	16.98	-0.214	0.146	
Women Novice-Untrained	5	0.894	15.764	-0.192	0.296	
Women Novice-Elite	5	0.63	24.282	-0.385	0.249	

N=number of athletes; r=correlation; bo=constant slope; b1=slope of adjusted proportionality

Table 13

Bivariate Regression Analysis of Judges Rankings on
Proporionality, Fat free weight, and Bodyfat in Overall Open Male Division

Fat Free Weight

Judges	N	r	bo	b1	p-valule	
Overall						
Trained	4	0.323	6.038	0.0476	0.677	
Untrained	4	0.317	5.011	0.0356	0.467	
Elite	4	0.075	1.659	0.01133	0.855	

Bodyfat

Judges	N	r	bo	b1	pvalue	
Trained	4	0.549	0.628	0.46	0.451	
Untrained	4	0.382	1.369	0.244	0.618	
Elite	4	0.814	-0.352	0.702	0.186	

Proportionality of Muscle

Judges	N	r	bo	b1	p-value	
Trained	4	0.829	30.829	-0.356	0.171	
Untrained	4	0.981	27.922	-0.321	0.019	sig.
Elite	4	0.917	34.713	-0.405	0.073	

Adjusted Proportionality of Muscle

Judges	N	r	bo	b1	p-value	
Trained	4	0.894	23.802	-0.286	0.106	
Untrained	4	0.932	19.307	-0.228	0.054	
Elite	4	0.968	26.227	-0.319	0.032	sig

N=number of athletes;r=pearson correlation;bo=constant slope;b1=partial slope;

Table 14

Bivariate Regression Analysis of Judges Rankings on
Proporionality, Fat free weight, and Bodyfat in Overall College Male Division

Bodyfat

Judges	N	r	bo	b1	p-valule
Trained	3	0.85	.-1.023	0.716	0.349
Untrained	3	0.85	.-1.023	0.716	0.349
Elite	3	0.85	.-1.023	0.716	0.349

Fat Free Weight

Judges	N	r	bo	b1	p-value
Trained	3	0.36	-3.626	0.0824	0.36
Untrained	3	0.36	-3.626	0.0824	0.36
Elite	3	0.36	-3.626	0.0824	0.36

Proportionality of Muscle

Judges	N	r	bo	b1	p-value
Trained	3	0.63	37.083	-4.5	0.565
Untrained	3	0.63	37.083	-4.5	0.565
Elite	3	0.63	37.083	-4.5	0.565

Adjusted Proportionality of Muscle

Judges	N	r	bo	b1	p-value
Trained	3	0.92	32.683	-0.427	0.244
Untrained	3	0.92	32.683	-0.427	0.244
Elite	3	0.92	32.683	-0.427	0.244

Note: N=number of athletes; r=pearson correlation; bo=constant; b1=slope
Of the variable.

Table 15

Bivariate Regression Analysis of Judges Rankings on
Fat-free weight, bodyfat, and Proportionality of Muscle in Women's College Division

Fat Free Weight

Judges	N	r	bo	b1	p-valule	
Trained	3	0.958	-7.608	0.197	0.234	
Untrained	3	0.949	-8.075	0.206	0.204	
Elite	3	0.973	-7.801	0.2	0.148	

Bodyfat

Judges	N	r	bo	b1	pvalue	
Trained	3	1	-6.215	0.646	0.002	sig
Untrained	3	1	-6.69	0.681	0.019	sig
Elite	3	0.998	-5.797	0.645	0.037	sig

Proportionality of Muscle

Judges	N	r	bo	b1	p-value
Trained	3	0.486	10.28	-0.123	0.677
Untrained	3	0.509	11.11	-0.135	0.666
Elite	3	0.432	9.334	-0.104	0.716

Adjusted Proportionality of Muscle

Judges	N	r	bo	b1	p-value
Trained	3	0.671	11.657	-0.163	0.532
Untrained	3	0.691	12.442	-0.177	0.51
Elite	3	0.625	10.963	-0.152	0.57

N= number of athletes; r= pearson correlation; bo= constant slope; b1= slope of variable

Table 16

Multiple Regression Analysis of Judges Rankings on
Adjusted Proporionality, Fat-Free Weight, and Bodyfat in Overall Open Male Division

Judges	N	r	r square	adj. R Sq.	bo	b1(Prop)	b2(Ffmass	b3(BF)	p-value
Trained									
pkg	8	0.898	0.806	0.774	25.53	-0.316			0.002
pkg,BF	8	0.961	0.923	0.893	20.75	-0.283	0.635		0.002
pkg,BF,FF weight	8	0.968	0.937	0.889	29.82	-0.267	0.555	-0.16	0.007
Untrained	8	0.854			37	-0.156	-0.401	0.911	0.124
pkg	8	0.686	0.471	0.283	21.5	-0.256			0.06
pkg, BF	8	0.815	0.664	0.529	15.01	-0.21			0.066
pkg,BF, FF weight		0.854	0.729	0.525	36.41	-0.172	0.671	-0.37	0.125
Elite									
pkg	8	0.848	0.719	0.673	25.29	-0.313			0.008
pkg,BF	8	0.896	0.803	0.724	21.06	-0.283	0.563		0.017
pkg,BF, FF weight	8	0.899	0.809	0.666	27.49	-0.272	0.506	-0.11	0.067

Note: N=number of athletes; r= pearson correlation; b1=proportionality of muscle;b2=fat free weight; b3=bodyfat

Table 17

Multiple Regression Analysis of Judges Rankings on Propotionality of Muscle, Fat free weight, and Bodyfat in Overall Open Male Divison

Judges	N	r	r squ	adj. R	bo	b1(Prop)	b2(Ffmass	b3(BF)	p-value
Trained									
pkg	4	0.74	0.6	0.48	22.878	-0.252			0.034
pkg,BF	4	0.96	0.9	0.88	19.124	-0.26	1.072		0.002
pkg,BF,FF weight	4	0.97	0.9	0.89	31.876	-0.242	0.927	-0.21	0.007
Untrained	4								
pkg	4	0.72	0.5	0.43	22.986	-0.254			0.046
pkg, BF	4	0.89	0.8	0.71	19.483	-0.261	1		0.019
pkg,BF, FF weight		0.9	0.8	0.67	29.584	-0.247	0.885	-0.17	0.063
Elite									
pkg	4								
pkg,BF	4								
pkg,BF, FF weight	4		1	1	19.544	-0.209	0.04	0.622	

N=subjects; r=pearson correlation; b1=adjusted proportionality of muscle; b2=fat-free weight; b3=bodyfat

Table 18

Multicollinearity of Independent Variables for Men

	Pkg	FFW	Adj. Pkg	BF
PKg	1	0.304	.947sig	0.098
FFW	0.304	1	.405sig	0.146
Adj Pkg	.947sig	.405sig	1	-0.183
BF	0.098	0.146	-0.183	1

Table 19

Multicolliearity of Independent Variables for Women

	PKG	FFW	Adj. Pkg	BF
PKG	1	0.294	.964sig	-0.137
FFW	0.294	1	0.359	-0.348
Adj. Pkg	.964sig	0.359	1	-0.396
BF	-0.137	-0.348	-0.396	1

Note:FFW=Fat-free weight; PKG=proportionality of muscle; BF=Bodyfat; Adj.Pkg=Adjusted Proportionality of muscle

Table 20

Multiple Regression Anaylsis of Judges' Rankings and Measures of Proportinality(PKG), Bodyfat, and Fat Free Weight (Trained Judges) of the Lightweight Men's Open Class

Source	df	SS	MS	F-Ratio	pvalue	
Regression	3	32.759	10.92	19.666	0.007	*
Error	4	2.221	0.555			
Total	7	34.98				

Table 21
Coefficients for Judges' Rankings and Measures of Muscularity(PKG), Bodyfat, and Fat Free Weight (Trained Judges) of the Lightweight Men's Open Class

	B	Std. Error	t	Sig.	
(Constant)	29.818	10.582	2.818	0.048	*
PKG	-0.267	0.049	-5.385	0.006	*
BF	0.555	0.25	2.214	0.091	
FFMASS	-0.155	0.17	-0.906	0.416	

Table 22

Multiple Regression Anaylsis of Judges' Rankings and Measures of Muscularity(PKG), Bodyfat, and Fat Free Weight (Elite Judges) of the Lightweight Men's Open

Source	df	SS	MS	F-Ratio	pvalue
Regression	3	31.057	10.352	5.651	0.064
Error	4	7.328	1.832		
Total	7	38.385			

Table 23

Coefficients for Judges' Rankings and Measures of Muscularity(PKG), Bodyfat, and Fat Free Weight (Elite Judges) of the Lightweight Men's Open Class

	B	Std. Error	t	Sig.	
(Constant)	27.486	19.221	1.43	0.226	
PKG	-0.272	0.09	-3.023	0.039	*
BF	0.506	0.455	1.111	0.329	
FFMASS	-0.11	0.31	-0.354	0.741	

Table 24

Multiple Regression Anaylsis of Trained Judges' Rankings and Measures of PKG, Bodyfat, and Fat Free Weight of the Men's Open Lightweight Class

Source	df	SS	MS	F-Ratio	pvalue	
Regressior	3	32.772	10.924	19.789	0.007	*
Error	4	2.208	0.552			
Total		34.98				

Note: PKG=proportionality of muscle

Table 25
Coefficients for Trained Judges' Rankings and Measures of PKG, BF, and FFW Weight of the Men's Open Lightweight Class

	B	Std. Error	t	Sig.	
(Constant)	31.876	10.537	3.025	0.039	*
Prop	-0.242	0.045	-5.403	0.006	*
BF	0.927	0.252	3.676	0.021	*
FFW	-0.211	0.166	-1.271	0.273	

Note: PkG= proportionality of muscle; BF= Bodyfat; FFW= Fat-free Weight

Table 26

Multiple Regression Anaylsis of Elite Judges' Rankings and Measures of (PKG), Bodyfat, and Fat Free Weight of the Men's Open Lightweight Class

Source	df	SS	MS	F-Ratio	pvalue
Regressior	3	31.081	10.36	5.674	0.063
Error	4	7.304	1.826		
Total	7	38.385			

Table 27

Coefficients for Elite Judges' Rankings and Measures of PKG, BF, and FFW Weight (Elite Judges) of the Lightweight Men's Open Class

	B	Std. Error	t	Sig.	
(Constant)	29.584	19.165	1.544	0.198	
Prop.	-0.247	0.082	-3.03	0.039	*
BF	0.885	0.459	1.93	0.126	
FFW	-0.168	0.303	-0.553	0.609	

Note: PKG=proportionality of muscle;BF=Bodyfat;FFW=Fat-free Weight

Table 28

Multiple Regression Anaylsis of Untrained Judges' Rankings and Measures of Adjusted PKG, Bodyfat, and Fat Free Weight of the Men's Open Lightweight Class

Source	df	SS	MS	F-Ratio	pvalue
Regression	3	28.497	9.499	3.58	0.125
Error	4	10.614	2.654		
Total	7	39.111			

Note: Adjusted PKG= Adjusted Proportionality of Muscle

Table 29
Coefficients for Untrained Judges' Rankings and Measures of Adjusted (PKG), BF, and FFW Weight of the Men's Open Lightweight Class

	B	Std. Error	t	Sig.
(Constant)	36.413	23.133	1.574	0.191
PKG	-0.172	0.108	-1.587	0.188
BF	0.671	0.548	1.225	0.288
FFW	-0.365	0.373	-0.978	0.383

Note: Adjusted PKG= Adjusted Proportionality of Muscle; BF= Bodyfat; FFW=Fat-free Weight

Table 30

Multiple Regression Anaylsis of Untrained Judges' Rankings and Measures of Proportionality, Bodyfat, and Fat Free Weight of the Men's Open Lightweight Class

Source	df	SS	MS	F-Ratio	pvalue
Regression	3	28.523	9.508	3.592	0.124
Error	4	10.589	2.647		
Total	7	39.111			

Table 31

Coefficients for Untrained Judges' Rankings and Measures of PKG, Bodyfat, and Fat Free Weight of the Men's Open Lightweight Class

	B	Std. Error	t	Sig.
(Constant)	37.738	23.075	1.635	0.177
Prop.	-0.156	0.098	-1.592	0.187
BF	0.911	0.552	1.649	0.174
FFW	-0.401	0.364	-1.101	0.333

Note: PKG= proportionality of muscle

Table 32

Overall Reliability of Judging Rankings consistiing of Elite, Trained, and Untrained Judges

	N	Interrater Reliability
Open Lightweight Division	8	0.97
Open Middleweight Divison	6	0.55
Open Light-Heavyweight Division	3	0.55
College Lightweight Division	4	0.9
College Middleweight Division	3	0.82
College Heavyweight Division	3	0.68
Novice Lightweight	4	0.34
Novice Heavyweight	4	0.48
Masters	4	0.85
Women's Novice	5	0.71
Women's College	3	0.9
Overall Male	4	0.89
Overall College Male	3	1

Note: N= Number of athletes in each class or division

Table 33

Correlation of Trained, Untrained, and Elite Judge
Within Each class and division

	Trained	Untrained	Elite
Open Men Lightweight			
Trained	1	.96sig	.93sig
Untrained	.96sig	1	0.96
Elite	.93sig	.97sig	1
Open Men Middleweight			
Trained	1	0.1	.99sig
Untrained	0.1	1	0.121
Elite	.99sig	0.121	1
Open Men Lt. Heavywt			
Trained	1	0.86	0.86
Untrained	0.86	1	0.5
Elite	0.86	0.5	1
College Men Lightweight			
Trained	1	1 sig.	.98sig
Untrained	1 sig	1	.98sig
Elite	.98sig	.98sig	1
College Men Middleweight			
Trained	1	0.86	0.86
Untrained	0.86	1	1sig
Elite	0.86	1sig	1
College Men Heavyweight			
Trained	1	0.51	.94sig
Untrained	0.51	1	0.58
Elite	.936sig	0.58	1
Novice Men Lightweight			
Trained	1	-0.577	0.408
Untrained	-0.577	1	0
Elite	0.41	0	1
Novice Men Heavyweight			
Trained	1	0.6	0.84
Untrained	0.6	1	0.93
Elite	0.84	0.93	1
Women's Novice			
Trained	1	0.88	0.8
Untrained	0.88	1	0.73

Table 33

Correlations of Trained, Untrained, and Elite Judges' Rankings

	Trained	Untrained	Elite
Men's Masters			
Trained	1	0.738	0.949
Untrained	0.738	1	0.889
Elite	0.949	0.889	1
Overall Open			
Trained	1	0.854	0.873
Untrained	0.854	1	0.774
Elite	0.949	0.889	1
Overall College			
Trained	1	1	1
Untrained	1	1	1
Elite	1	1	1
Women College			
Trained	1	0.96	0.96
Untrained	0.96	1	1
Elite	0.96	1	1

Note: All Scores were Significant at .01 level.

Table 34

Reliability of Trained, Untrained, and Elite Judges' Rankings

	Trained	Untrained	Elite
Open Men Lightweight			
Trained	1	0.9767	0.965
Untrained	0.9767	1	0.9835
Elite	0.965	0.9835	1
Open Men Middleweight			
Trained	1	0.1569	0.9925
Untrained	0.1569	1	0.1961
Elite	0.9925	0.1961	1
Open Men Lt. Heavywt			
Trained	1	0.8571	0.9231
Untrained	0.83571	1	0.5714
Elite	0.9231	0.5714	1
College Men Lightweight			
Trained	1	1	0.9897
Untrained	1	1	0.9897
Elite	0.897	0.9897	1
College Men Middleweight			
Trained	1	0.931	0.9231
Untrained	0.923	1	1
Elite	0.9231	1	1
College Men Heavyweight			
Trained	1	0.625	0.9667
Untrained	0.625	1	0.6875
Elite	0.9667	0.6875	1
Novice Men Lightweight			
Trained	1	0.266	0.533
Untrained	0.266	1	0
Elite	0.533	0	1
Novice Men Heavyweight			
Trained	1	0.7407	0.9032
Untrained	0.7407	1	0.963
Elite	0.9032	0.963	1
Women's Novice			
Trained	1	0.9375	0.8887
Untrained	0.9375	1	0.84221
Elite	0.8889	0.8421	1

Table 34 Continued

Reliability of Trained, Untrained, and Elite Judges' Rankings

Men's Masters			
Trained	1	0.8485	0.973
Untrained	0.8485	1	0.9412
Elite	0.973	0.9412	1
Overall Open			
Trained	1	0.788	0.932
Untrained	0.788	1	0.7327
Elite	0.932	0.7327	1
Overall College			
Trained	1	1	1
Untrained	1	1	1
Elite	1	1	1
Women's college			
Trained	1	0.9796	0.9796
Untrained	0.9796	1	1
Elite	0.9796	1	1

Table 35

Inter-Reliability of Trained, Untrained, and Elite Judges' Rankings

	Reliability
Open Men Lightweight	
Trained	0.96833
Untrained	0.9873
Elite	0.979
Open Men Middleweight	
Trained	0.738
Untrained	0.20797
Elite	0.8571
Open Men Lt. Heavywt	
Trained	0.733
Untrained	0.3037
Elite	0.2518
College Men Lightweight	
Trained	0.8932
Untrained	0.8859
Elite	0.89865
College Men Middleweight	
Trained	0.822
Untrained	0.732
Elite	1
College Men Heavyweight	
Trained	0.8376
Untrained	0.4928
Elite	0.66
Novice Men Lightweight	
Trained	0.51569
Untrained	0.1214
Elite	0.2399
Novice Men Heavyweight	
Trained	0.3467
Untrained	0.5785
Elite	0.5198
Women's Novice	
Trained	0.7511
Untrained	0.6748
Elite	0.7

Table 35 Continued

Inter-Reliability of Trained, Untrained, and Elite Judges' Rankings

Men's Masters	
Trained	0.8535
Untrained	0.8926
Elite	0.7599
Overall Open	
Trained	0.71
Untrained	0.06
Elite	0.74
Overall College	
Trained	1
Untrained	1
Elite	1
Women's College	
Trained	0.882
Untrained	0.888
Elite	1

Table 36

Correlation of Elite Judges' Ranking with Predicted Rankings
UsingY1'=31.876-.242(x1)+.927(x2) and Y2'=19.1224-1.072x1
where b1=adjusted proportionality and b2=bodyfat

	y1	y2
Men's Lightweight	0.9	0.96
Men's middlleweight	0.714	0.657
Men's light heavywt	0.5	0.5
Masters	0.4	0.4
Novice Lightweight	1	1
Novice Heavyweight	1	1
College Lightweight	1	1
College Middleweight	0.5	0.5
College Heavyweight	-0.41	-0.139
Overall Males	1	0.8
Overall College	0.5	0.5

Table 37

Correlation of Elite Judges' ranking with Predicted Rankngs Using
y'=13.986-.358(x1)+.617(x2) and y2'=-7.777+.01892(x1)+.679(x2)
where b1=adjusted proportionality and b2=bodyfat

	y1	y2
Women's Novice	0.9	0.9
Women's College	1	1

Table 38

Athlete Placement Predictions using the Lightweight Formula
y1'=3.876-.242(x1)+.927(x2) and y2'=19.124-1.072(x1)
where x1=proportionality and x2=bodyfat

Athlete	PKG&BF	PKG
1	0.87	0.674
2	1.82	1.77
3	2.22	1.83
4	2.59	2.193
5	3.1987	2.25
6	3.26	2.35
7	3.55	2.54
8	3.68	2.616
9	3.72	2.68
10	3.76	3.08
11	3.8	3.256
12	3.82	3.307
13	4.46	3.477
14	4.46	3.62
15	4.57	3.669
16	5.16	3.8267
17	5.18	3.82788
18	5.6	3.89
19	5.8	4.489
20	6.29	4.95
21	6.58	5.11
22	6.79	5.58
23	6.88	6.1
24	7.73	6.63
25	7.24	6.87
26	7.627	7.34
27	10.201	7.5

Note: PKG=Adjusted Proportionality and BF=Bodyfat; There is a correlation of .97 between predicted and actual rankings when using the Lightweight Formula

Table 39

Women's Placement Prediction Using Prediction Formulas
y1'=13.986-.358(x1)+.617(x2) and College y2'=-7.777+.01892+.79

Actual Ranking	y1	y2
1	2.75	3
2	2.0888	2
3	3.64	2.99
4	1.24	1.17
5	1.49	1.77
6	-0.029	1.1
7	2.58	1.72
8	4.912	4.51
9	2.795	2.93

Note: y1=Women's Novice Formula; y2'=Women's College Formula

Table 40

Athlete Predictions using Overall Formula
y1'=19.937+(-.250*x1)
where x1=proportionality-Adjusted

Athlete	Pkg	R-Finals
1	3.289993	5
2	2.176949	3
3	1.139661	1
4	5.676724	8
5	3.654735	3
6	1.596487	1
7	2.489274	4
8	2.314694	2
9	5.547485	6
10	2.76681	1
11	2.354945	1
12	4.987157	5
13	4.56503	4
14	3.787132	7
15	1.517015	2
16	2.603605	1
17	0.271679	1
18	2.641525	4
19	5.174374	3
20	2.816183	2
21	1.472088	3
22	1.189453	1
23	2.765897	2
24	1.808406	3
25	4.158757	5
26	1.74899	6
27	1.859262	2

Note: Pkg=Adjusted Proportionality of muscle; r-final= Pearson Correlation

Table 41

Correlation of Each Judge Score to Final Placings in all Divisions
J1-J10=Trained Judges; J1-J18=Untrained; J19-J23=Elite Judges

Judges-Trained	Correlation
Judge 1	0.901
Judge 2	0.883
Judge 3	0.852
Judge 4	0.864
Judge 5	0.801
Judge 6	0.87
Judge 7	0.883
Judge 8	0.895
Judge 9	0.901
Judge 10	0.901
Judge-Untrained	
Judge 11	0.734
Judge 12	0.722
Judge 13	0.889
Judge 14	0.87
Judge 15	0.846
Judge 16	0.838
Judge 17	0.852
Judge 18	0.716
Judge-Elite	
Judge 19	0.852
Judge 20	0.949
Judge 21	0.92
Judge 22	0.872
Judge 23	0.917

Table 41

Correlation of Each Judge Score to Final Placings in all Divisions
J1-J10=Trained Judges; J1-J18=Untrained; J19-J23=Elite Judges

Judges-Trained	Correlation
Judge 1	0.901
Judge 2	0.883
Judge 3	0.852
Judge 4	0.864
Judge 5	0.801
Judge 6	0.87
Judge 7	0.883
Judge 8	0.895
Judge 9	0.901
Judge 10	0.901
Judge-Untrained	
Judge 11	0.734
Judge 12	0.722
Judge 13	0.889
Judge 14	0.87
Judge 15	0.846
Judge 16	0.838
Judge 17	0.852
Judge 18	0.716
Judge-Elite	
Judge 19	0.852
Judge 20	0.949
Judge 21	0.92
Judge 22	0.872
Judge 23	0.917

Note: Average correlations of the Trained group=.87; Untrained group=.80; Elite group = .90 .

Table 42

Predictions using Men's Lightweight formula-
y'=20.750-.283x1 + .635x2

Novice Heavyweight	Prediction	Ranks
1	3.55	1
2	7.02	4
3	4.27	2
4	6.87	3
Masters Men 40		
1	4.45	1
2	7.02	2
3	11.08	4 Misplaced
4	7.07	3 Misplaced

Note: Misplaced means that the actual score does not agree with prediction placement

Table 42

Predictions using Men's Lightweight formula-
y'=20.750-.283x1 + .635x2

Lightweigt Placings		Prediction	Ranks	
	1	2.97	1	
	2	3.1	2	
	3	5.2	3	
	4	5.8	5	Misplaced
	5	4.8	4	Misplaced
	6	8.47	6	
	7	8.52	7	
	8	8.75	8	
Middleweight				
	1	1.36		
	2	3.41	2	
	3	5.38	4	Misplaced
	4	no report		
	5	5.82	5	
	6	4.45	3	Misplaced
Light Heavyweight				
	1	5.54	2	Misplaced
	2	5.98	3	Misplaced
	3	4.57	1	Misplaced
College Lightweight				
	1	2.973		
	2	5.83		
	3	no report		
	4	4.82		
College Middleweigt				
	1	5.66	2	Misplaced
	2	4.62	1	Misplaced
	3	8.01	3	
College Heavyweigt				
	1	5.83	2	
	2			
	3	6.88	4	
	4	4.27	1	
	5	8.44	3	
Novice Lightweight				
	1	no report		
	2	5.66	2	
	3	7.1	3	
	4	8.44	4	

Table 43

Predictions using Men's Overall formula
y'=19.937-.250x1+.281x2

Lightweigt Placings		Prediction	Ranks	
	1	2.39	1	
	2	2.66	2	
	3	3.51	3	
	4	3.91	4	
	5	4.05	5	
	6	6.65	7	Misplace
	7	5.58	6	Misplace
	8	6.84	8	
Middleweight				
	1	1.15	1	
	2	2.56	2	
	3	3.46	4	
	4			
	5	5.05	5	
	6	3.14	3	
Light Heavyweight				
	1	3.95	2	Misplace
	2	3.15	1	Misplace
	3	4.39	3	Misplace
College Lightweight				
	1	2.39	1	
	2	3.91	2	
	3	No Report		
	4	4.05	4	
College Middleweigt				
	1	2	3.98	Misplace
	2	1	3.47	Misplace
	3	3	6.38	
College Heavyweigt				
	1	5.05	2	Misplace
	2	No report		
	3	5.26	3	
	4	3.52	1	Misplace
	5	6.46	4	
Novice Lightweight				
	1	No report	No Report	
	2	5.66	2	
	3	7.1	3	
	4	8.45	4	

Table 44

Predictions using Men's Overall formula-
y'=20.750-.283x1 + .635x2

Novice Heavyweight	Prediction	Ranks	
1	2.53	1	
2	4.7	3	Misplace
3	3.52	2	Misplace
4	5.25	4	
Masters Men 40			
1	3.14	1	
2	4.7	3	Misplace
3	7.19	4	Misplace
4	4.55	2	Misplace

Note: Misplaced means that the actual score does not agree with prediction placement; no report means no data

Table 45

Predictions using Women's Novice
y'=14.138+.634x1-.312x2

Placings		Prediction	Ranks
College Women			
	1	1.49	1
	2	2.08	2
	3	2.752	3
Novice Women			
	1	1.49	1
	2	2.79	2
	3	2.08	3
	4	3.6	4
	5	4.9	5
Women's Open			
	1	-0.02	1
	2	2.58	2

APPENDIX B

INFORMED CONSENT FORMS

Request for Approval of Research Proposal

Submitted to J. Nespor, Chairman, Division

Title: A comparison of anthropometric measurements of amateur bodybuilders scores in relation to analysis and prediction of judges' contest scores

Background/Scientific Justification.

In Sports modern day technologies have developed methods to strength the objectivity of officiating and judging of events. For example, In the NFL the instant replay has allowed many calls to be reversed. A panel of judges determines many sport outcomes, and there is usually a lack of methods to validate or criteria to test the validity of the judges. Some examples are the sport of gymnastics, diving, ice skating, boxing, and bodybuilding. Bodybuilding has been a controversial sport over the years, since judges have different perceptions of the ideal physique. Most bodybuilders are judged on the amount of muscle, body symmetry or proportionality, and relatively muscular definition. Some judges give higher scores for one of the three criteria mentioned above. A previous study analyzed anthropometric measurements and judges scores. This study will replicate the anthropometric measurements taken on amateur bodybuilders, and it will include male subjects.

BODYBUILDER'S CONSENT FORM

Please read the following consent form before participating in this research study. There are minimum to no risk involved with your health and safety. You may resign from participating in this study at anytime. This study will be investigating and comparing anthropometric measurements to judge scores. The impact of this study will possibly develop new standards for judging bodybuilding contests, and also report descriptive data on today's natural male and female bodybuilders.

I understand

1) I will be asked to give anthropometric measurements, and due to the nature of these measurements there will be physical contact by the measuring tool and by the investigator taking the measurements. The instruments used in this study will be a Lange skin fold caliper, anthropometer, weight and height scale, and a flexible non-stretchable tape measure, which will measure circumferences. Te skin fold calipers will be used to take three body measurements to assess % body fat. The anthropometer will be used to assess breadth, which will be used to report body proportionality and body type. The tape measure will be used to gather girth measurements, and it also will be used to figure body proportionality. The height and weight scale will be used to figure weight and height. I will be measured at 3 sites for skin fold, two for breadths, seven for circumferences, height and weight measures. I understand that the following measurements could take twenty to thirty minutes to complete the evaluation.

2) The possible risks that may occur from this study are bruises on the skin surface that may be due to the use of skin fold and anthropometric instruments. However, bruising is not common.

3) The benefits of this study to me are that the measurements will provide an accurate measurement of my body composition as it relates to % body fat, fat-free weight, somatotype, and proportionality.

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 investigators, Virginia Tech, or the bodybuilding competition. I may ask any questions about the process at anytime.

6) Any questions or concerns regarding this study can be directed to Dr. Redican, Chairperson for this study at 540 231-5743.

DATE_________ SUBJECT____________

INVESTIGATOR__________________

Dear Competitor/Volunteer:

The results of your body composition analysis have been computed from the pilot study/competition that you volunteered to participate in last spring semester. The following values will give you an average of three different or sometimes the same scores, resulting from the same body composition equation. Your results are reported as follows:

Percent Body fat:______________

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 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 ½-14; mesomorph values typically range from 1-10; and ectomorph values typically range from ½-9. In general, ratings from ½ to 21/2 are regarded as low values; ratings of 3 to 5 are mid-range values; and 51/2 and up are high values.

Thanks for your participation in this study, and please call or write if you have questions about your results.

Sincerely,

Rodney Gaines
Graduate Student, Health Promotion
Virginia Tech

JUDGE'S CONSENT FORM

Please read the following consent form before participating in this research study. There are minimum to no risk involved with your health and safety. You may resign from participating in this study at anytime. This study will be investigating and comparing anthropometric measurements to judge scores. The impact of this study will possibly develop new standards for judging bodybuilding contests, and also report descriptive data on today's natural male and female bodybuilders.

I understand

1) I will be asked to rank and score the male and female bodybuilders to the best of my knowledge. If I am selected to attend the training session, I will follow the guidelines of the training session. I also agree not to share any portion of the training session with other judges who were not selected to attend the training session

2) If volunteering as a judge in this competition I agree to rate the athletes to the best of my ability. If not an experienced judge, I agree that I have never judged another fitness or bodybuilding competition. There is minimum risk participating as a judge.

3) The possible risks that may occur from this study are minimum. I understand that bodybuilders after the event may ask me how I scored his/her performance.

4) The benefits of this study to me are that the measurements will provide an accurate measurement of my body composition as it relates to % body fat, fat-free weight, somatotype, and proportionality.

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

6) If I decide to participate, I am free to withdraw my consent and discontinue participation at any time without prejudice from the investigators, Virginia Tech, or the bodybuilding competition. I may ask any questions about the process at anytime.

7) Any questions or concerns regarding this study can be directed to Dr. Redican or Dr. Janet Wojcik, Chairpersons for this study at 540 231-5743 and/or 540 231-8746

DATE_________ SUBJECT____________

INVESTIGATOR__________________

Dear Judge/Volunteer:

There will be three groups of judges in this study: Elite, Trained, and Untrained. As a judge I will be asked to score the bodybuilders to the best of my ability, and I agree not to share this information with anyone. I can share my opinions with the bodybuilders after the competition is over. If you are a novice judge, you must not have judged a competition prior to this event. Also, as a novice judge I may be selected to participate in an education session. I agree not to discuss the education sessions with the other judges until the competition is over. Please do not discuss your rankings with the athlete or general audience until the competition is over.

Thanks for your participation in this study, and please call or write if you have questions about your results.

Sincerely,

Rodney Gaines

APPENDIX C

DATA COLLECTION FORMS

DATA COLLECTION FORM

RESEARCHER___________________________

DATE____________________________________

CONTESTANT NAME_____________________

CONTESTANT #__________________________

WEIGHT(KG)_____________________________

HEIGHT(CM)_____________________________

ANTHROPOMETRY:

ELBOW BREADTH(CM)_____________________

KNEE BREADTH(CM)_______________________

DATA COLLECTION FORM

RESEARCHER__________________________ DATE________________

CONTESTANT NAME____________________

CONTESTANT #_________________________

SKINFOLDS:

TRICEP__________________________________

SUBSCAPULA____________________________

SUPRAILIUM_____________________________

THIGH___________________________________

CALF_____________________________________

CHEST___________________________________

WAIST___________________________________

DATA COLLECTION FORM

RESEARCHER__________________________

DATE__________________________________

CONTESTANT NAME____________________

CONTESTANT #_________________________

GIRTH MEASUREMENTS:

CHEST_________________________________

ARM____________________________________(RELAXED)

ARM____________________________________(FLEXED)

FOREARM_______________________________

THIGH__________________________________

CALF____________________________________

HEATH-CARTER SOMATOTYPE RATING FORM

NAME .... AGE .... SEX: M F NO: ....

OCCUPATION .... ETHNIC GROUP .... DATE ....

PROJECT: .... MEASURED BY: ....

Skinfolds mm

Triceps =

Subscapular =

Supraliac =

TOTAL SKINFOLDS = [ ]

Calf =

TOTAL SKINFOLDS (mm)

Upper Limit	10.9	14.9	18.9	22.9	26.9	31.2	35.8	40.7	46.2	52.2	58.7	65.7	73.2	81.2	89.7	98.9	108.9	119.7	131.2	143.7	157.2	171.9	187.9	204.0
Mid-point	9.0	13.0	17.0	21.0	25.0	29.0	33.5	38.0	43.5	49.0	55.5	62.0	69.5	77.0	85.5	94.0	104.0	114.0	125.5	137.0	150.5	164.0	180.0	196.0
Lower Limit	7.0	11.0	15.0	19.0	23.0	27.0	31.3	35.9	40.8	46.3	52.3	58.8	65.8	73.3	81.3	89.8	99.0	109.0	119.8	131.3	143.8	157.3	172.0	188.0
FIRST COMPONENT	½	1	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12

Height cm [ ]	139.7	143.5	147.3	151.1	154.9	158.8	162.6	166.4	170.2	174.0	177.8	181.6	185.4	189.2	193.0	196.9	200.7	204.5	208.3	212.1	215.9	219.7	223.5	227.3
Humerus width cm [ ]	5.19	5.34	5.49	5.64	5.78	5.93	6.07	6.22	6.37	6.51	6.65	6.80	6.95	7.09	7.24	7.38	7.53	7.67	7.82	7.97	8.11	8.25	8.40	8.55
Femur width cm [ ]	7.41	7.62	7.83	8.04	8.24	8.45	8.66	8.87	9.08	9.28	9.49	9.70	9.91	10.12	10.33	10.53	10.74	10.95	11.16	11.36	11.57	11.78	11.99	12.21
Biceps girth [ ] -T* [ ]	23.7	24.4	25.0	25.7	26.3	27.0	27.7	28.3	29.0	29.7	30.3	31.0	31.6	32.2	33.0	33.6	34.3	35.0	35.6	36.3	37.0	37.6	38.3	39.0
Calf girth [ ] -C* [ ]	27.7	28.5	29.3	30.1	30.8	31.6	32.4	33.2	33.9	34.7	35.5	36.3	37.1	37.8	38.6	39.4	40.2	41.0	41.7	42.5	43.3	44.1	44.9	45.6

SECOND COMPONENT	½	1	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9

Weight kg =

Ht. / ∛Wt. = [ ]

Upper limit	39.65	40.74	41.43	42.13	42.82	43.48	44.18	44.84	45.53	46.23	46.92	47.58	48.25	48.94	49.63	50.33	50.99	51.68
Mid-point	and	40.20	41.09	41.79	42.48	43.14	43.84	44.50	45.19	45.89	46.32	47.24	47.94	48.60	49.29	49.99	50.68	51.34
Lower limit	below	39.66	40.75	41.44	42.14	42.83	43.49	44.19	44.85	45.54	46.24	46.93	47.59	48.26	48.95	49.64	50.34	51.00
THIRD COMPONENT	½	1	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9

	FIRST COMPONENT	SECOND COMPONENT	THIRD COMPONENT	
Anthropometric Somatotype				BY: ....
Anthropometric plus Photoscopic Somatotype				RATER: ....

*Biceps girth in cm corrected for fat by subtracting triceps skinfold value expressed in cm.

*Calf girth in cm corrected for fat by subtracting medial calf skinfold cm.

APPENDIX D

EDUCATION SESSION

EDUCATION SESSION FOR TREATMENT JUDGES

I. INTRODUCTION

II. SHOW VIDEO

III. SCORINGS ARE DONE

IV. DISCUSSION TAKES PLACE-

V. LECTURE ON SOMATOTYPES

VI. LECTURE ON INBF PHYSIQUE MANUAL

VII. GO OVER FORMS

VIII. SHOW MORE VIDEO AND RATINGS ARE DONE

IX. CONCLUSION

SESSION WITH JUDGES WITH NO TREATMENT OR TRAINING

I. INTRODUCTION

II. GIVEN FORMS FOR SCORING

shows.

Scoresheets that are distributed at Prejudging to the panel shall consist of one sheet per class, which will have columns for judgement of Symmetry, Muscularity and Final Placement, as well as space for individual comments. After each class is judged, and giving final placing rankings by each judge, the scoresheets will be collected by the Head Judge for final tabulation.

Placements (including tie-breakers) will be made from the Final Placements column of the scoring sheets as judged by the official panel, and tabulated by the Head Scorer.

Note: All judging procedures as explained herein will be conducted in the same manner for both Men's and Women's divisions.

* **Tie-breakers** consist of taking two contestants with equal final scores on the master scoresheet on a one-to-one judging basis, based on individual judges' scores. The athlete with the most highest-ranked placements as given by the judges in this one-to-one comparison will win the higher placement. These tie-breaker scores shall consist of the final placements by all judges.

INBF PREJUDGING PROCEDURE

ROUND ONE - SYMMETRY

Semi-Relaxed Comparisons

All the athletes in a given class will file out across the stage and form a line or semi-circle. The entire lineup will be required to go through all four semi-relaxed positions: Front, left side, back, right side, and then back to the front. Judging of Symmetry will be taken from these comparison quarter-turns. In the event of an extremely large class, the Head Judge has the option of additional comparisons: The lineup may be split in half and the group on the right side instructed to go the the left side of the stage, and vice versa. By moving the group around in this manner, every athlete will be seen in relatively close proximity to each judge, and will gain variations in lighting. Once the lineup has gone through the semi-relaxed poses for a second time in this new configuration, they will be instructed to return to their original positions and numerical order.

The Head Judge may, with some assistance from the rest of the panel, also call out groups of 3-6 athletes at a time for comparisons of semi-relaxed posing. Each group will go through all relaxed stances. Comparisons between the apparent top contenders, middle-level contenders, and lower-level contenders will be interspersed. This does not necessarily mean each judge has to skip up and down in making the comparisons, nor will it be absolutely structured this way. There should be some continuity, especially when trying to pin down placings for closely matched competitors. Each contestant should be called out for at least one set of comparisons with his peers. Athletes not being considered in various comparisons will wait to the rear of the stage until called. Once all the judges are satisfied with their ranking of placements, the round will be terminated and athletes will file off stage.

ROUND TWO - MUSCULARITY

Mandatory Poses and Comparisons

After Symmetry comparisons are completed, the Muscularity Round will commence. The athletes will remain on stage in numerical order for the mandatory poses. They may be again divided in half for additional comparisons and reversed if they cannot all fit stage front at once (in the event of extremely large classes), as they were in the first round, performing a series of mandatory poses (seven for women, eight for men). These include the *front double biceps, front lat spread, side chest (both sides), rear double biceps, rear lat spread, side triceps (both sides), and front overhead abdominal pose with one leg extended, plus a favorite most muscular for men only.* Other poses (serratus, calf, quadriceps, etc.) may also be requested by the Head Judge if deemed necessary.

The Head Judge also has the option of calling smaller groups of 3-5 athletes forward for additional comparisons. After going through the mandatory poses, the competitors at stage front will be instructed to return to the lineup in their correct numerical positions, while 3-5 new competitors may be called forward. (It should be noted that 1-2 of the competitors from one comparison may be called out for the next one or more comparisons.) Athletes not in the immediate comparisons will step to stage rear until they are called forward.

Once every judge is fairly satisfied with his/her scoring, the competitors will be told to return to their original lineup positions. At this time, there will be one last opportunity for a few final comparisons if the Head Judge deems it necessary to resolve any remaining scoring conflicts or close placings. When all comparisons are completed, the round will be terminated and all competitors will file off stage. This will conclude the Prejudging presentation.

SCORING FOR PRESENTATION

A certain amount of scoring weight should be given to the appearance, professionalism, stage presence, ability to follow directions and posing prowess that the athletes present during the Prejudging. Attention should be given to the following characteristics in judging "presentation" as part of the Symmetry and Muscularity rounds: Tan, application of oil, grooming, choice of posing suit (which must adhere to INBF rules), ability to hit poses on command and exhibiting he correct INBF poses for both Symmetry stances and Muscularity mandatory poses.

PLACEMENTS AND AWARDS CEREMONY

After both Prejudging rounds are assessed, the judges will come up with final placements for each competitor. These will then be tabulated by the Head Judge and Official Scorer, with up to two other INBF representatives (who may or may not be part of the judging panel, such as the Promoter). All competitors will be ranked in the final placements based on scoring by the panel for each class. At the discretion of the Promoter, these scores may be distributed to the athletes no earlier than seven days after the competition. (Note: Only the judges' numbers numbers, and not their names, should be identified).

The awards ceremony can take place either at the end of the show (all classes) or as the show progresses (after each class finishes their posing routines). At the actual awards ceremony, the top three or five athletes (at the Promoter's discretion) will be announced, and then brought on stage in closest numerical order. At this time the awards will be presented for last through 1st, in that order.

This presentation ceremony shall be conducted in the same manner for both the Men's and Women's divisions, as well as Novice, Teens, Masters, Women's Masters and Couples divisions.

The overall posedown for the Men's and Women's open classes will take place at the Night Show after all class awards have been handed out. The Head Judge will take the class winners through the Symmetry and Muscularity poses and then a brief posedown will take place. Judges must score all the athletes in the posedown by placement (not simply by picking their choice for winner). This is necessary in case an athlete chosen as overall winner fails a urinalysis test, at which time the second placer in the posedown (provided he also passed the test) gains the overall award.

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Created 2/23/00

Section IV. THE JUDGEMENT OF PHYSIQUE CONTESTS

A. OFFICIAL CRITERIA OF PHYSIQUE JUDGEMENT.

1. BASIS OF JUDGEMENT.

The judging of physique in INBF-certified competitions shall be based solely on the appearance and presentation of contestants on stage during the prejudging and final show.

2. DIMENSIONS OF JUDGEMENT.

The judgement of physique in INBF-certified competitions shall include three related dimensions, as described below:

a. MUSCULARITY: Muscularity refers to the size of the muscles, their shape, definition and hardness. Muscularity is determined, in part, by the extent of the development in relation to the size of the skeletal structure. It also includes the shape/contour of the developed muscles and muscle groups, and separation (i.e., the lines of demarcation between adjacent muscles) and striations delineating sections or fibers within the same muscle group, and the degree of firmness and muscle tone (lack of fat or water under the skin).

b. SYMMETRY: Symmetry refers to the structural harmony of the physique -- the relative size of the various bodyparts and their shape. There must be a balance and proportion between different components (upper body and lower body, upper and lower parts and front and back of extremities, as well as between same bodyparts from each side view, etc.). Symmetry refers not only to balance in size of these elements, but also the degree of definition and detail. The presence of muscularity and definition must also be included when determining symmetrical balance, as a tight, defined physique that is properly shaped is the ideal of this judging maker. Symmetry is a measurement of evenness of development and how well all parts of the physique fit together.

c. PRESENTATION: The element of presentation covers everything not included in muscularity and symmetry. This includes the effectiveness of the display of the contestant's assets, and includes posture, carriage, projection and posing ability. Skin quality, evenness of skin tone and skin color, choice of posing outfit and grooming are considered. The finesse in assuming mandatory poses, as well as the strict following of instructions when asked to hit the poses, are factors included in presentation.

3. MARKERS OF PHYSIQUE JUDGEMENT.

Certain markers are evident within the structure of physique judgement embraced by the INBF. These markers help to clarify the dimensions of judgement referred to above (muscularity, symmetry and presentation), and have evolved over the history of bodybuilding as a sport. Judges are required to consider all aspects of each dimension of judgement, and to use these markers to compare and make placements within each INBF certified competition.

a. **MUSCULARITY:** In comparing muscularity, judges should look for evidence that the competitor is a bodybuilder, with muscularity that is greater-than-average. An impressive development of defined muscle, and NOT solely the definition of average muscularity achieved simply via dieting, is the quality sought in this area. In gauging muscularity, the judge should examine the degree of muscularity over the entire body.

In the **ARMS**, judges should look for prominent bifurcated peaks in the biceps brachii, and for separate and distinct development of the brachialis and coracobrachialis. All three heads of the triceps should be separately visible and exhibit appropriate thickness and size. Muscle is the forearm should give the appearance of having 75% of the circumference of the upper arms when flexed, and have necessary detail.

The **SHOULDERS** should exhibit all three heads of the deltoids in a balanced development, separated distinctly from the trapezius, chest and muscles of the upper arm. Also in this area, the sternocleidomastoid (neck) muscles should be visible. In the **BACK** region, the trapezius should be developed and visible. The traps should extend down into the center back (rhomboid) muscles and the infraspinatus and teres minor groups (located along the upper, outer lats) should be visible. The latissimus should sweep widely from the spinal insertions to beneath the arms, giving the back width and a "V" taper. There should also be a deep furrow and "Christmas tree" definition along the lower spine, reflecting thickness of the erector spinae muscles.

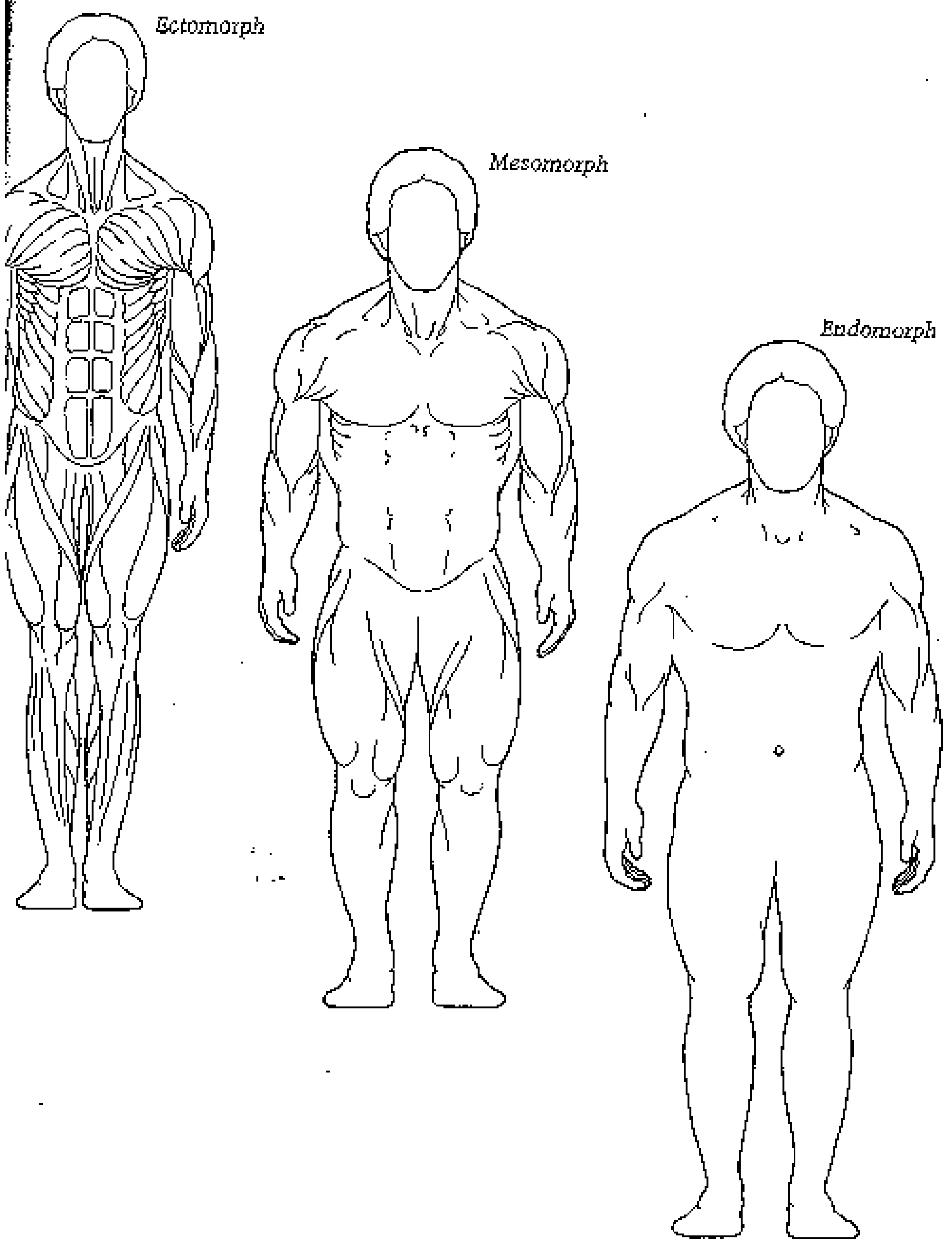
From a frontal view, the **CHEST** should exhibit developed pectorals that are thick and defined. Upper and lower portions should be distinguishable and of approximate equal thickness, with squared shape desirable along the outside, inside and lower edges for men. There should be no unsightly puffiness in male contestants, which is evidence of gynecomastia generally associated with prior steroid use. Such evidence of gynecomastia should be included in scoring the individual downward in comparison to other competitors who exhibit no such physical imperfections. Beneath the chest, the **ABDOMINAL** area should be clearly visible, with at least three horizontal grooves (lineae transversae), the third being at the level of the navel or slightly below. A vertical groove (linea alba) should be visible along the midline, with the abdominals clearly separated from the external obliques by lines which arc around and extend downward and inward toward the pubis (linea semilunares). The serratus anterior should be visible above the obliques, and below, the internal obliques and tensor fasciae latae should be visible above the hips.

The **LEGS** should feature balanced development of the quadriceps at the front, as well as that of the adductors along the inner thigh. From a rear view, the gluteals should be of a muscular nature, squared and trim rather than appearing soft and round. Separate and distinct development should be evident in the leg biceps when rear poses are done, featuring the biceps femoris, semitendinosis and semimembranosis. Calf muscles should be developed and appear prominent from the front (tibialis) and rear (gastrocnemius and soleus). The gastrocnemius should be noticeably divided between the two muscle heads, with the medial head somewhat longer. Calves should have a 60% circumference ratio when compared to the upper legs.

In looking at these muscle groupings, judges should be aware of the **SHAPE, SIZE, DEFINITION** and **HARDNESS** of each muscle. Muscles should have a pleasing contour (shape), with origins and insertions that give them the appearance of appropriate placement within the anatomy. Average- or long-bellied muscles are more desirable than short-bellied, in that they do not leave gaps in the physique (such as a gap near the inside elbow for a person with a short biceps muscle, or the long gap in the achilles area for someone with short calve muscles). A full, well-positioned muscularity has a more favorable appearance and should be judged accordingly. Size is not necessarily the key determining factor, but evidence of thick muscularity is desirable in comparing qualities among bodybuilders. While genetic predispositions affect these qualities, successful bodybuilders have been able to overcome such "shortcomings" and make up for lack of muscle belly length or size by overcompensating in other areas.

The aspect of **DEFINITION** is equally important in judging muscularity. It must be possible to distinguish between muscles and muscle groups, as in demarcation of muscle outlines, as well as the visibility of markings (striations) between fibers within a separate muscle. Leanness is important, but an anorexic or overly dieted appearance is NOT advantageous nor desirable. Definition within the confines of a well-muscled physique is what judges should be looking for. Definition and hardness are the signs of a "finished" physique which is the result of hard training, the absence of bodyfat, and a limited retention of body water. Vascularity is a sign of a defined muscularity, but is not always an indication of a finished physique (i.e.: vascular forearms on a competitor with a bloated midsection). Judges should examine vascularity in context with the other factors named herein when ascertaining levels of muscularity among competitors.

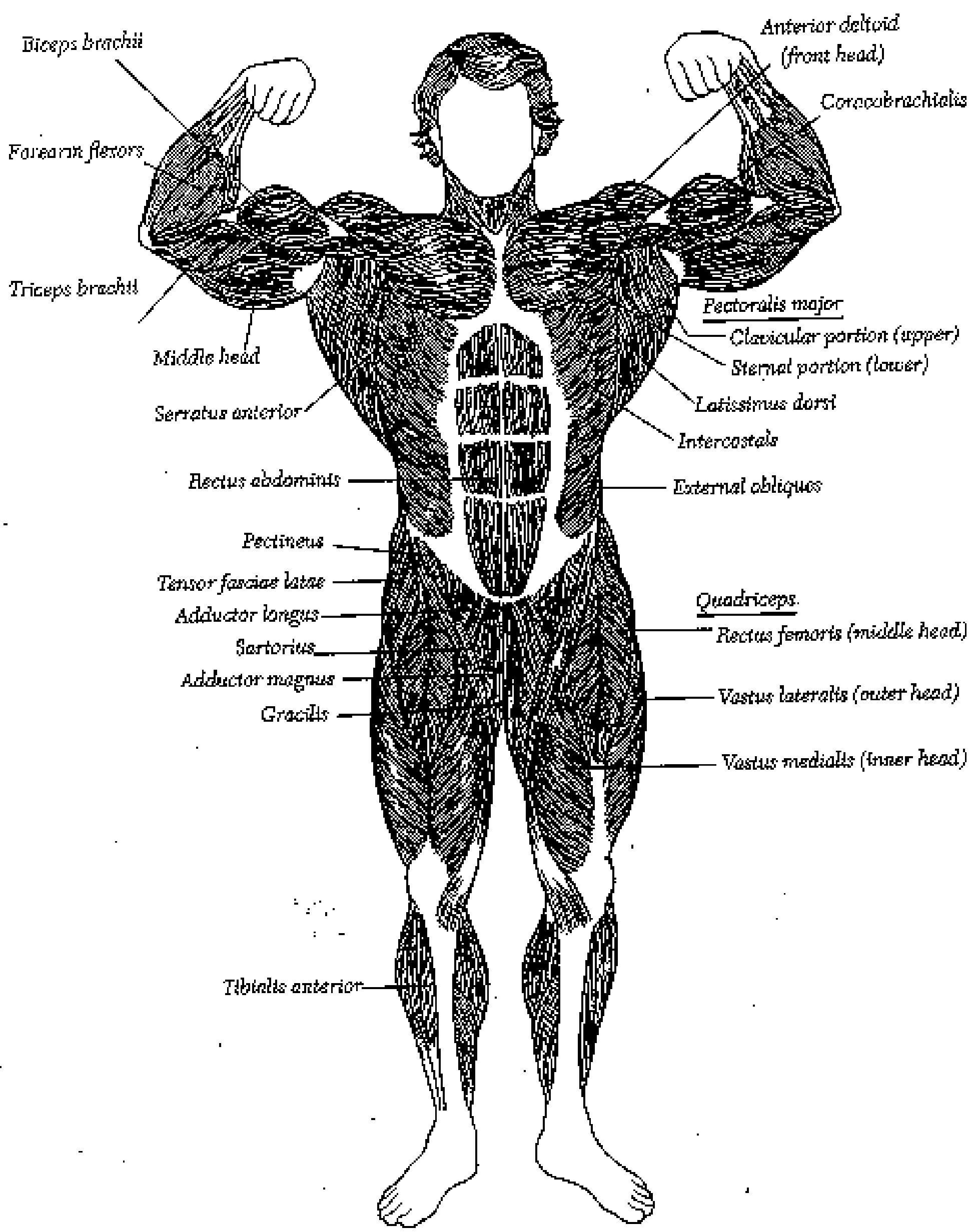
b. SYMMETRY: In evaluating symmetry, the judge should be concerned with the harmony and proportion of the physique. This evaluation should begin with the **SKELETAL STRUCTURE** itself. Although a competitor may be limited by his genetic structure, the judge has to honestly examine this characteristic to make necessary distinctions between bodybuilders. The ideal structure should include a near-equal ratio of torso to leg length, broad shoulders and narrow hips for a man, with similar proportions for a woman (albeit not so broad of shoulders). Furthermore, skeletal


Ectomorph
Mesomorph
Endomorph

Important Muscles of the Body

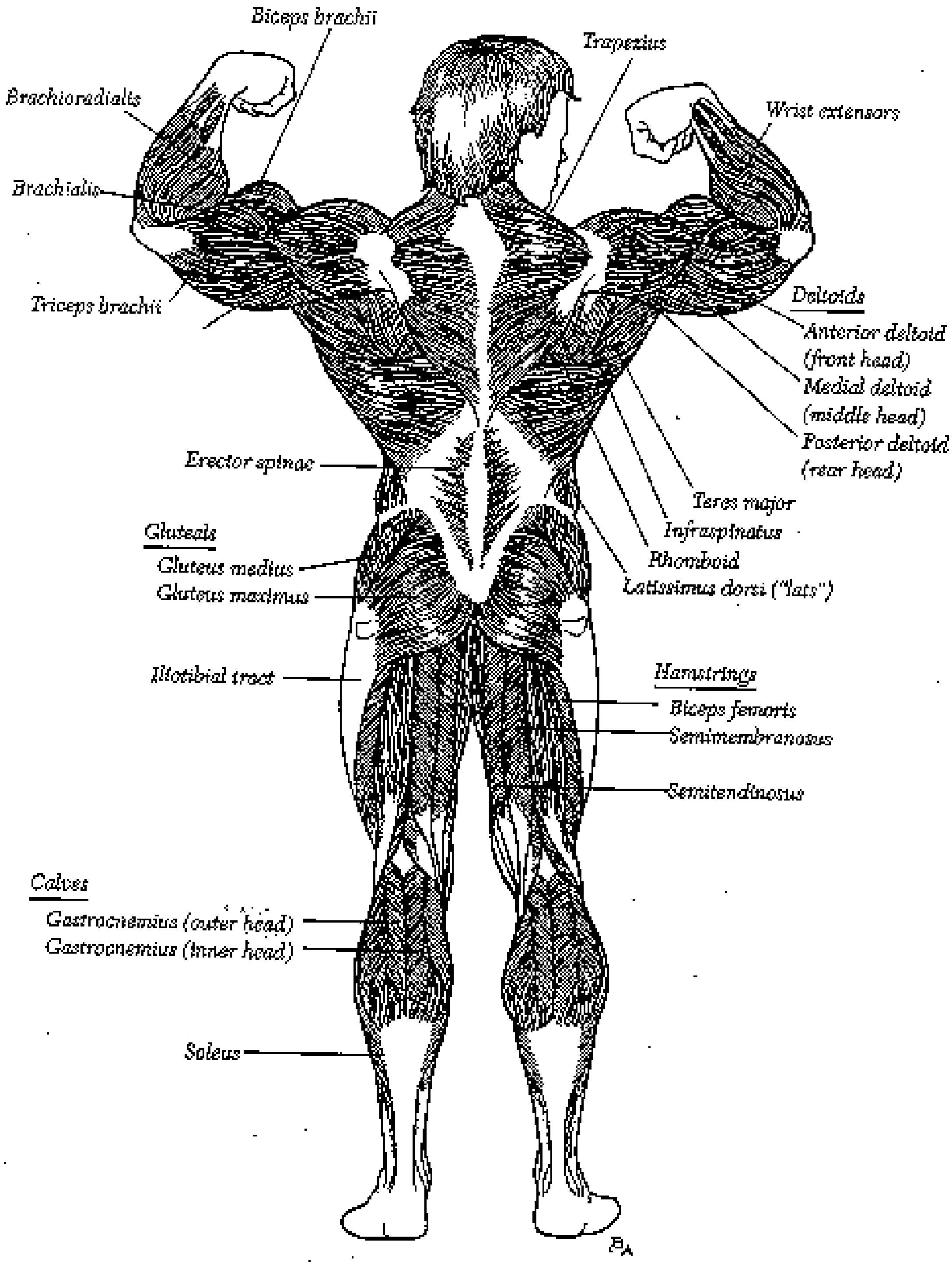
Muscle	Action
Pectoralis Major (has Minor)	Adduction of Arm
Latissimus Dorsi	Adduction of Arm
Teres Major and Minor	Adduction of Arm
Rhomboid Major and Minor	Adductions of Scapula
Trapezius	Adduction of Scapula, elevation
Deltoids	
Anterior	Flexion of Arm
Middle	Abduction of Arm
Posterior	Extension/Hyperextension of Arm
Triceps (3 heads)	Extension of Forearm
Biceps (2 heads)	Flexion of Forearm, Supination
Iliopsoas	Flexion of Hip
Gluteus Maximus	Extension of Hip
Gluteus Minimus	Abduction of Hip
Tensor Fasciae Latae	Abduction of Hip
Adductor Muscles	Adduction of Hip
Quadriceps (4 muscles)	
Vastus Lateralis	Extension of Knee
Vastus Medialis	Extension of Knee
Vastus Intermedius	Extension of Knee
Rectus Femoris	Extension of Knee, Flexion of Hip
Hamstrings (3 muscles)	
Semitendinosus	Flexion of Knee, Extension of Hip
Semimembranosus	Flexion of Knee, Extension of Hip
Biceps Femoris	Flexion of Knee, Extension of Hip
Anterior Tibialis	Dorsiflexion
Gastrocnemius	Plantar Flexion
Soleus	Plantar Flexion
Abs	
Rectus Abdominis	Flexion of Trunk
Obliques	Medial and Lateral Flexion of Trunk
Transverse	Lateral Flexion of Trunk
Erector Spinae	Extension of Trunk

Front View



Biceps brachii
Forearm flexors
Triceps brachii
Middle head
Serratus anterior
Rectus abdominis
Pectineus
Tensor fasciae latae
Adductor longus
Sartorius
Adductor magnus
Gracilis
Tibialis anterior
Anterior deltoid
(front head)
Coracobrachialis
Pectoralis major
Clavicular portion (upper)
Sternal portion (lower)
Latissimus dorsi
Intercostals
External obliques
Quadriceps
Rectus femoris (middle head)
Vastus lateralis (outer head)
Vastus medialis (inner head)

Back View


Biceps brachii
Trapezius
Brachioradialis
Wrist extensors
Brachialis
Triceps brachii
Deltoids
Anterior deltoid (front head)
Medial deltoid (middle head)
Posterior deltoid (rear head)
Erector spinae
Teres major
Infraspinatus
Rhomboid
Latissimus dorsi ("lats")
Gluteals
Gluteus medius
Gluteus maximus
Iliotibial tract
Hamstrings
Biceps femoris
Semimembranosus
Semitendinosus
Calves
Gastrocnemius (outer head)
Gastrocnemius (inner head)
Soleus

PART III. OFFICIAL AAU PHYSIQUE COMPETITION POSES

A. Introduction

1. **Applicability.** The standard physique poses illustrated in this section are the official poses for both males and females in all AAU-certified physique competition.

2. **Procedure.** The poses shall be used during competition as outlined below:

   a. **Semi-relaxed facing poses:** Used during the group facings phase.

   b. **Mandatory poses:** Used during the comparison posing phase. In the initial comparison, these poses shall be used in numerical sequence and all will be used. Selections of these poses may be used for subsequent additional comparisons of selected subgroups of contestants.

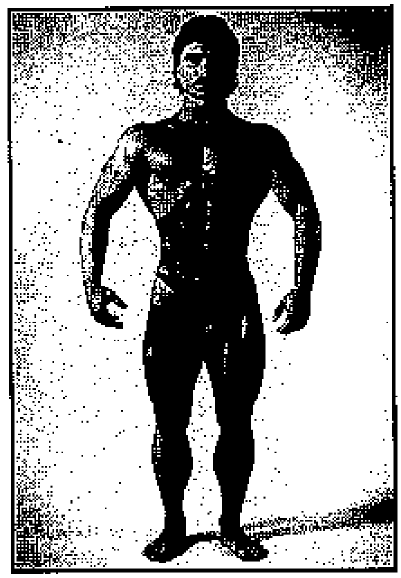
   c. **Optional poses:** Used during the comparison posing phase after the initial comparison has been completed. Selections of these poses may be used as desired by the judges.

3. **Guidance to contestants.** The poses shall be done as shown in this section, with particular attention to the requirements accompanying each photograph. (Contestants may be downrated for failure to assume the standard poses properly.) The poses should be formed by first placing the feet, and then assuming the pose as prescribed. While the focus of many of the poses is on a particular area of the body or body part, the whole body should be posed in every case. The semi-relaxed poses are meant to be semi-relaxed and not flexed, with feet flat on the floor, weight distributed evenly, posture symmetrical, and head facing forward. During the judging, contestants should generally focus their posing toward the center of the judging panel, and may rotate in place slightly in order to facilitate viewing by all judges.

SEMI-RELAXED FACING POSES

1. **Semi-relaxed front pose**

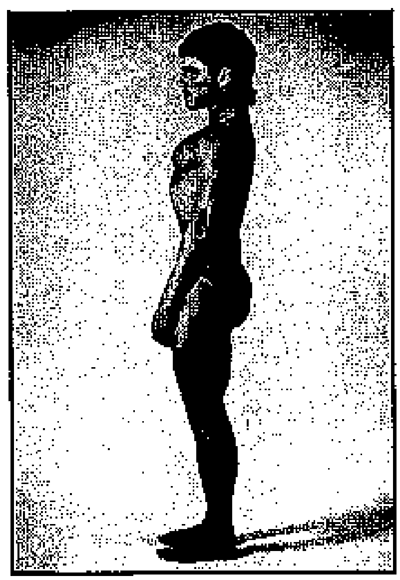
The contestant stands symmetrically, facing the judges, with both feet flat on the floor and weight distributed evenly. The arms should hang as naturally as possible at the sides.



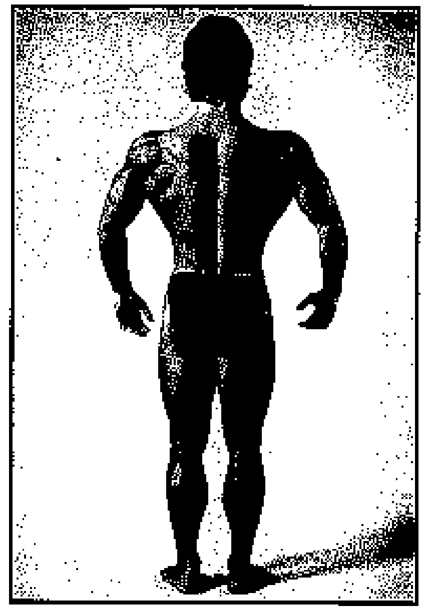
ALL PHOTOS BY J. H. RIEGER

2. **Semi-relaxed left-side pose**

The contestant stands in the same fashion as above, facing right, and exposing his/her left side to the judges. Both feet are flat on the floor. There is no twisting of the body. The contestant faces straight ahead.

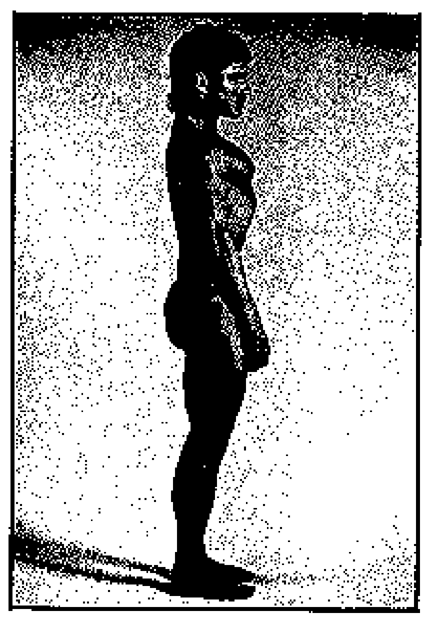


3. **Semi-relaxed back pose**



The contestant stands in the same fashion as in previous facing poses, with feet flat on floor and weight distributed evenly. The arms should hang as naturally as possible at the sides.

4. **Semi-relaxed right-side pose**

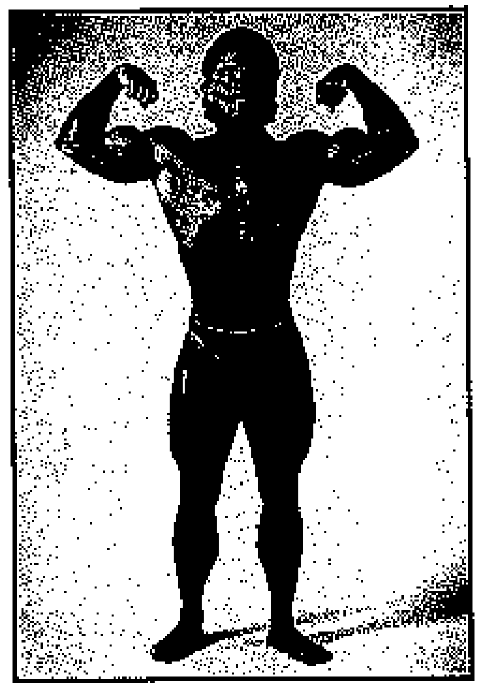


The contestant stands in the same fashion as above, facing left, and exposing his/her right side to the judges. Both feet are flat on the floor. There is no twisting of the body. The contestant faces straight ahead.

MANDATORY POSES

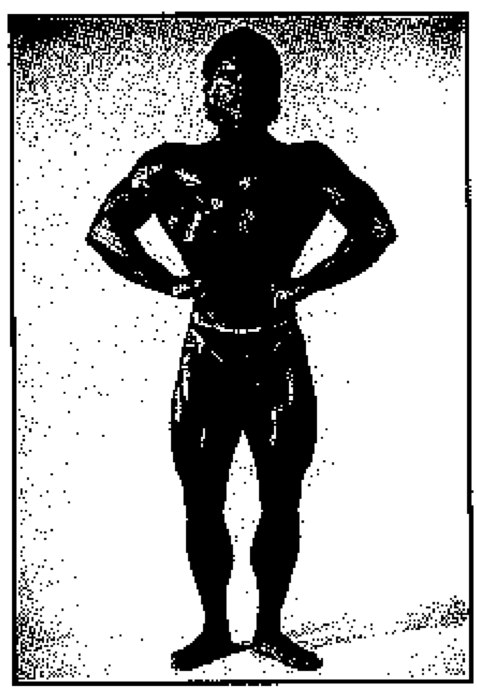
1. **Front double biceps**

The upper arms are held approximately parallel to the floor and the fists are balled. (The leg positions are not specified in this pose.)



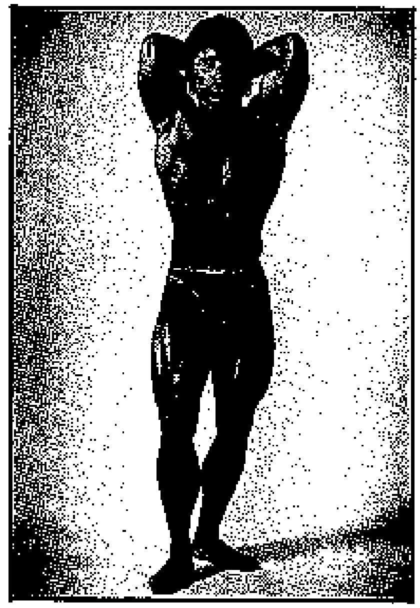
2. **Front lat spread with thighs flexed**

The heels are together, with the toes pointed out at a 45 degree angle. The legs are slightly flexed.



3. **Abdominal pose with hands behind the head**

   The torso should be symmetrical. (The leg positions are not specified in this pose.)



4. **Left-side lifted ribcage (side chest pose)**

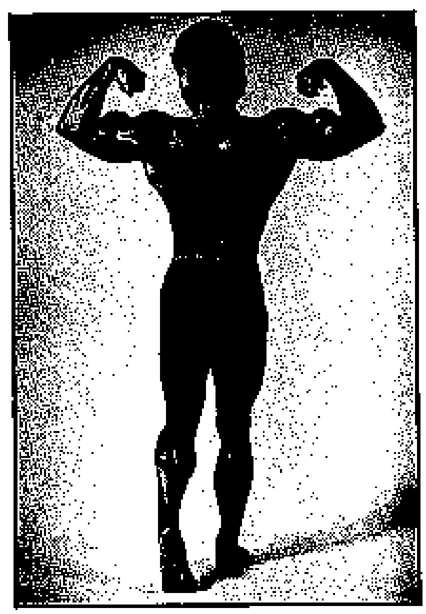
   The chest is raised. The shoulders are held at approximately even height. The left wrist is clasped with the right hand. (The leg positions are not specified in this pose.)

5. Left-side triceps pull with leg flexed to display the side of the thigh

The left arm is held straight or nearly so, and may be rotated slightly. The left wrist is held with the right hand (or the right hand may be cupped in the left). The left calf is spiked, with the toe placed at the instep of the right foot.

6. Back double biceps

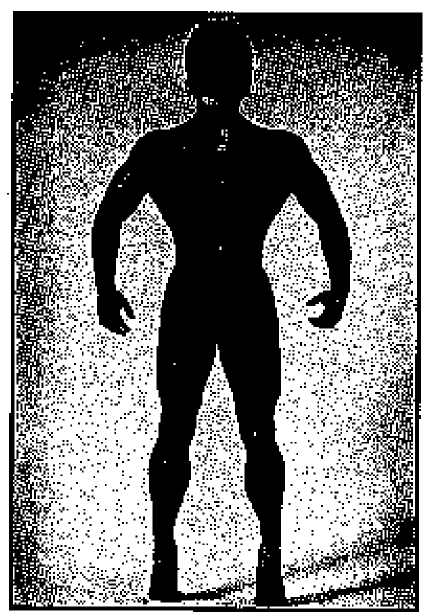
The upper arms are held approximately parallel to the floor and the fists are balled. (The leg positions are not specified in this pose.)



7. **Back lat spread**

One calf is spiked.

8. **Double calf raise**



9. Right-side lifted ribcage (side chest pose)

The chest is raised. The shoulders are held at approximately even height. The right wrist is clasped with the left hand. (The leg positions are not specified in this pose.)

10. Right-side triceps pull with leg flexed to display the side of the thigh

The right arm is held straight or nearly so, and may be rotated slightly. The right wrist is held with the left hand (or the left hand may be cupped in the right). The right calf is spiked, with the toe placed at the instep of the left foot.

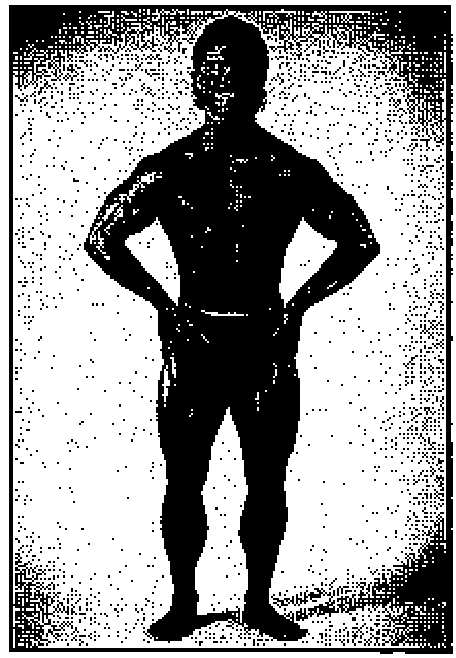
11. **Right leg display**

The right leg is extended forward, flexed, and rotated.

12. **Left leg display**

The **left** leg is extended forward, flexed, and rotated.

13. Hands-on-thighs "Most Muscular"

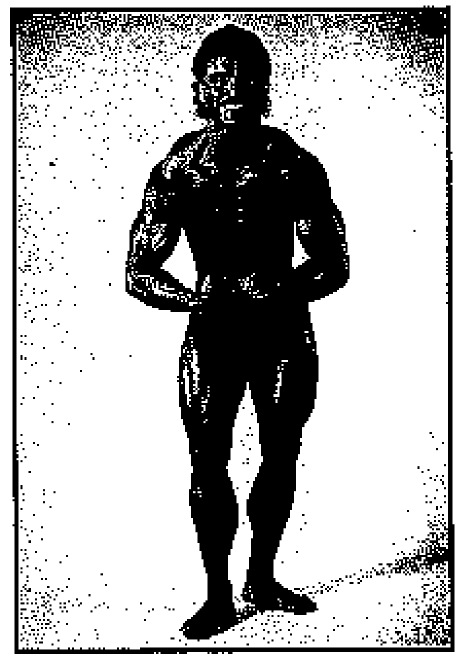


The hands are placed on the thighs (below the suit) with palms flat and thumbs forward.

OPTIONAL POSES

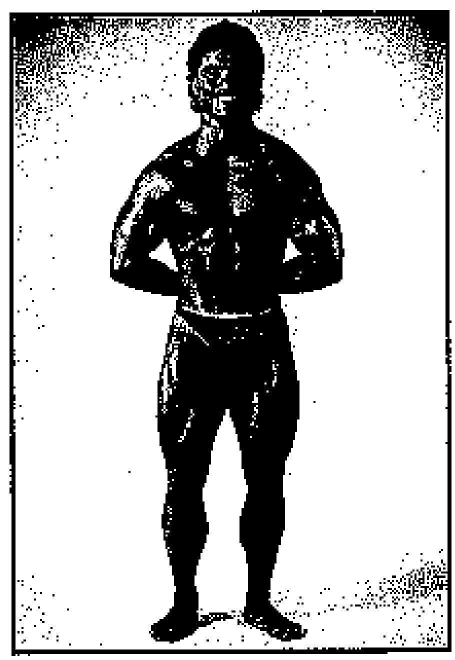
1. **Crab "Most Muscular"**

   The hands are not clasped.



2. **Hands-behind-the-back "Most Muscular"**

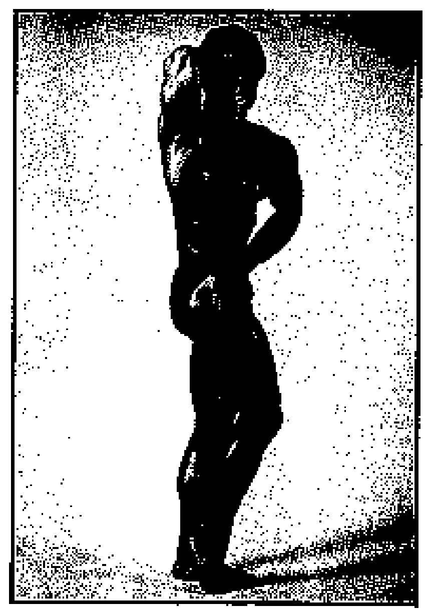
   The hands are clasped behind the back.



3. **Serratus/intercostal twisted crunch**

This view shows the pose done with the contestant facing to the right, exposing his/her left side to the judges. The left hand is placed behind the head and the right hand on the right hip. The torso is twisted slightly toward the judges.

This view shows the pose done with the contestant facing to the left, exposing his/her right side to the judges. The right hand is placed behind the head and the left hand on the left hip. The torso is twisted slightly toward the judges.



4. **Moving thigh flex**

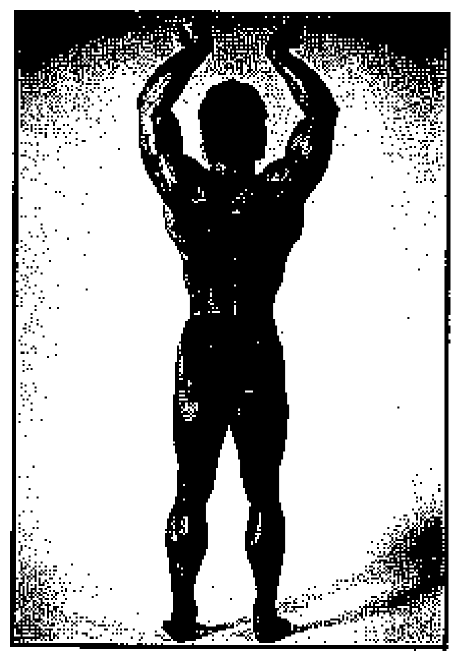
This view shows the pose done with the contestant facing to the side. (The pose can be done to either side.) The leg nearest the judges is flexed, and moved up and down to display the development of the posterior and lateral surfaces of the thigh.

This view shows the pose done with the contestant facing to the rear. (The pose can be done with either leg, and the leg to be used will be specified.) The leg is flexed, and moved up and down to display the development of the posterior surface of the thigh.

5. **Overhead victory**

This view shows the pose done with the contestant facing the judges.

The view shows the pose done with the contestant facing to the rear.



INBF BODYBUILDING JUDGING SCORE SHEET

EVENT: ______________________ DATE: __________

JUDGE'S NAME: ______________________________

DIVISION: ______________________ CLASS: __________

JUDGE'S SIGNATURE: __________________________

CONTESTANT NUMBER	SYMMETRY ROUND	MUSCULARITY ROUND	NOTES	FINAL SCORE

INDIVIDUAL JUDGES POSEDOWN SCORE SHEETS

JUDGE # ______________________

NAME ______________________

FINAL POSEDOWN – Rank Athletes 1st-4th **MEN**			
LW	MW	L-HW	HW

JUDGE # ______________________

NAME ______________________

FINAL POSEDOWN – Rank Athletes 1st-2nd **WOMEN**	
LW	HW

APPENDIX E
RAW DATA

Table 46
Trained Judges

JUDGES	1	2	3	4	5	6	7	8	9	10
Fitness										
1	1	1	1	1	1	1	1	1	1	1
Masters Women 35-39										
27	1	1	1	1	1	1	1	1	1	1
Masters Women over 40										
2	1	1	1	1	1	1	1	1	1	1
Master Men over 40										
4	3	4	4	4	4	4	4	4	3	3
5	4	2	3	3	3	3	3	3	4	4
6	2	3	2	2	2	2	2	2	2	2
7	1	1	1	1	1	1	1	1	1	1
Master Men over 50										
4	1	1	1	1	1	1	1	1	1	1
College Women										
8	1	2	2	1	2	2	2	2	2	2
9	3	3	3	3	3	3	3	3	3	3
10	1	1	1	2	1	1	1	1	1	1
college Men lightweight										
12	3	3	2	2	3	3	2	2	2	2
13	4	4	4	4	4	4	4	4	4	4
14	2	2	3	3	2	2	3	3	3	3
15	1	1	1	1	1	1	1	1	1	1
College Men Middleweight										
17	2	1	2	1	1	1	1	1	1	1
18	1	2	1	2	2	2	2	2	2	2
19	3	3	3	3	3	3	3	3	3	3
College Men Heavyweight										
22	5	5	4	4	5	4	3	5	5	4
23	4	3	3	3	3	3	4	3	3	3
24	3	4	5	5	4	5	5	4	4	5
25	1	1	2	1	1	1	1	1	2	2
26	2	2	1	2	2	2	2	2	1	1
Novice Women										
8	2	2	1	1	3	3	3	2	2	3
10	1	1	2	2	1	1	1	1	1	1
27	5	3	3	5	4	4	2	4	4	4
28	4	5	5	4	5	5	5	5	5	5
29	3	4	4	3	2	2	4	3	3	2

Table 46 Continued
Trained Judges' Rankings

Novice Men-lightweight										
5	3	2	3	3	3	2	4	4	3	4
13	1	1	2	2	2	4	2	3	1	2
17	2	3	1	1	1	1	1	1	2	1
22	4	4	4	4	4	3	3	2	4	3
Novice Men-Middleweight										
23	4	2	2	1	3	2	2	4	4	4
24	3	3	4	4	2	4	3	3	3	3
31	1	1	1	2	1	3	1	1	1	1
6	2	4	3	3	4	1	4	2	2	2
Women's Open Lightweight										
2	1	1	2	2	2	1	2	2	1	1
33	2	2	1	1	1	2	1	1	2	2
Womens Open heavyweight										
9	1	1	1	1	1	1	1	1	1	1
Men's Open Lightweight										
12	5	5	4	4	4	4	5	4	5	6
14	4	4	5	5	3	5	4	5	4	5
15	1	1	2	3	1	2	1	2	2	1
35	2	3	3	2	2	3	3	3	3	3
36	8	6	7	6	5	6	6	8	6	4
37	6	8	6	8	8	7	7	6	7	7
38	7	7	8	7	6	8	8	7	8	8
39	3	2	1	1	7	1	2	1	1	2
Men's Open Middleweight										
7	6	6	5	6	6	6	6	6	6	6
25	5	4	2	3	5	3	3	4	3	4
26	4	5	6	5	4	5	5	5	4	5
41	2	2	4	1	1	1	1	2	5	2
42	1	1	1	2	1	4	2	1	1	1
43	3	3	3	4	3	2	4	3	2	3
Men's Open Light-heavyweight										
45	2	2	1	2	2	1	1	1	1	1
46	3	3	3	3	3	3	3	3	3	3
47	1	1	2	1	1	2	2	2	2	2
Men's Open Heavyweight										
49	1	1	1	1	1	1	1	1	1	1

Table 47

Untrained Judges' Rankings

JUDGES	11	12	13	14	15	16	17	18	19	20
Fitness										
1	1	1	1		1	1	1	1	1	1
Masters Women 35-39										
27	1	1	1		1	1	1	1	1	1
Masters Women over 40										
2	1	1	1		1	1	1	1	1	1
Master Men 40-49										
4	4	4	4		4	4	4	4	4	4
5	3	3	3		3	2	3	3	3	3
6	2	2	2		2	3	2	2	1	2
7	1	1	1		1	1	1	1	2	1
Master Men over 50										
4	1	1	1		1	1	1	1	1	1
College Women										
8	2	2	2		2	2	2	2	3	2
9	3	3	3		3	3	3	3	2	3
10	1	1	1		1	1	1	1	1	1
College Men Lightweight										
12	2	3	2		2	3	2	3	3	3
13	4	4	4		4	4	4	4	4	4
14	3	2	3		3	2	3	2	2	2
15	1	1	1		1	1	1	1	1	1
College Men Middleweight										
17	1	1	1		1	2	2	2	1	1
18	2	2	2		2	1	1	1	2	2
19	3	3	3		3	3	3	3	3	3
College Men Heavyweight										
22	4	4	3		4	3	5	5	3	5
23	3	3	4		3	5	4	3	4	2
24	5	5	5		5	4	3	4	1	4
25	1	2	1		1	2	1	1	2	1
26	2	1	2		2	1	2	2	5	3
Novice Women										
8	1	3	3		5	3	2	3	3	3
10	2	1	1		1	1	1	1	2	1
27	4	5	4		2	4	5	5	4	4
28	5	4	5		4	5	4	4	5	5
29	3	2	2		3	2	3	2	1	2

Table 47 Continued
Untrained Judges' Rankings

Novice Men Lightweight									
5	2	3	4	2	4	2	4	2	1
13	4	1	3	3	1	3	1	4	4
17	1	2	1	1	2	1	2	3	2
22	3	4	2	4	3	4	3	1	3
Novice Men Heavyweight									
23	3	3	2	3	2	3	1	2	2
24	4	4	4	4	3	4	4	3	4
31	1	2	1	1	1	1	2	1	1
6	2	1	3	2	4	2	3	4	3
Women's Open									
2	2	1	2	1	1	2	1	1	2
33	1	2	1	2	2	1	2	2	1
Womens Heavyweight									
7	1	1	1	1	1	1	1	1	1
Men's Open Lightweight									
12	5	5	5	6	6	5	6	6	6
14	6	6	6	5	5	6	4	4	5
15	1	3	2	2	2	2	1	1	1
35	3	2	3	3	4	3	2	3	3
36	4	4	4	4	3	4	5	5	4
37	7	7	7	8	7	8	8	7	8
38	8	8	8	7	8	7	7	8	7
39	2	1	1	1	1	1	3	2	2
Men's Open Middleweight									
7	4	3	6	6	6	4	6	6	6
25	1	1	4	4	5	2	2	2	4
26	2	2	5	5	4	4	5	5	5
41	5	4	1	1	1	3	4	3	2
42	3	5	2	2	3	1	1	4	1
43	6	6	3	3	2	2	3	1	3
Men's Open Light-Heavyweight									
45	1	3	1	2	2	3	1	3	1
46	3	2	3	3	3	2	3	2	3
47	2	1	2	1	1	1	2	1	2
Men's Open Heavyweight									
49	1	1	1	1	1		1	1	1

Table 48

Elite Judges' Ranking

JUDGES	21	22	23	24	25
Fitness					
1	1	1	1	1	1
Masters Women's 35-39					
27	1	1	1	1	1
Masters Women over 40					
2	1	1	1	1	1
Master Men over 40					
4	4	4	3	3	3
5	3	2	4	4	4
6	2	3	2	2	2
7	1	1	1	1	1
MasterMen over 50					
4	1	1	1	1	1
College Women					
8	2	2	2	2	2
9	3	3	3	3	3
10	1	1	1	1	1
College Men Lightweight					
12	2	2	2	3	4
13	4	3	3	4	2
14	2	2	2	3	4
15	1	1	1	1	1
College Men Middleweight					
17	1	1	1	1	1
18	2	2	2	2	2
19	3	3	3	3	3
College Men Heavyweight					
22	5	5	3	5	4
23	4	3	5	4	3
24	3	4	4	3	5
25	1	2	1	2	2
26	2	1	2	1	1
Novice Women					
8	3	2	1	4	5
10	1	1	2	1	1
27	4	4	3	2	4
28	5	5	5	5	3
29	2	3	4	3	2

Table 48 Continued
Elite Judges' Ranking

	21	22	23	24	25
Novice Men Lightweight					
5	3	2	4	3	3
13	2	1	1	1	1
17	1	3	2	2	2
22	4	4	3	4	4
Novice Men Heavyweight					
23	4	2	2	4	3
24	3	3	3	3	4
31	1	1	1	1	1
6	2	4	4	2	2
Women's Open Lightweight					
2	1	1	1	1	2
33	2	2	2	2	1
Womens heavyweight					
9	1	1	1	1	1
Men's Open Lightweight					
12	4	5	3	4	6
14	5	4	5	6	5
15	2	1	1	2	1
35	3	3	2	1	2
36	6	6	6	5	4
37	7	7	8	7	7
38	8	8	7	8	8
39	1	2	4	3	2
Men's Open Middleweight					
7	5	6	6	6	6
25	4	5	4	5	4
26	6	4	5	4	5
41	1	1	1	3	1
42	2	2	2	1	3
43	3	3	3	2	2
Men's Open Light-Heavyweight					
45	1	1	2	1	1
46	3	3	3	3	3
47	2	2	1	2	2
Men's Open Heavyweight					
49	1	1	1	1	1

Table 49

Trained Judges' Rankings for Overall Placements

JUDGES	1	2	3	4	5	6	7	8	9	10
College Male Division										
15	1	1	1	1	1	1	1	1	1	1
26	2	2	2	2	2	2	2	2	2	2
17	3	3	3	3	3	3	3	3	3	3
Novice Male Divison										
13	1	2	1	1	1	2	1	2	2	2
31	2	1	2	2	2	1	2	1	1	1
Female Open Division										
2	1	1	1	1	1	1	1	1	1	1
9	2	2	2	2	2	2	2	2	2	2
Men's Open Division										
15	3	2	3	3	3	3	1	3	3	3
41	2	1	2	2	1	1	2	2	2	2
47	4	4	4	4	4	4	4	4	4	4
49	1	3	1	1	2	2	3	1	1	1

Table 50

Untrained Judges'Rankings for Overall Placements

JUDGES	11	12	13	14	15	16	17	18	19	20
College Male Division										
15			1			1	1	1	1	1
26			2			2	2	2	2	2
17			3			3	3	3	3	3
Novice Male Division										
13		1				2	2	2	2	2
31		2				1	1	1	1	1
Female Open Division										
2			1			1	1	1	2	1
9			2			2	2	2	1	2
Male Open Division										
15						4	2	3	3	
41						1	3	2	2	
47						3	4	4	1	
49						2	1	1	4	

Table 51

Elite Judges Final Rankings

JUDGES	21	22	23	24	25
College Male Division					
15	1	1	1	1	1
26	2	2	2	2	2
17	3	3	3	3	3
Novice Male Division					
13	1	1	1	1	1
31	2	2	2	2	2
Female Open Divison					
2	1	1	1	1	1
9	2	2	2	2	2
Men's Open Division					
15	2	2	2	3	3
41	1	1	1	2	1
47	4	4	4	4	4
49	3	3	3	1	2

Table 52

Athlete Numbers

Male	#		Female	#	
	1	14		1	9
	2	35		2	8
	3	49		3	27
	4	38		4	1
	5	24		5	10
	6	15		6	2
	7	23		7	33
	8	18		8	28
	9	36		9	29
	10	5			
	11	45			
	12	22			
	13	4			
	14	37			
	15	42			
	16	17			
	17	41			
	18	12			
	19	19			
	20	6			
	21	46			
	22	32			
	23	47			
	24	43			
	25	26			
	26	7			
	27	39			
	28	25 NA			
	29	26 NA			

Subjects 28 and 29 refused to give measurements

Table 53

Final Placings by Elite Judges

JUDGES	
Fitness	
1	1
Master's Women 35-39	
27	1
Master's Women over 40	
2	1
Master's Men over 40	
4	3
5	4
6	2
7	1
Master Men Over 50	
4	1
College Women	
8	2
9	3
10	1
College Men Lightweight	
12	2
13	3
14	4
15	1
College Men Middleweight	
17	1
18	2
19	3
College Heavyweight	
22	5
23	4
24	3
25	2
26	1
Novice Women	
8	3
10	1
27	4
28	5
29	2

Table 52 Continued

Novice Men Lightweight	Rankings
5	3
13	1
17	2
22	4
Novice Men Heavyweight	
23	3
24	4
31	1
6	2
Women's Open Lightweight	
2	1
33	2
Women's Open Heavyweight	
9	1
Men's Open Lightweight	
12	4
14	5
15	1
35	3
36	6
37	7
38	8
39	2
Men's Open Middle	
7	6
25	4
26	5
41	1
42	2
43	3
Men's Open Light-heavyweight	
45	1
46	3
47	2
Men's Open Heavyweight	
49	1

APPENDIX F

VITA

Rodney Gaines

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EDUCATION

Doctor of Philosophy, Education, Curriculum, and Instruction, August 2001, Virginia Polytechnic Institute and State University, Blacksburg, VA. Dissertation: Comparison of Anthropometric Measures of Competitive Bodybuilders to Judges' Scores and a Comparison of Judges' Scores, Kerry Redican, Ph.D., and Janet R. Wojcik, Ph.D., Co-Chairs

M.S. in Physical Education, emphasis in Adult Fitness and Cardiac Rehabilitation, May 1996, Virginia Polytechnic Institute and State University, Blacksburg, VA. Thesis: Effects of Velocity Specific Isokinetic Strength Training on Strength, Hypertrophy, and Cross Education, Don R. Sebolt, P.E.D, and Ronald Bos, Ph.D., Co-Chairs

B.S. in Business Finance, R.B. Pamplin College of Business, December 1989, Virginia Polytechnic Institute and State University, Blacksburg, VA

HONORS/AFFILIATIONS

Virginia Tech University Council

Virginia Tech Faculty Outreach/Residence Halls/Leadership and student development

Member of Virginia Tech Black/Faculty Caucus

United Way Corporate Chair Award-Richfood 1998

Contributing Writer, Natural Bodybuilding and Fitness Magazine

1999 WNBF Pro Mr. Universe title

World Natural Bodybuilding Federation (WNBF) Professional Athlete 1998

Excellence Award for HNFE Graduate Students-1996 (Cardiac Rehab Program)

1995 AAU Overall Mr. Virginia Bodybuilding Champion

CERTIFICATIONS/MEMBERSHIPS

1999 AFAA- Primary Aerobics Certification

1998 ACSM-Health/Fitness Instructor Certification and member

1997 NSCA-Certified Strength and Conditioning Specialist (C.S.C.S.) and member

RESEARCH INTERESTS

- Measurement, research design, and evaluation in education
- Health promotion and cost savings in the workplace
- Measurement and Evaluation of student development

TEACHING INTERESTS

- Instruct courses in research methods, measurement, and evaluation
- Instruct courses in health and sport science education

RELATED EXPERIENCE

Coordinator of Assessment/Research, University Unions and Student Activities, Virginia Tech, Blacksburg, VA July 1, 2001-Present

- Provide Leadership for assessment efforts in UUSA, Unions, Activities, Rec. Sports, and Cromwell International Center
- Conduct assessment projects and oversees assessment work done by other staff
- Acts as development officer for UUSA
- Provide support to the Assistant Vice President with planning, assessment, and Reporting efforts
- Serve as lead staff member for Comprehensive Reviews at unit and division level
- Works with other staff in Division of Student Affairs to promote assessment

Extramural Sport Club Coordinator, Department of Recreational Sports, Virginia Tech, Blacksburg, VA, July 1998-June 2001

- Managed all budget and administrative needs of Extramural Sport Clubs
- Developed an evaluation and appraisal system to promote student development
- Promoted student leadership through training, roundtable, and workshops
- Supervised a core of student officers, office assistants, and athletic trainers
- Worked in liaison with the fiscal staff to uphold all polices and procedures
- Recruit, hire, and train student office staff and athletic trainers

Personal Trainer, Fitness Connection, Blacksburg, VA, September 1998-January 2000

- Provided screenings, assessments, and periodic testing to clientele
- Instructed safe and efficient exercise prescriptions for a select clientele
- Developed exercise programs for healthy and special population

Corporate Wellness/Fitness Manager, Richfood, Inc., Richmond, VA, January 1997-July 1998

- Directed and managed the operation of a 6500sq. foot facility
- Provided exercise and wellness programs for 2500 employees
- Supervised one staff members and coordinated internships
- Assisted the department with human resource functions, application screening, recruiting and hiring

Fitness Director and Personal Trainer, American Family Fitness, Richmond, A, July 1996-July 1998

- Supervised and trained a staff of personal trainers and fitness instructors
- Developed exercise and wellness programs for the 4000 members in the club
- Marketed personal training programs to increase revenue and sales
- Assumed the duties of a personal trainer after director's work

Instructor, Graduate Teaching Assistant, Virginia Tech, Dept. of Human Nutrition, Foods, and Exercise, August 1994-May 1996

- Provided instruction in weight training and fitness to Virginia Tech Students
- Kept homework, quiz, and exam records for classroom administration
- Assessed all students in areas of strength, flexibility, and bodyfat analysis
- Lectured also on topics in wellness, nutrition, and certain areas of exercise physiology

Assistant Strength Coach, Athletic Department, Virginia Tech, May 1994-August 1995,

- Assisted with athletic screening, testing, and exercise prescription
- Checked weight equipment and cardio equipment for safety and cleanliness
- Assisted athletes with proper exercise technique and spotting
- Trained and conditioned the football, tennis, women's basketball, and baseball team at Virginia Tech

Student Fitness Manager, Department of Recreational Sports, Virginia Tech, Blacksburg, VA, August 1993-January 1994

- Recruited, hired, and trained a staff of fitness monitors
- Trained staff in areas of proper facility care, equipment inspection, and exercise prescription
- Supervised a staff of personal Trainers
- Developed the UFO or University Fitness Organization

Human Resources Coordinator, SouthTech, Inc., Tappahannock, VA, July 1990-August 1993

- Screened applications, recruited, hired, and handled new employee orientations
- Administered the 401k and life insurance plan for the company
- Served as the employee relations administrator
- Assisted with Job Analysis, Compensation surveys, and job descriptions

PRESENTATIONS:

Gaines, R., Muttech, M., Crowder, M. Presentation of a Case Study on Student Leadership and Student Inventory of Student Outcomes. NIRSA Sport Club Symposium. New Mexico, June 20, 2001, Albuquerque, New Mexico.

Gaines, R. Effective Evaluation of Student Leadership and Budgeting. NIRSA Sport Club Symposium. New Mexico, June 20, 2001, Albuquerque, New Mexico.

Gaines, R. Proper Lifting and Training Techniques for Strength Training. Fitness Expo. Virginia Tech, January 2001.

Gaines, R. Staff/student development and leadership seminar, VIRSA State Workshop, University of Virginia, September 2000.

Gaines, R. Sport Club Roundtable: Developing the Extramural Sport Club Council. VIRSA state workshop, University of Virginia, September 2000.

Gaines, R. Basics to Personal Training. Fitness Expo, Virginia Tech, McComas Hall, February 1999, Rodney Gaines

Gaines, R.Effective Evaluations and Budget System for Fund Allocations, Hyannis Massachusetts-Cape Cod, June 3-5, 1999.

Gaines, R., Sebolt, D., Bos, R., and Williams, J. Effects of Velocity Specific Isokinetic Strength Training on strength, hypertrophy, and cross education. Published abstract in Medicine Science and Sports Exercise,1996

BODYBUILDING HISTORY OF RODNEY GAINES

2002 Plan to compete in the WNBF World Championships

2001 Promoter of INBF Eastern U.S. Championship-October 20th, 2001

2001 Promoter of INBF MidAtlantic States and Collegiate Nationals Championship-April 28th

1999 WNBF Pro Mr. Universe* –Winner of Lightweight Division in Tucson, Arizona

1998 NGA Hercules International Champion*- Turned Professional in WNBF-New York City

1998 AAU Mr. America –2nd Place in Lightweight- Cocoa Beach, Florida

1995 Overall Mr. Virginia- Hampton, VA*

1995 NABBA Central Atlantic USA Champion-Richmond, VA

1993 NGA United States Championship-2nd place Light Heavyweight Division-New York City

1992 Mr. Fredericksburg Overall Winner-Fredericksburg, VA

1992 NPC Virginia States Novice Champion- Roanoke, VA

1992 AAU Neptune Classic Champion-1st place, Virginia Beach, VA

1992 AAU Mr/Ms. USA Drug Free Championships-2nd Place-Hampton, VA

1992 NGA Chiropractic Cup-2nd place Light Heavyweight-Spartansburg, SC

1992 AAU Junior Mr. America-3rd Place-San Mateo California- Medium Tall Class

1987 AAU Roanoke Valley Championships-3rd place Novice Division

*denotes overall winner