AN ANALYSIS OF SOMATOTYPES OF WRESTLERS AT VARIOUS
COMPETITION LEVELS AND WEIGHT DIVISIONS

by

John Williamson

A Thesis Submitted to the Faculty of the
DEPARTMENT OF PHYSICAL EDUCATION
In Partial Fulfillment of the Requirements
For the Degree of
MASTER OF SCIENCE
In the Graduate College
THE UNIVERSITY OF ARIZONA

1978
STATEMENT BY AUTHOR

This thesis has been submitted in partial fulfillment of requirements for an advanced degree at The University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgment of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in his judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED:

APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

PATRICIA C. FAIRCHILD
Associate Professor of
Physical Education

August 7, 1978
Date
Dedicated to my wife, Beth.
ACKNOWLEDGMENTS

The author would like to take this opportunity to express his appreciation to Dr. Patricia Fairchild, Associate Professor of Physical Education at The University of Arizona. Dr. Fairchild served as the thesis advisor and was of great help in reviewing the manuscript. Many of her comments and suggestions are incorporated in the paper.

Appreciation is extended to Dr. Richard Munroe, Associate Professor, and Dr. Jack Wilmore, Professor, who served on the thesis committee and whose advice was valuable in the completion of the study.

The author acknowledges and thanks the coaches and wrestlers of the 20 intercollegiate wrestling teams measured in the study. Their cooperation allowed this thesis to become a reality.

Finally, the author wishes to extend sincere thanks to William Nelson, wrestling coach at The University of Arizona, and Dr. Michael McCarty, Associate Professor and wrestling coach at Southwest Missouri State University. The efforts of these two aided considerably in obtaining subjects for the project.
TABLE OF CONTENTS

LIST OF TABLES .............................................. vii
LIST OF ILLUSTRATIONS ..................................... viii
ABSTRACT ....................................................... ix

1. NATURE AND SCOPE OF THE STUDY ............................ 1
   Statement of the Problem ........................................ 2
   Hypotheses ...................................................... 2
   Research Hypothesis 1 ........................................... 2
   Research Hypothesis 2 ........................................... 3
   Research Hypothesis 3 ........................................... 3
   Scope of the Study ............................................. 3
   Terminology ..................................................... 4
   Significance of the Study ..................................... 6

2. REVIEW OF LITERATURE ....................................... 8
   Brief Background of Physique Classification .................... 8
   The Heath-Carter Anthropometric Somatotyping Method .......... 11
   Validation of the Heath-Carter Somatotype Method ............. 12
   Somatotype Studies of Athletes ................................ 16
   Somatotype and Body Composition Studies of Wrestlers .......... 23
   Summary ......................................................... 31

3. DESIGN AND PROCEDURES OF THE STUDY ........................ 33
   Subjects Participating in the Study ............................. 33
   Securing Permission of the Subjects ............................ 35
   Conditions Under Which the Measurements Were Taken .......... 36
   The Heath-Carter Anthropometric Somatotyping Method .......... 36
   The First Component ............................................ 37
   The Second Component .......................................... 37
   The Third Component ............................................ 37
   Body Composition Assessment ................................... 38
   Statistical Analysis ............................................ 39
   Description of the Data ........................................ 39
   Percent Fat Compared to the First Component .................. 40
   Variance Differences Within Competition Levels ............... 40
   Physique Differences Between Competition Levels .............. 40
   Physique Differences Between Weight Groups ................... 41
   Summary ......................................................... 41
**TABLE OF CONTENTS--Continued**

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4. ANALYSIS OF THE DATA AND PRESENTATION OF THE FINDINGS</strong></td>
</tr>
<tr>
<td>Comparison of Endomorphy to Relative Fat</td>
</tr>
<tr>
<td>A Comparison of Variance from the Group Mean at Lower, Middle, and Upper Competition Levels</td>
</tr>
<tr>
<td>Endomorphy</td>
</tr>
<tr>
<td>Mesomorphy</td>
</tr>
<tr>
<td>Ectomorphy</td>
</tr>
<tr>
<td>Component Differences Between Competition Levels</td>
</tr>
<tr>
<td>Endomorphy</td>
</tr>
<tr>
<td>Mesomorphy</td>
</tr>
<tr>
<td>Ectomorphy</td>
</tr>
<tr>
<td>Somatochart Distribution by Competition Level</td>
</tr>
<tr>
<td>Component Variation at Different Weight Groups</td>
</tr>
<tr>
<td>Endomorphy</td>
</tr>
<tr>
<td>Mesomorphy</td>
</tr>
<tr>
<td>Ectomorphy</td>
</tr>
<tr>
<td>Somatochart Distribution by Weight Level</td>
</tr>
<tr>
<td>The Heavyweights</td>
</tr>
<tr>
<td>Discussion of the Findings</td>
</tr>
<tr>
<td>Comparison of Endomorphy to Percent Fat</td>
</tr>
<tr>
<td>Variance Changes Within Competition Levels</td>
</tr>
<tr>
<td>Component Changes Between Competition Levels</td>
</tr>
<tr>
<td>Component Changes Between Weight Groups</td>
</tr>
<tr>
<td>The Heavyweights</td>
</tr>
<tr>
<td>Summary</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5. SUMMARY, MAJOR FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS</strong></td>
</tr>
<tr>
<td>Summary</td>
</tr>
<tr>
<td>Major Findings</td>
</tr>
<tr>
<td>Conclusions</td>
</tr>
<tr>
<td>Recommendations for Further Study</td>
</tr>
</tbody>
</table>

| APPENDIX A: SAMPLE SUBJECT'S CONSENT FORM | 77 |
| APPENDIX B: SAMPLE SUBJECT'S UNDERWATER WEIGHING CONSENT FORM | 79 |
| APPENDIX C: SAMPLE RAW DATA FORM | 81 |
| APPENDIX D: MEANS AND STANDARD DEVIATIONS BY COMPETITION LEVEL AND WEIGHT DIVISION | 83 |
| LIST OF REFERENCES | 85 |
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rasch's ponderal indices of United States freestyle wrestlers by weight division</td>
<td>26</td>
</tr>
<tr>
<td>2. Means, standard deviations, and ranges for relative fat and the endomorphic component</td>
<td>43</td>
</tr>
<tr>
<td>3. Means, standard deviations, and ranges for body weight and absolute skinfold value</td>
<td>43</td>
</tr>
<tr>
<td>4. Mean and variance summary table by competition level</td>
<td>44</td>
</tr>
<tr>
<td>5. Test of independent variances results for endomorphy</td>
<td>45</td>
</tr>
<tr>
<td>6. Mesomorphic summary by competition level</td>
<td>46</td>
</tr>
<tr>
<td>7. Results of test of independent variances in mesomorphy</td>
<td>46</td>
</tr>
<tr>
<td>8. Ectomorphic summary by competition level</td>
<td>47</td>
</tr>
<tr>
<td>9. Results of test of independent variances in ectomorphy</td>
<td>47</td>
</tr>
<tr>
<td>10. ANOVA table for endomorphy by competition level</td>
<td>49</td>
</tr>
<tr>
<td>11. ANOVA table for mesomorphy by competition level</td>
<td>49</td>
</tr>
<tr>
<td>12. ANOVA table for ectomorphy by competition level</td>
<td>50</td>
</tr>
<tr>
<td>13. Means and standard deviations by weight group</td>
<td>55</td>
</tr>
<tr>
<td>14. ANOVA table for endomorphy by weight group</td>
<td>56</td>
</tr>
<tr>
<td>15. ANOVA table for mesomorphy by weight group</td>
<td>57</td>
</tr>
<tr>
<td>16. ANOVA table for ectomorphy by weight group</td>
<td>58</td>
</tr>
</tbody>
</table>
# LIST OF ILLUSTRATIONS

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The Heath-Carter somatochart</td>
<td>13</td>
</tr>
<tr>
<td>2.</td>
<td>Somatochart distribution of the upper competition level</td>
<td>51</td>
</tr>
<tr>
<td>3.</td>
<td>Somatochart distribution of the middle competition level</td>
<td>52</td>
</tr>
<tr>
<td>4.</td>
<td>Somatochart distribution of the lower competition level</td>
<td>53</td>
</tr>
<tr>
<td>5.</td>
<td>Somatochart distribution of competition level means</td>
<td>54</td>
</tr>
<tr>
<td>6.</td>
<td>Somatochart distribution of the lower weight group</td>
<td>60</td>
</tr>
<tr>
<td>7.</td>
<td>Somatochart distribution of the middle weight group</td>
<td>61</td>
</tr>
<tr>
<td>8.</td>
<td>Somatochart distribution of the upper weight group</td>
<td>62</td>
</tr>
<tr>
<td>9.</td>
<td>Somatochart distribution of the heavyweight division</td>
<td>63</td>
</tr>
<tr>
<td>10.</td>
<td>Somatochart distribution of weight group means</td>
<td>64</td>
</tr>
</tbody>
</table>
ABSTRACT

The purpose of this study was to determine if somatotypes of wrestlers vary between competition levels or weight divisions. A comparison was made between percent body fat and the endomorphic component. One hundred seventy-three subjects from 20 intercollegiate teams were somatotyped using the Heath-Carter method. They were divided into lower, middle, and upper competition levels and weight groups. Fourteen wrestlers were somatotyped and weighed underwater.

The Pearson correlation showed that only a moderate relationship existed between percent fat and the first component. It was also determined that skinfold totals increased with an increase in absolute body weight.

A one-factor analysis of variance and a test of independent variances determined that within-group variance for endomorphy decreases as the competition level increases. No change was found for mesomorphy and ectomorphy.

One-factor analyses of variance and multiple t tests were used to determine component differences by competition and weight levels. No differences were found in any of the components between levels of competition.

Differences in component values were found between weight levels. As the weight division became heavier, the wrestlers increased in endomorphy and mesomorphy and decreased in ectomorphy.
Wrestling has commonly been characterized as a sport in which all men or boys have an equitable opportunity for competition. Wrestling is different from most other sports in that it supposedly pitches boys of equal size and weight against each other.

Most studies involving wrestling have looked at the physique or body composition of individual champions (Hirata, 1966) or have lumped all the weight divisions together to arrive at a mean weight for all wrestlers (Medved, 1966; Carter, 1970). These studies have not investigated differences between weight divisions or levels of competition. Important physical characteristics may be averaged out in such studies. Simply giving the average physique and body composition of champions does not show what sets them apart from the average athlete.

Carter (1970, p. 535) posed the questions:

Are there differences in physique at levels of competition within a sport? What particular sports and what modifying factors within sports are selective in regard to physique? If physique and physical performance are related, at what level of competition does this selective factor become apparent?

In wrestling both level of competition and weight division are important. To date, no study has been attempted to determine the relationship between somatotype and weight division. In sports such as football and basketball there is no restriction to size. Success may be related to a size or weight advantage. Wrestling is different in that any
differences in physique must take place within a restricted weight allowance. Increased size in wrestling simply puts the wrestler into a larger weight division against larger opponents. The advantage of increased size is therefore lost.

**Statement of the Problem**

The present study was undertaken to examine similarities and differences between group body types with respect to competition level and weight division. Specifically, the study sought to determine whether the mean somatotype and variance from that somatotype differed between lower, middle and upper competition levels in wrestling. Also, the study attempted to determine if mean somatotypes varied between lower, middle and upper weight divisions.

A third purpose of the study was to compare the Heath-Carter first component with lean body weight as determined by hydrostatic weighing. An attempt was made to determine if body size affected relative fat as measured by the endomorphic component.

**Hypotheses**

For the purposes of the present study the following hypotheses were formulated:

**Research Hypothesis 1**

Somatotypes of wrestlers at higher competition levels will show less variance from the mean than those at lower levels of competition.

H0: Only chance differences will be found in variance from the mean at different competition levels.
Research Hypothesis 2

As the level of competition increases the endomorphic component will decrease, the mesomorphic component will increase, and the ectomorphic component will remain stable.

Ho2. Only chance differences will be found between component ratings at various levels of competition.

Research Hypothesis 3

As the weight division increases the endomorphic and mesomorphic components will increase, while the ectomorphic component will decrease.

Ho3. Only chance differences will be found between component ratings at various weight divisions.

Scope of the Study

This study was designed to include three levels of competition designated as lower, middle, and upper levels. Competition level was established as being the caliber of competition faced by the wrestler on a regular basis. Such factors as size of the institution, number of scholarships, and national versus regional competition were taken into consideration. In no way were the abilities of any single performer taken into consideration. However, only the varsity competitors at each institution were measured, thereby eliminating the variable of some coaches maintaining squads of many lower level performers not representative of the competition level.

Representing the highest level of competition were the varsity squads of the Western Athletic Conference (WAC). These were all NCAA Division I teams. The NCAA Division I is the highest level of
collegiate competition in the United States. Twenty-five wrestlers can qualify through the WAC tournament for the NCAA Division I championships.

The intermediate level of competition was represented by the varsity teams of the Missouri Intercollegiate Athletic Association (MIAA). These were all NCAA Division II teams. Conference restrictions allowed fewer scholarships. Qualification to the NCAA Division II tournament was through the MIAA tournament. The NCAA Division II tournament qualifies only two wrestlers in each weight for the Division I nationals. No MIAA wrestler qualified for the Division I tournament.

The lower level of competition was represented by the varsity teams of seven junior colleges in Missouri and Arizona. These teams are usually recruited locally and compete against other junior colleges and junior varsities of four year institutions.

Care should be taken in the generalization of the findings. A possibility exists that physique differences or similarities may be due to recruiting preferences of coaches or the type of conditioning used in a certain region.

Terminology

Terms used throughout this study were defined as follows:

1. **Competition Level.** This was defined as the caliber of competition faced by the performer on a regular basis.

2. **Lower Competition Level.** Wrestlers at this level were varsity performers on seven junior college teams. These teams competed predominantly against other junior college teams and junior
varsity squads of four year institutions. Qualification for the National Junior College Athletic Association tournament (NJCAA) was through regional and district junior college tournaments.

3. **Lower Weight Group.** This classification was composed of the first three intercollegiate wrestling weight divisions: 118, 126, and 134 lbs.

4. **Middle Competition Level.** Wrestlers at this competition level were varsity performers on MIAA teams. These teams competed predominantly against other NCAA Division II teams and qualified for the NCAA Division II tournament through the MIAA championships. The top two finishers from the Division II tournament qualify to the Division I championships.

5. **Middle Weight Group.** This classification was composed of the second three intercollegiate wrestling weight divisions: 142, 150, and 158 lbs.

6. **Upper Competition Level.** Wrestlers at this competition level were varsity performers on WAC teams. These athletes competed predominantly against NCAA Division I teams and qualified through the WAC tournament for the NCAA Division I championships.

7. **Upper Weight Group.** This classification was composed of the 167, 177, and 190 lb. intercollegiate wrestling weight divisions. Because of distortion due to extreme ratings, heavyweights were not included in this group.

8. **Weight Divisions.** This term was used in reference to the ten intercollegiate weight classifications: 118, 126, 134, 142,
150, 158, 167, 177, 190 lbs. and heavyweight.

9. **Weight Group.** For the purposes of analysis the individual weight divisions were placed into larger categories. These categories were the lower, middle, and upper weight groups. Intercollegiate rules place no maximum weight on the heavyweight division, thereby allowing extreme physiques. Due to possible distortion caused by extreme ratings the heavyweight division was analyzed separately.

**Significance of the Study**

It has been demonstrated in many studies that physique has a bearing on success in certain sports. This is particularly true in sports such as football and basketball where size is unrestricted. However in wrestling, size is restricted in that a wrestler will compete against an opponent approximately his own weight. Any gain in size will place the wrestler into a larger weight division against a larger opponent. This neutralizes any advantage gained by the increased size. As in other sports, body type may be a factor contributing to success. However, any change in physique must take place within a restricted pound allowance. Most earlier studies dealt with wrestling only to compare it to other sports. The weight divisions were not considered, and an average value was given to represent the body type of wrestlers. This "wrestlers body type" may not hold true throughout the lower, middle and upper weight divisions.

Earlier studies have indicated that variation from the ideal physique for a given sport diminishes as the competitiveness increases.
However, no research on wrestlers has cut across several competition levels to investigate this reduction in variance.

This study is concerned with comparisons of physiques within the sport of wrestling. To date, no studies have attempted to determine the similarities and differences of body types among wrestlers at various competition levels and weight divisions.
CHAPTER 2

REVIEW OF LITERATURE

A review of literature pertinent to this study is presented in this chapter. A brief background on the development of somatotyping systems is presented along with a discussion of the development and validation of the Heath-Carter Anthropometric Somatotype Method. Due to the lack of somatotyping studies on wrestlers, some studies involving other sports are presented to outline the use of somatotyping in the past.

**Brief Background of Physique Classification**

Classification of the body into descriptive categories is thousands of years old. A brief outline of past procedures as related to the methods of somatology today can provide some perspective.

Early proponents of physique typing and many somatologists of today have maintained that physique and personality are interrelated. Around 400 B.C. Hippocrates, the Greek Father of Medicine, decided that the human form could be divided into two categories. Hippocrates named them *phthisic habitus* and *apoplectic habitus*. The *phthisic habitus* tended to have a long thin, body dominated by the vertical plane and was thought to be susceptible to *phthisis* or tuberculosis. The *apoplectic habitus* was a more ponderous and thick person, dominated by the horizontal plane, and thought predisposed to apoplexy.
In 1828 Rostan (as cited in Sheldon, Stevens, and Tucker, 1940) described three major kinds of human constitution. The forms were named according to the supposed dominance of the digestive system, muscles, or brain and were called \textit{type digestif}, \textit{type musculaire}, and \textit{type cerebral}, respectively.

Around the year 1869 body typing became greatly intertwined with personality and attempts to describe personality. Samuel Wells (as cited in Sheldon et al., 1940) divided the body into three areas of dominance. These three areas were the Motive or Mechanical system, the Vital or Nutritive system, and the Mental or Nervous system. Temperament was supposedly determined by the predominance of one of these systems.

In the early twentieth century Viola (as cited in Sheldon et al., 1940), using information from his earlier anthropometric studies, also decided the human form could be divided into three morphological types: microsplanchnic, normosplanchnic, and macrosplanchnic. The microsplanchnic was the same as Hippocrates' old \textit{phthisic habitus}, and the macrosplanchnic was the same as the \textit{apoplectic habitus}. The normosplanchnic was an intermediary between the two. Unfortunately, no distinction was made between fat and muscle as Rostan and Wells had done. Viola (as cited in Sheldon et al., 1940), and later, his colleague Naccarati (as cited in Sheldon et al., 1940) were some of the first to differentiate body types through the use of anthropometric measurements.

In 1936 Kretchmer (as cited in Sheldon et al., 1940) reinstated the musculeary dominated body type and called it the athletic type.
For the linear and ponderous physiques he used the Greek words **pyknic** meaning "compact" and **asthenic** meaning "without strength."

These early classifications of physique had some major problems. It was thought that the physique was either **pyknic**, athletic, or **asthenic**. The person was one of the three. The concept of components for each type of physique was not postulated until Sheldon, Stevens, and Tucker (1940) described the method that provided the ground work for the systems used today.

Sheldon et al. (1940) used the concept of three major morphological classifications. These were termed endomorphy, mesomorphy, and ectomorphy because of their supposed evolution from the endodermal, ectodermal, and mesodermal layers of tissue found in the embryo. Endomorphy was characterized by what Sheldon called a "soft roundness and predominance of the absorptive tissues, digestion, over the energy expenditure functions" (Sheldon et al., 1940, p. 37). Mesomorphy indicated a "square hardness of the body with prominent bones and massive muscling" (Sheldon et al., 1940, p. 39). The third term, ectomorphy, denoted a "linearity, fragility, and delicacy of the body" (Sheldon et al., 1940, p. 42).

The uniqueness of this system was that a person possessed all three components to varying degrees. Each component was rated on a closed scale of one (low in quality) through seven (high in quality). Ratings were done photoscopically in a subjective setting by experts experienced in the Sheldon method. An extreme endomorph would be rated 711 while an extreme mesomorph and an extreme ectomorph would be rated 171 and 117, respectively.
Sheldon developed his procedure mainly for psychological use. Yet, it proved useful for physique classification in other disciplines. Many of the earlier studies (Cureton, 1951; Kroll, 1954; and Tanner, 1964) of the body structure of athletes used Sheldon's technique.

In 1963, Heath published a paper citing the need for an improved somatotyping method. She emphasized that a more objective procedure should be adopted. Heath questioned Sheldon's concept of a person having a permanent somatotype throughout his life. Thirdly, Heath questioned the use of closed rating scales.

A comparison of somatotype methods then in use was published by Heath and Carter (1966). A year later a new method of somatotyping was proposed (Heath and Carter, 1967). The new method contained many of the original ideas of the Sheldon procedure but was changed to allow objective ratings through anthropometric measurement. Also adopted was an open-ended scale allowing for extreme ratings.

**The Heath-Carter Anthropometric Somatotyping Method**

The Heath-Carter method developed in 1967 can be used anthropometrically or in combination with photoscopic evaluation. The method allows researchers skilled in performing anthropometric measurements to conduct studies involving somatology.

A somatotype is defined as a "description of present morphological configuration" (Carter, 1972, p. 1). The somatotype is expressed by a series of three numbers denoting endomorphy, mesomorphy, and ectomorphy in that order. The larger the number the more dominant the component.
The first component endomorphy is no longer defined as a "soft roundness" or "dominance of the absorptive function" (Sheldon et al., 1940, p. 37), but is now referred to as relative fatness if the component is high or relative leanness if the component is low.

The second component mesomorphy is described as the relative musculoskeletal development with respect to height. This component concerns itself with the dominance of the muscle, bone, and connective tissue of the body.

The third component ectomorphy denotes linearity. If the ectomorphic component is high, it indicates an absence of tissue rather than a dominance. This component is calculated as the height divided by the cube root of the weight and, like the other components, is determined by the use of constructed rating scales on a rating form.

The rating scales theoretically begin at zero and have no arbitrary end point. Low and high extremes of each component provide the actual range possible. The somatotype rating can be compared to other ratings on a tri-axial somatochart. Various physiques are located at different areas of the somatochart. Figure 1 is a somatochart. Distance away from or toward the corners representing the three components can be used to compare physiques.

Validation of the Heath-Carter Somatotype Method

When Heath and Carter first presented their system in 1967, they tested 844 male and female subjects. Validation of the first component was shown by a .90 to .96 Pearson correlation between the skinfold measures with constructed scales and the photoscopic ratings conducted by
Figure 1. The Heath-Carter somatochart
Heath. The scales were adjusted so that anthropometric rating would produce results similar to those of photoscopic ratings.

The second component was also validated by comparing Heath's evaluation to ratings obtained by circumferences and diameters. The relationship was not as high as with endomorphy. The mesomorphic scale did agree with Heath's ratings to a greater degree than other somatotyping methods then in use.

The third component expressed a relationship between height and weight. The value obtained by dividing the cube root of the weight into the height was termed the ponderal index, later termed the height-weight index. The height-weight index was compared to standard scales which were regression lines for predicting the ectomorphic rating. The third component correlated .91 with Heath when somatotype ratings varied between .5 and 6 units.

The Heath-Carter system was compared to a system very much like Sheldon's. The scales were constructed so that anthropometric and photoscopic assessment would be in agreement. Definitions in the systems used terms like "relative fatness" and "relative musculoskeletal development" (Carter, 1972). These references drew some criticism.

Wilmore (1970) believed that linking relative fat to the first component could be useful in assessing physique. Though he thought the use of relative fat an advantage to somatotyping he doubted its validity in the Heath-Carter system. Wilmore obtained the percent fat and lean body weight of 261 males and females through hydrostatic weighing and compared them to rated endomorphic and mesomorphic components. He found a relationship of only .58 for women and .72 for men between percent fat
and the F scale. Even lower correlations were found between lean body weight and the M scale. Wilmore also found a high degree of relationship between the two components and suggested a lack of discrimination.

Slaughter and Lohman (1976) compared somatotype rating with potassium 40 counting and underwater weighing methods of obtaining body composition. Slaughter and Lohman pointed out that the Heath and Carter method does not only attempt to describe body composition but morphology as well. Both of these factors should be taken into consideration when investigating relationships between component ratings and body composition. All the variance seen in somatotype could not be accounted for in body composition alone. The first component was found to be significantly related to weight and body fatness when these factors were considered together. Slaughter and Lohman, like Wilmore, found that lean body mass, whether relative or absolute, was not highly related to mesomorphy when considered alone. However, when predicting the second component considering lean body mass and height, the coefficient of determination for mesomorphy was 61%. This coefficient of determination increased to 72% when lean body mass, height, and weight were combined for prediction. Slaughter and Lohman stated that Wilmore had, "interpreted Heath and Carter's second component incorrectly when he tried to validate it through the use of absolute weight and lean body mass" (Slaughter and Lohman, 1976, p. 768).

Slaughter, Lohman, and Boileau (1977) studied the relationship between Heath and Carter's second component and lean body mass and height in college-age women. Again, potassium 40 counting and density were used to determine body composition. Using height, weight, and the
M scales, they found that lean body mass could be predicted within 2.2 kilograms. It was stated that this error was comparable to other anthropometric predictions of lean body mass in college women.

Somatotype Studies of Athletes

Somatotypes are useful for obtaining a general classification of physique for the body. Many other techniques are more useful and yield more information on such things as relative fat and lean body mass. However, the somatotype is a useful tool for summarizing the general morphology of the body.

Of major interest to researchers is the relationship between the body's structure and its function. Carter pointed out that, "Competitive sport demands the utmost from the body and it is therefore reasonable to expect to find in athletes a demonstration of the relationship between structure and function" (Carter, 1970, p. 535). Carter emphasized that sports were convenient to the researcher because clearly defined measures of success and level of competition were present. The person who succeeds according to the criteria of his sport can be seen as a champion, and the study of this type of athlete can provide researchers with information on the structural requirements needed to succeed. Another factor to consider was that champion athletes represent the extremes of performance of a population.

Tanner (1964) defended the use of athletes as subjects for the human biologist. Tanner's study dealt with 1960 Olympic games athletes and athletes from the 1958 British Commonwealth games. His rationale for studying Olympic athletes was that they represented extreme cases.
Tanner, like Carter, maintained that the extremes of performance would yield information of the relationship of structure and function. Tanner emphasized the need for compiling data on the athletes of today for use in the future. He pointed to the fact that little usable information on the body composition and physique of past Olympians is available to allow the charting of changes of athletes and sport.

DeGaray, Levine, and Carter (1974), in their study of 1968 Olympians, said that the defined tasks and the outstanding performers would give an estimate of what the appropriate body structure for maximum performance could be. They explained that the participants represented an elite group and that the tasks were standardized, thereby allowing greater opportunity to isolate structure and function. The study was one of the first to utilize the Heath-Carter method.

Carter (1970) posed the question of whether or not physique is a determinant of success in athletics. He asked whether or not there were differences in physique between sports or differences between levels of competition within a single sport.

Athletes tend to have a different distribution of body builds on the somatochart when compared to non-athletes. The distribution of the general population spreads evenly across the entire chart while the somatotypes of the athletes tend to gather in the upper portion of the chart (Tanner, 1964; Carter, 1970; deGaray et al., 1974). Tanner depicted the Olympic games as largely a "festival of persons in the northeastern half of the somatotype distribution" (Tanner, 1964, p. 41). Tanner's 137 track and field athletes were all mesomorphic ectomorphs, ectomorphic mesomorphs, endomorphic mesomorphs, or balanced mesomorphs.
He summarized that only half the somatotypes found in the general population were represented in the Olympic games.

DeGaray et al. (1974) found a similar difference in distribution among the athletes in the 1968 Olympics. When the average somatotype for each sport was calculated and plotted on the somatochart, the distribution was limited to only endomorphic mesomorph, balanced mesomorph, and ectomorphic mesomorph sections of the chart.

In a study conducted by Falls and Humphrey (1978) AIAW female gymnasts were shown to have somatotypes significantly different from non-athletes. The gymnasts also had significantly lower fat ratings than non-athletes. Sinning et al. (1977) found Nordic skiers significantly different from non-athletes as did Carter (1968) with college football players. Athletes at fairly high levels of competition appear to differ in somatotype from the average population.

Studies have also shown that athletes differ among themselves between sports. Carter (1970) asked the questions, "How does training for the sport influence physique?", and, "What particular sports and what modifying factors within the sport are selective with regard to physique?" When comparing studies of the physique of athletes one must remember that the techniques used for assessing body build may differ.

In 1929 Kohlraush (as cited in Cureton, 1951) measured 300 athletes at the 1928 Olympic games in Amsterdam for such things as height, weight, vital capacity, thorax circumference, upper arm circumference, calf circumference, and several ratios. Statistical analysis was limited, but it did indicate body differences between some events.
In 1931 Arnold (as cited in Cureton, 1951) divided athletes into three physique types. The "gymnastics type" possessed a relatively long hulk compared to breadth which gave the body a linear aspect. On the other hand, the "wrestling type" was a "mighty form with great breadth of shoulders combined with great breadth and depth of chest" (Cureton, 1951, p. 12). The "pentathlon type" was a medium to slender type with relatively longer legs and less breadth than other types. Most of Arnold's conclusions seem to be of a subjective nature and little factual evidence was presented.

Cureton (1951) was one of the first researchers to use the somatotype as a tool to determine physique of athletes. He emphasized that the body builds of athletes are specific to the sports in which they participate. He also, like Arnold, specified physique types among athletes. One of these was the "wrestling and weight lifting type". Cureton utilized the Sheldon, Stevens, and Tucker method of somatotyping.

In 1964 Correnti and Zauli (as cited in deGaray et al., 1974), studied swimmers and track and field athletes at the 1960 Olympics in Rome. They observed that age, height, and weight varies between different events. Within certain events body shape is similar, but the size varies. Compared with earlier studies of the same events, the body sizes had increased in dimension but not in proportion.

Tanner (1964) also studied track and field athletes at the Rome Olympics and found physique differences between performers of various events. Care must be taken when comparing the similar results of Correnti and Zauli (as cited in deGaray et al., 1974) and Tanner (1964).
There was an overlap of 79 subjects between the two studies. Tanner showed that it is erroneous to talk about an average body type of track and field performers. Each event is dominated by participants of a homogenous physique. Though some overlapping does occur, the body builds are quite different and the mean may not be representative of any single event. It was also found that certain dimensions of physique discriminate by event to a greater degree than others. Tanner compared the Olympians in his research with those of Kohlraush (as cited in Cureton, 1951) and found that while the relative dimensions remain the same, the body size of the athletes had increased.

Medved (1966) researched body height as a predisposition for certain sports. He took athletes in many sports and averaged his data by sport. It was found that differences did exist between sports with respect to height. Basketball and volleyball players are tall while wrestlers, boxers, and gymnasts are shorter than average.

Hirata (1966) researched athletes at the 1964 Olympic games in Tokyo to determine differences in physique and age. Hirata was recording age, height, and weight. Taking the height and weight he computed a "stout lean index" or what he called an F ratio. Hirata calculated the F ratio as 1000 multiplied by the cube root of the quantity weight divided by height. A value above 24 was considered stout while a value below 22 was considered lean. Unfortunately, this was simply a modified ponderal index and in no way took body composition into account. No distinction was made between fat and lean body weight. Hirata did find differences in the F ratio between performers in various sports. Hirata also found that physiques of the athletes from the various nations
entered in the games differed. He concluded that for a smaller nation to be competitive in the games, they should specialize in sports that require body builds common to their athletes.

Novak, Hyatt, and Alexander summarized the literature by stating, "It seems that each type of physical activity with its demand for certain types of physical performance may modify the body composition of the athletes to what is suitable or adequate for such activity" (1968, p. 766). Novak supported his conclusion by looking at the similarities and differences of football players by position. Large differences in body composition were found in players at different positions.

Carter (1968) also studied football players, but he used a somatotyping system. His findings indicated differences in size and somatotype between players of different positions. He also noted that differences occurred at different levels of play. He found that somatotypes rare in the average population were common on football teams. The extreme endomorphic mesomorph was the dominant somatotype on the studied team.

Considerable evidence exists that athletes in different sports or specialties within the sport have distinct body builds. Novak et al. (1968) mentioned modification of the body composition as a result of training for a specific sport. DeGaray et al. (1974) found great differences between somatotypes of performers of different events. Do athletes gravitate to various sports according to their body build, or are inappropriate physiques weeded out as the level of competition increases? Carter (1970, p. 535) asked the question, "If physique and athletic performance are related, at what level does this selective
factor become recognizable?" Carter also pointed out that "Almost anyone can play sandlot football. However, as the player progresses through junior league, high school, college, and professional football certain physical, personal and performance requirements become paramount" (Carter, 1968, p. 476).

Few studies have dealt with the physiques of athletes with respect to level of competition. Most of those attempted have dealt with champion teams or individuals compared to "average" performers. Few studies have been attempted on entire stratas of competition such as professional football versus semi-pro or major league baseball compared to the minor leagues. When comparing high school, college, and professional sports, age, differences, and maturity can cloud the comparison.

Falls and Humphrey (1978) compared AIAW tournament placers with non-placers and non-athletes. Both somatotype and body composition were assessed. The results of the place winners, concerning somatotype, were consistent with results of studies on national and world champion gymnasts. However, there was a greater variability about the mean among the AIAW placers in somatotype than in national and world champion gymnasts. No significant difference was found between placers and non-placers with respect to somatotype.

Alexander (1976) attempted to determine if selected anthropometric measures or somatotype had effect on performance in highly skilled female basketball players. Somatotypes were not found related to performance, but body size and height were. Alexander's study showed that the top ten players were significantly larger than the remaining
players in humeral diameter, biceps girth, calf girth, height, and weight.

Almost all the studies presented contained subjects performing at high levels of competition. The groups tended to be quite homogeneous within the performance specialty. Carter (1970) stated that the champion athletes at various levels of a particular sport exhibit similar patterns of body size and somatotype, with patterns tending to become narrower as the level of performance increases.

Somatotype and Body Composition Studies of Wrestlers

Physique studies on wrestlers have been few. Most of the earlier studies attempted to study wrestling like other sports and did not take weight divisions into account. Wrestling and sports like boxing and judo are unique in that the athletes compete within specified weight divisions. A wrestler can be a champion or outstanding performer at 118 pounds, at 190 pounds, or heavyweight. However, few 118 pound wrestlers look like heavyweights in either size or relative physique. Medved (1966) reported that the average wrestler was 170.95 cm. tall, which placed him 3.8 cm. shorter than the average athlete. It is doubtful whether the average 118, 126, or 134 pound wrestler is 170.95 cm. tall. Medved grouped all the weight divisions together and came up with an average not representative of large and small weight division wrestlers. Kroll (1954) also did this, except he studied somatotype and various anthropometric measures as well. He concluded that the average Big Ten wrestler possessed a 2.7-5.0-3.8 somatotype, was 174.8 cm. tall, and weighed 73.1 kg. Again, this may be unrepresentative for the 50
or 100 kg. wrestler. Somatotyping reduces size to relative terms, but there is no reason to believe that the somatotypes of wrestlers will be the same through the lower, middle, and upper weight divisions.

The sport of wrestling has changed considerably through the years and most likely the "physique prototype" has also changed. Kohlraush (as cited in deGaray et al., 1974) and Arnold (as cited in Cureton, 1951) characterized the wrestler as an athlete possessing brute strength. They picturied the average wrestler as being short legged and massively muscled, ideal for a "stationary" sport like wrestling. The sport as it is conducted today could hardly be called stationary.

In 1933 Boardman (as cited in Cureton, 1951) maintained that wrestlers, football players, and weight lifters possessed physiques with "short necks, powerful shoulders, wide trunks, and short legs" (Cureton, 1951, p. 12). In 1931 Arnold (as cited in Cureton, 1951) decided there were three basic body builds in athletics, and the "wrestling type" was one of them. He described the type as "mighty forms with great breadth of shoulders coupled with great depth and depth of chest."

Cureton (1951), like Arnold, thought that athletes could be divided into physique types. One of these was the "gymnastic-wrestling" type. They were characterized as having a medial build found on a scale between the "jumping (agility) type" and the "weight throwing type" (1951, p. 13).

Kroll (1954) conducted the first research on United States collegiate wrestlers using somatotype methods. Kroll used the Sheldon, Stevens, and Tucker method. Kroll's results showed that the average
wrestler was 174.8 cm. tall and weighed 73.1 kg, with a somatotype of 2.7 - 5.0 - 3.8. The ectomorphic rating of 3.8 would change to a rating of 2.5 using the ponderal index method of the Heath-Carter system. The application of the Heath-Carter method would make the average wrestler in Kroll's study a balanced mesomorph. Kroll's results show a physique considerably different from those depicted by Kohlraush and Arnold. Kroll concluded that the average collegiate wrestler possessed body type characteristics like those of agility athletes.

Rasch (1958) compared United States freestyle wrestlers to non-wrestlers and found no marked differences in body build. However, Rasch merely measured ponderal indices and then calculated an average index by combining all the weight divisions. This average index is what he compared to the general population. Simply using a ponderal index is not very informative, does not give any information on body composition, and should not be used alone to describe body build. Though Rasch did not mention it in his paper, it can be seen by looking at the average ponderal index for each weight division that differences occur. The average ponderal index decreased as the weight division increased. On the Heath-Carter third component scale this drop in ponderal index would decrease the ectomorphic component from 3.5 for the 114.5 pound division to 0.5 for the heavyweight division (see Table 1).

Rasch (1959) showed that wrestlers did not deviate from the population norm in density and, therefore, percent fat and lean body weight. The study is of doubtful validity because of the method used to find density. Rasch used the formula:
Table 1. Rasch's ponderal indices of United States freestyle wrestlers by weight division

<table>
<thead>
<tr>
<th>Weight Division</th>
<th>Ponderal Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>114.5</td>
<td>13.2</td>
</tr>
<tr>
<td>125.5</td>
<td>13.0</td>
</tr>
<tr>
<td>136.5</td>
<td>12.9</td>
</tr>
<tr>
<td>147.5</td>
<td>12.9</td>
</tr>
<tr>
<td>160.5</td>
<td>12.6</td>
</tr>
<tr>
<td>174.5</td>
<td>12.8</td>
</tr>
<tr>
<td>191.0</td>
<td>12.5</td>
</tr>
<tr>
<td>Hwt.</td>
<td>11.9</td>
</tr>
</tbody>
</table>

\[ \log \text{Specific Gravity} = 0.8 \frac{\text{ht. cm.}}{\text{wt. g.}} + 0.162 \]

Actually the formula expressed only a relationship between height and weight without taking endomorphy or mesomorphy into account. Rasch concluded that a, "provision must be made for the inclusion of a somatotype" (1959, p. 93).

Rasch (1964) summarized his research and the research of Cureton and Kroll to conclude that the successful amateur wrestler was not characterized by a highly mesomorphic build. Rasch stated that the wrestler differed little from the average American male and that in wrestling, body types capable of agility were preferable to those with brute strength.
Tanner's (1964) study, as mentioned previously, was predominantly concerned with track and field athletes. For purposes of comparison Tanner somatotyped wrestlers and weight lifters at the 1958 British Commonwealth games at Cardiff. He was surprised to find that the somatotype distribution of wrestlers completely overlapped that of Olympic sprinters. It was said that wrestlers could be distinguished from sprinters, "only by the state of their ears" (Tanner, 1964, p. 49). All the wrestlers somatotyped were either endomorphic mesomorph, balanced mesomorphs, or ectomorphic mesomorph. Contrary to studies by Rasch, the distribution in no way resembled one of the general population. Tanner noted that wrestlers were not very well represented in his study. He summarized that wrestlers appeared to have body proportions that range between weight lifters and 100 meter runners. He also observed that the bones and muscles in the arms were large in relation to the legs. This was not as pronounced in the wrestlers as in the weight lifters.

As mentioned earlier, Medved (1966) sought to find if various sports showed differences in height. He found that wrestlers were significantly shorter than the average athlete. Weight divisions should be taken into consideration here. Height may be necessary to success in some sports, but height is linked to size and increased size in wrestling puts the wrestler into a larger weight division against larger opponents. Little advantage is gained by increased height or size. The average height of wrestlers will usually be approximately 170 cm. and the average weight will be approximately 72 kg. This is simply an average of the weight divisions skewed upwards because no limits are placed on the heavyweights. It is doubtful that the average wrestler will be
significantly shorter than a population of his weight. Since wrestlers almost always gather at the upper limits of the weight divisions, the weight categories must be the same for comparison. The international weight divisions are different from the American collegiate weights. Carter (1970) compared Russian and British wrestlers to Kroll's Big Ten wrestlers. He found the British and Russians averaged 77.2 and 77.1 kg., respectively. This was approximately 4.6 kg. heavier than the Big Ten wrestlers. The Russians and the British were competing at international weights, and the difference between them was only .1 kg. Both the Russian and British teams were heavier than the American wrestlers, but this was merely due to the greater number of heavier weight categories in international wrestling.

The wrestlers somatotyped in Carter's (1970) study provided some of the first information on wrestlers through the use of the Heath-Carter method. The Soviet wrestlers were almost entirely endomorphic mesomorphs and had a smaller variability about the mean than the British wrestlers. When the distribution was broken down into those wrestlers above or below 70 kg., it was found that the endomorphic components were higher for the heavier weights. The Soviet wrestlers are of interest because they were rated as being outstanding in their country. The Soviet Union has long been the greatest wrestling power in the world. No ectomorphic mesomorphs were found in the Russian sample while 21% of the British wrestlers were this type. The mean somatotype for the Soviet wrestler was 2.5 - 6.5 - 1.5. It is possible that this is a physique "prototype" for wrestlers. This can be compared to Kroll's
average of Big Ten wrestlers of 2.7 - 5.0 - 2.5 (ectomorphic component adjusted to Heath-Carter scales).

DeGaray et al. (1974) somatotyped 90 wrestlers at the 1968 Olympics in Mexico City using the Heath-Carter method. The study was the first to consider weight division as a factor in somatotyping wrestlers. Other studies such as Katch and Michael (1971), Tcheng and Tipton (1973), and Tipton and Tcheng (1974), considered weight division as it related to body composition but did not concern themselves with somatotype. deGaray grouped the wrestlers into categories of two weight divisions each for the purposes of statistical analysis. The mean somatotype for all wrestlers was 2.5 - 6.5 - 1.5. This is identical to the average of the Russian wrestling team reported by Carter (1970). The endomorphic component increased an average of almost two units between the lightest and heaviest weight classes. All the extreme endomorphic mesomorphs were competitors in the heavyweight division. Most of the heavyweights were high in endomorphy. Mesomorphy, like endomorphy, increased as the weight division increased. There was an increase of one point between the lowest and the highest weight group. Mesomorphy was found to have a fairly constant range at each weight division except for the range of only 1.5 points at heavyweight. Unlike mesomorphy and endomorphy, ectomorphy decreased as the wrestlers became heavier. There was a decrease of one point between the lowest and the heaviest weight division.

DeGaray et al. did not evaluate body sizes of the wrestlers for representation. He asserted that the wrestling weight categories were, "by definition discrete and, therefore different" (1974, p. 45). He did
show that the body proportions increased in direct proportion to the weight classification. As the weight division increased, the wrestlers became taller and broader with longer trunk and limb lengths.

Three studies in the early 1970's contributed much to the knowledge of body composition of wrestlers. Katch and Michael (1971) studied the body composition of high school wrestlers by age and weight division. They found that as the weight category increased, the absolute skinfold value increased. He also pointed out that the percent fat of the wrestler increased with the weight division and showed correlations between .86 and .96. Katch, like deGaray, Levine, and Carter, grouped the weight divisions into larger weight groups for analysis. His groups were light (98-123 lbs.), medium (130-157 lbs.), and heavy (168-208 lbs.). The heavyweight in the study weighed only 208 lbs.

Prompted by excesses in weight reduction of high school wrestlers, Tcheng and Tipton (1973) conducted the "Iowa Wrestling Study". For four years the body composition of each high school state finalist was taken. The assumption was made that the state finalist would represent the best example of a well-conditioned athlete. The body composition of 835 "average" scholastic wrestlers was taken for comparison. Comparisons showed that the finalists were older, had a greater biacromial and chest diameters, less thigh and gluteal circumferences, and a lower skinfold total. While the upper body measures of the finalists were larger than the average, the lower body values were smaller. The Iowa finalists would most likely be the wrestlers recruited for college wrestling. By recruiting from such a select group,
the homogeneity of the next level would probably increase. This points towards a "weeding out" of inappropriate body types.

Sinning (1974) assessed the body composition of an intercollegiate wrestling team. He found that 1300 ml. was a good constant value to use for residual volume when conducting underwater weighing. The constant value correlated .989 with actual lean body weight. Sinning found that wrestlers tended to be lean but not as lean as swimmers, track men, and gymnasts as reported in other studies.

Summary

A brief outline of the classification of the human physique was presented. Early systems of physique typing linked body build heavily to personality and psychology. While this is no longer generally accepted, some of the systems developed for somatotyping are of use to researchers in physical education and sport.

The Heath-Carter Anthropometric Somatotyping method was introduced and explained. The system is more objective than earlier methods because of the anthropometry involved.

Studies were presented that used athletes for subjects. Athletes were deemed useful as subjects because they represent the extremes of performance in a population. By studying the extremes of performance in a population, it is easier to discern the relationship between structure and function. Sports are amenable to research because they provide well-defined tasks to represent such things as success or competition level.

It was shown that athletes differ from the general population in somatotype distribution. The Olympic games were characterized as a
Athletes at high levels of competition were primarily endomorphic mesomorphs, balanced mesomorphs, or ectomorphic mesomorphs.

Athletes differed in somatotype distribution not only from the general population but among themselves. Significant differences were found between athletes of various sports or specialties within a sport.

Somatotype and body composition studies of wrestlers were presented. Earlier studies presented the wrestler as a "massively muscled, large trunked, short legged athlete possessing brute strength." Later research showed the Olympic wrestler to have an average somatotype of 2.5 - 6.5 - 1.5. As the weight division increased there was a corresponding increase in endomorphy and mesomorphy and a decrease in ectomorphy. Research showed that wrestlers had a relatively large upper body when compared to the legs. Body proportions of wrestlers increased in direct proportion to the weight division. The distinct and different weight divisions can confound average values. The point was made that care must be taken in comparing "average" values for wrestlers with respect to somatotype.
CHAPTER 3

DESIGN AND PROCEDURES OF THE STUDY

The purpose of this study was to determine if body types differ between various levels of collegiate competition, and to determine if the mean somatotype of wrestlers differed between lower, middle, and upper weight divisions. A third purpose of the study was to determine the relationship of Heath and Carter's first component to percent body fat. The present chapter will describe the techniques and procedures used to obtain and analyze the data.

Subjects Participating in the Study

The subjects participating in the study were all varsity wrestlers on teams selected for use in the project. The teams were selected on the basis of availability to the investigator and ranked according to level of competition. Seven junior colleges in Missouri and Arizona were selected along with member teams in the Western Athletic Conference and the Missouri Intercollegiate Athletic Association.

The teams in the Western Athletic Conference represented the highest level of competition in the study. The conference included The University of Arizona, Arizona State University, Brigham Young University, Colorado State University, The University of New Mexico, The University of Utah, and The University of Wyoming. However, The University of Wyoming was eliminated from the study because the wrestlers were not available for measurement.
The Western Athletic Conference was chosen as representing the highest competition level because its teams compete on a nationwide basis. The conference qualifies 25 wrestlers to the Division I NCAA championships through its conference tournament. The teams of the Western Athletic Conference carry a greater number of scholarship athletes than other teams in the study, and recruiting is nationwide.

The varsity wrestlers of the Missouri Intercollegiate Athletic Association represented the intermediate level of competition. Teams in the association included Central Missouri State University, Lincoln University, Northeast Missouri State University, Northwest Missouri State University, Southeast Missouri State University, Southwest Missouri State University, and The University of Missouri at Rolla. These teams were determined as intermediate level teams because they competed and recruited at a regional level. Conference restrictions limited the number of scholarships. Wrestlers qualified to the NCAA Division II tournament through the MIAA championships. The NCAA Division II tournament annually qualified 20 wrestlers to the Division I championships. No MIAA wrestler qualified for the Division I tournament.

Chosen to represent the lower level of competition were seven junior colleges in Missouri and Arizona. This group included Florissant Valley Community College, Forest Park Community College, Meramec Community College, Mesa Community College, Phoenix Junior College, Central Arizona Community College, and Pima Community College. Recruiting and competition at these institutions is predominantly local, and aid to athletes is usually through government financed work-study and grants.
At all levels of competition, wrestlers competing at 118, 126, and 134 lb. weight divisions were considered as lower weight wrestlers. Those wrestlers competing at 142, 150, and 158 lbs. were considered middle weight wrestlers. Wrestlers who competed in the 167, 177, and 190 lb. weight division were considered upper weight wrestlers. Heavyweights were considered separate and distinct. Heavyweight wrestlers do not have to attain a specific weight level and, therefore, often have extreme physiques. The extreme values characteristic to this weight division necessitated its separation from the other groups.

The subjects used for comparing Heath and Carter's first component to lean body weight were 14 University of Arizona wrestlers. Of these 14 wrestlers, 10 were also included in the competition level and weight division portion of the study.

Securing Permission of the Subjects

The investigator contacted the coaches of the 21 teams by telephone or mail. Permission was asked of the coach as to whether or not he would mind if the investigator solicited cooperation from his team. Most of the coaches were very cooperative and usually a date was set where the investigator and the potential subjects could meet.

Upon meeting with the potential subjects, the investigator gave a brief presentation as to the purpose of the project and the nature of the subjects participation. The wrestlers who agreed to participate signed a consent form, co-signed by a witness, and were somatotyped immediately. A sample of this form is presented in Appendix A. Wrestlers at The University of Arizona used in the underwater weighing
portion of the study signed an additional underwater weighing consent form. A sample of this form may be found in Appendix B.

**Conditions Under Which the Measurements Were Taken**

An attempt was made to measure the wrestlers as close to the time of actual competition as possible. Ten of the teams were somatotyped shortly before competition. This time was usually between weigh-in and the start of the dual meet or tournament. The wrestlers and coaches were anxious about the ensuing competition. Because of this tension the investigator was required to operate as quickly as possible. Three of the teams were somatotyped immediately after the competition. Five of the teams were measured before their practice session. The practice sessions were within two days of an actual competition. Care was taken that the wrestler was measured before he had engaged in a workout.

**The Heath-Carter Anthropometric Somatotyping Method**

The tool used for assessing the body types of the wrestlers was the Heath-Carter Anthropometric Somatotyping method. Procedures were utilized as outlined by Carter (1972). The method was chosen because of its ease of use with large numbers of subjects and a relatively short time for measurement. The method has been in extensive use for the study of the physique of athletes. Equipment used in the somatotyping procedure included a GPM sliding anthropometer, a Harpenden skinfold caliper, a Preston steel Gulick type tape measure, and an available certified balance scale. The entire somatotyping procedure took about five minutes per subject.
The reliability of the investigator was established with a correlation of .99 for first and second skinfold measurements.

The First Component

The first component is an evaluation of the general fatness of a subject on a continuum from low to high. Three skinfolds are used in evaluating endomorphy. A fourth skinfold was used in the evaluation of mesomorphy. Due to the limited time in which the measures had to be made, the skinfolds were completed entirely before measuring circumferences or diameters. Three trials were taken at each site. The two closest values were averaged to obtain the value representative of that site. The three trials were not taken consecutively. All four sites were measured and then remeasured two more times.

The Second Component

The second component mesomorphy indicated the relative musculo-skeletal development of the subject. This rating was obtained by measuring the bi-epicondylar diameters of the humerus and the femur and by measuring the circumferences of the biceps and the calf. Unless there was irregularity due to injury, all measurements were taken on the right side of the subject.

The Third Component

The third component expresses a relationship between height and weight. This relationship is called a height-weight ratio or a ponderal index and is the height divided by the cube root of the weight. This value can be obtained through the use of nomograms or calculated on a
calculator equipped with a fraction exponent function. The ponderal index was calculated to the nearest .01 unit and compared with the scale on the ectomorphic portion of the Heath-Carter somatotype rating form. The closest value was circled and the column of the circled value indicated the third component.

**Body Composition Assessment**

Fourteen University of Arizona wrestlers were weighed underwater to determine their relative fat for comparison to the Heath-Carter endomorphic component. The weighing was conducted in the University of Arizona Sport Sciences Laboratory. The subjects were first weighed with the use of a balance scale. The subjects then entered the underwater weighing tank wearing only shorts. The weighing procedure followed was very much like that followed by Wilmore (1969). The subject completed a maximal expiration and was weighed while completely underwater through the use of a suspension scale. This was repeated for ten trials. The actual underwater weight was determined by the method outlined by Wilmore (1969). The highest weight obtained was used if it were observed more than twice. The second highest weight was used if observed more than once. The third highest weight was used if the first and second criteria were not met. Once the proper underwater weight was determined, the weight of the weighing chair was subtracted.

No equipment was at that time available for direct measurement of residual lung volume. A constant value of 1300 milliliters was selected because of its use in earlier studies involving wrestlers (Sinning, 1974). Wilmore (1969) showed that 1300 ml. was very close to the mean value of college age males in his research.
Body density was calculated using the following equation:

\[
\text{density} = \frac{\text{wt. air}}{\text{wt. air} - \text{wt. water} - 1.3} \times \frac{1.3}{0.994}
\]

Percent fat was calculated from the body density using the regression equation developed by Siri (1956).

\[
\% \text{ body fat} = \left( \frac{4.95}{\text{density}} \right) - 450
\]

**Statistical Analysis**

The rated somatotypes were placed into groups for statistical analysis. Somatotype components do not represent independent values and, therefore, cannot be analyzed together. An increase in endomorphy or an increase in mesomorphy would cause a corresponding decrease in ectomorphy. When the investigator analyzed for differences between groups, a separate analysis needed to be conducted on each component.

**Description of the Data**

Descriptive statistics such as mean, standard deviation, and variance were used to show characteristics of the values. Each competition level, weight division, and weight group was presented in such a manner. Correlations using the Pearson were performed on absolute skinfold measures compared to body weight and also between trials of skinfold measures.
Percent Fat Compared to the First Component

Fourteen University of Arizona wrestlers were both somatotyped and weighed hydrostatically. Density was determined and percent fat was calculated through the use of the Siri (1956) regression equation. The percent fat was compared to the endomorphic component through the use of the Pearson correlation. The coefficient of determination was also computed.

Variance Differences Within Competition Levels

The subjects were divided into the three competition levels. A one-factor analysis of variance was performed to determine if any differences existed between the three groups. The analysis of variance yielded a value for the variance within each group. Upon this value, a test of independent variances was run to determine if within-group variance decreased as the level of competition increased. The level of significance was tested at .01. However, because this was a repeated test, the .05 level was reported as the significance level. Failure to increase the level of reported significance would have resulted in alpha slippage.

Physique Differences Between Competition Levels

The data on the subjects was arranged into the determined levels of competition. A one-factor analysis of variance was performed on the data. A .01 level of significance was used to show if any differences existed between the groups. When differences were found, a multiple t test was run to find the directionality of the differences.
Physique Differences Between Weight Groups

The data on the subjects was arranged according to the determined weight groups. A one-factor analysis of variance was implemented at the .01 level of significance. When differences were found between weight groups, a multiple t test was used to show where the differences actually were.

Summary

This chapter was concerned with describing the subjects, structure, measuring devices, equipment, and procedures of the present study. The subjects were all varsity wrestlers on teams selected for use in the study. The subjects were divided into three levels of competition and three weight groups. Due to possible distortion because of extreme values, the heavyweights were not included in the above-mentioned groups.

This chapter explained the tools used in measuring the subjects and the conditions under which the subjects were measured. The procedure of somatotyping was the Heath-Carter Anthropometric Somatotyping method. The procedures used in determining percent fat through underwater weighing were explained.

The statistical analysis of each hypothesis was outlined. Differences in within-group variances with respect to competition level were determined through the use of a test of independent variances. One-factor analysis of variances and multiple t tests were used to determine physique differences with respect to competition level and weight group. A Pearson correlation and coefficient of determination were used to show the relationship of the endomorphic component to the percent fat.
CHAPTER 4

ANALYSIS OF THE DATA AND PRESENTATION OF THE FINDINGS

This chapter contains an analysis of the data and a presentation of the results as they apply to the three research hypotheses of the study. Also a discussion of the correlation run between the endomorphic component and relative fat as determined by hydrostatic weighing will be presented.

Comparison of Endomorphy to Relative Fat

Fourteen subjects from the University of Arizona wrestling team were somatotyped and weighed underwater. The subjects were evenly distributed throughout the ten weight divisions. The group tended to be quite homogenous. The greatest percent fat was that of the heavyweights at 16.1%. Even though the heavyweight had the greatest percent body fat, heavyweights usually are higher in percent fat. Means, standard deviations, and ranges for the endomorphic component and percent fat are presented in Table 2.

A correlation was performed on the relative fat and the endomorphic component. The coefficient of correlation was shown as .72. The coefficient of determination therefore, was .52.

The investigator decided to run another correlation. This time the correlation was used to determine the relationship of the total
Table 2. Means, standard deviations, and ranges for relative fat and the endomorphic component

<table>
<thead>
<tr>
<th>Factor</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endomorphic Component</td>
<td>2.8</td>
<td>1.1</td>
<td>1.5-6.0</td>
</tr>
<tr>
<td>Relative Fat</td>
<td>9.2</td>
<td>4.0</td>
<td>3.8-16.1</td>
</tr>
</tbody>
</table>

skinfold value of a subject to his body weight. Since collegiate weight divisions are described in pounds, this correlation used pounds. The triceps, subscapular, suprailiac, and calf skinfolds of each of the 173 subjects in the study were totalled and compared to his body weight. The means, standard deviations, and ranges for body weight and skinfold totals are presented in Table 3.

The correlation showed a relationship of .75. The coefficient of determination was .56.

Table 3. Means, standard deviations, and ranges for body weight and absolute skinfold value

<table>
<thead>
<tr>
<th>Factor</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Weight in lbs.</td>
<td>160.90</td>
<td>34.75</td>
<td>117-345</td>
</tr>
<tr>
<td>Absolute Skinfold mm.</td>
<td>39.32</td>
<td>15.89</td>
<td>19.5-112.8</td>
</tr>
</tbody>
</table>
A Comparison of Variance from the Group Mean at Lower, Middle, and Upper Competition Levels

The first hypothesis stated that variance from the group mean within would decrease as the level of competition increased. The subjects excluding the heavyweights, were categorized by their competition levels. With each component the variance within was computed. This was done by using a one-factor analysis of variance on the data with respect to competition level. After the within-group variances were ascertained, a test of independent variances was run at the .01 level to determine if there were any significant differences.

Endomorphy

The number of subjects, mean endomorphic value, and the variance for each level of competition are shown in Table 4.

Using the data in Table 4, a test of independent variances was performed. The F statistic was used at the .01 level. However, this was a repeated test on data obtained through an analysis of variance.

Table 4. Mean and variance summary table by competition level

<table>
<thead>
<tr>
<th>Level</th>
<th>N</th>
<th>Mean</th>
<th>Variance Within</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Level</td>
<td>47</td>
<td>2.3</td>
<td>.35</td>
<td>1.5-4.0</td>
</tr>
<tr>
<td>Middle Level</td>
<td>59</td>
<td>3.0</td>
<td>.95</td>
<td>1.5-6.0</td>
</tr>
<tr>
<td>Lower Level</td>
<td>52</td>
<td>2.6</td>
<td>.81</td>
<td>1.5-6.0</td>
</tr>
</tbody>
</table>
To avoid alpha slippage, .05 was used as the reported level of significance. Results of the test of independent variances are reported in Table 5.

Table 5. Test of independent variances results for endomorphy

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Critical F</th>
<th>Test F</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper-Middle</td>
<td>1.98</td>
<td>2.70*</td>
<td>Reject Ho</td>
</tr>
<tr>
<td>Upper-Lower</td>
<td>1.98</td>
<td>2.29*</td>
<td>Reject Ho</td>
</tr>
<tr>
<td>Middle-Lower</td>
<td>1.94</td>
<td>1.18</td>
<td>Accept Ho</td>
</tr>
</tbody>
</table>

*Note: Significant at the .05 level

Reported at the .05 level of significance, the upper level of competition was shown to have significantly less variance from its group mean than either of the middle and the lower competition levels. In endomorphy the lower level of competition and the middle level were statistically the same.

Mesomorphy

The same procedures used earlier to determine variance differences in endomorphy were used with mesomorphy. On the whole, variances tended to be greater with mesomorphy than with endomorphy. A description of the data concerning the mesomorphic values by competition level is presented in Table 6.
Table 6. Mesomorphic summary by competition level

<table>
<thead>
<tr>
<th>Level</th>
<th>N</th>
<th>Mean</th>
<th>Variance Within</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Level</td>
<td>47</td>
<td>5.7</td>
<td>.57</td>
<td>3.0-7.5</td>
</tr>
<tr>
<td>Middle Level</td>
<td>59</td>
<td>5.4</td>
<td>1.35</td>
<td>3.0-8.5</td>
</tr>
<tr>
<td>Lower Level</td>
<td>52</td>
<td>5.6</td>
<td>.81</td>
<td>4.0-8.0</td>
</tr>
</tbody>
</table>

Again, as it did with the endomorphic component, the lower level of competition has a lesser variance than the middle level. Again, the upper level has the lowest variance. Table 7 shows the results of the test of independent variances.

The only significant differences found in variance with mesomorphy was found between the upper and middle competition levels. No significant differences were found between the upper and lower, or the middle and lower levels.

Table 7. Results of test of independent variances in mesomorphy

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Critical F</th>
<th>Test F</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper-Middle</td>
<td>1.98</td>
<td>2.36*</td>
<td>Reject Ho</td>
</tr>
<tr>
<td>Upper-Lower</td>
<td>1.98</td>
<td>1.42</td>
<td>Accept Ho</td>
</tr>
<tr>
<td>Middle-Lower</td>
<td>1.94</td>
<td>1.66</td>
<td>Accept Ho</td>
</tr>
</tbody>
</table>

*Note: Significant at the .05 level
Ectomorphy

The procedure for determining variance with regard to ectomorphy paralleled that used with endomorphy and mesomorphy. A description of the data on ectomorphy by competition level is represented in Table 8.

Table 8. Ectomorphic summary by competition level

<table>
<thead>
<tr>
<th>Level</th>
<th>N</th>
<th>Mean</th>
<th>Variance Within</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Level</td>
<td>47</td>
<td>2.5</td>
<td>.74</td>
<td>1.0-4.5</td>
</tr>
<tr>
<td>Middle Level</td>
<td>59</td>
<td>-2.5</td>
<td>1.19</td>
<td>1.0-5.0</td>
</tr>
<tr>
<td>Lower Level</td>
<td>52</td>
<td>2.4</td>
<td>.76</td>
<td>0.5-4.0</td>
</tr>
</tbody>
</table>

The upper level again showed the least amount of variance, while the lower level had the second least amount of variance. However, none of the differences in variance in ectomorphy were significant. Table 9 gives a summary of the test for independent variances.

Table 9. Results of test of independent variances in ectomorphy

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Critical F</th>
<th>Test F</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper-Middle</td>
<td>1.98</td>
<td>1.61</td>
<td>Accept Ho</td>
</tr>
<tr>
<td>Upper-Lower</td>
<td>1.98</td>
<td>1.03</td>
<td>Accept Ho</td>
</tr>
<tr>
<td>Middle-Lower</td>
<td>1.94</td>
<td>1.57</td>
<td>Accept Ho</td>
</tr>
</tbody>
</table>
Component Differences Between Competition Levels

The second hypothesis stated that the somatotype components would differ at lower, middle, and upper levels of competition. The endomorphic component was expected to decrease as the level of competition increased while the mesomorphic component was expected to rise. The ectomorphic value was expected to remain relatively stable.

The subjects, excluding the heavyweights, were somatotyped, and the data were arranged according to level of competition. A one-factor analysis of variance was performed on the data for each component. When significant differences were found, a multiple t test was run on the groups to determine where the differences occurred.

Endomorphy

The highest level of competition showed the lowest rating in endomorphy with a 2.3 and a standard deviation of .59. The lowest level of competition had an endomorphic rating mean of 2.6 with a .90 standard deviation. This placed it between the two other levels. The middle range of competition had a mean of 3.0 with a .97 standard deviation. A one-factor analysis of variance was performed. Results of the analysis are presented in Table 10. The F test showed significant differences at the .01 level. A multiple t test was applied to the groups. The upper and middle levels were significantly different at the .001 level. The upper and lower groups were different at the .05 level. The middle and lower groups also showed differences at the .05 level. However, the differences were not in the direction expected. The middle competition level had a greater endomorphic rating than the lower.
Table 10. ANOVA table for endomorphy by competition level

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Levels</td>
<td>2</td>
<td>14.58</td>
<td>7.29</td>
<td>10.01*</td>
</tr>
<tr>
<td>Within Levels</td>
<td>155</td>
<td>112.89</td>
<td>.73</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>157</td>
<td>127.47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Note: Significant at the .01 level F .01 (df 2, 155) = 4.75

Mesomorphy

The highest level of competition had a mean rating of 5.71 with a standard deviation of .76. The middle level of competition had the lowest mean at 5.44 with a 1.16 standard deviation. The lower competition level was again in between the other two groups. The lower level had a mean of 5.59 with a .90 standard deviation. The analysis of variance was run, and no significant differences were found between the three groups. Results are presented in Table 11.

Table 11. ANOVA table for mesomorphy by competition level

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Levels</td>
<td>2</td>
<td>1.98</td>
<td>.99</td>
<td>1.05</td>
</tr>
<tr>
<td>Within Levels</td>
<td>155</td>
<td>146.43</td>
<td>.95</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>157</td>
<td>148.41</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Ectomorphy

The highest level had a mean ectomorphic rating of 2.5 with a standard deviation of .86. The middle group had a mean of 2.5 and a standard deviation of 1.09. The lower group possessed a mean rating of 2.4 with a standard deviation of .87. An analysis of variance was run, and no significant differences were found between the groups. The results are shown in Table 12.

Table 12. ANOVA table for ectomorphy by competition level

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Levels</td>
<td>2</td>
<td>.19</td>
<td>.10</td>
<td>.10</td>
</tr>
<tr>
<td>Within Levels</td>
<td>155</td>
<td>142.02</td>
<td>.92</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>157</td>
<td>142.21</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Somatochart Distribution by Competition Level

Somatochart distributions are represented in Figures 2, 3, and 4. It can be seen that of the 158 wrestlers somatotyped, all but one are endomorphic mesomorphs or balanced mesomorphs. A somatochart representing the competition level means is presented in Figure 5. All three groups were balanced mesomorphs. The mean somatotypes were 2.3 - 5.7 - 2.5 for the highest level, 3.0 - 5.4 - 2.5 for the middle level, and 2.6 - 5.6 - 2.4 for the lower level of competition. The overall somatotype for the subjects was 2.7 - 5.6 - 2.5.
Figure 2. Somatochart distribution of the upper competition level
Figure 3. Somatochart distribution of the middle competition level
Figure 4. Somatochart distribution of the lower competition level
Figure 5. Somatochart distribution of competition level means
Component Variation at Different Weight Groups

The third hypothesis stated that component ratings would differ between lower, middle, and upper weight divisions. As the weight divisions increased, the endomorphic and mesomorphic components would increase while the ectomorphic component decreased. The subjects were somatotyped, and the data were arranged by weight groups. Three wrestling weight divisions were placed into one weight group. The three weight groups represented the lower, middle, and upper weight divisions. A one-factor analysis of variance was performed to determine if significant differences were present. When differences were found, a multiple t test was run to determine what the differences were. Table 13 shows the group means and standard deviations for the three weight levels.

Table 13. Means and standard deviations by weight group

<table>
<thead>
<tr>
<th>Weight Group</th>
<th>Endomorphy</th>
<th>Mesomorphy</th>
<th>Ectomorphy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower</td>
<td>2.4</td>
<td>5.13</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td>.66</td>
<td>.82</td>
<td>.85</td>
</tr>
<tr>
<td>Middle</td>
<td>2.4</td>
<td>5.5</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>.60</td>
<td>.95</td>
<td>.82</td>
</tr>
<tr>
<td>Upper</td>
<td>3.4</td>
<td>6.1</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>1.01</td>
<td>.90</td>
<td>.85</td>
</tr>
<tr>
<td>Overall</td>
<td>2.7</td>
<td>5.6</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>.72</td>
<td>.44</td>
<td>.91</td>
</tr>
</tbody>
</table>
Endomorphy

The hypothesized outcome for the first component was for the rating to increase as the weight division increased. The rating taken on the subjects went in this direction. The one-factor analysis of variance showed significant differences at the .01 level. Table 14 summarizes the analysis.

The multiple t test showed that significant differences occurred at the .001 level between the lower and upper groups, and the middle and upper groups. No significant differences were found between the lower group and the middle group.

Table 14. ANOVA table for endomorphy by weight group

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Weight Groups</td>
<td>2</td>
<td>32.94</td>
<td>16.47</td>
<td>27.13*</td>
</tr>
<tr>
<td>Within Weight Groups</td>
<td>155</td>
<td>94.08</td>
<td>.61</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>157</td>
<td>127.02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Note: Significant at the .01 level  F .01 (df 2, 155) = 4.75
Mesomorphy

Mesomorphy was expected to increase as the subjects became heavier. By looking at Table 13 it can be seen that this was the case. Mesomorphy increased by .96 of a unit from the lower to the upper weight divisions. The one-factor analysis of variance showed significant different at the .01 level. Table 15 gives a summary of the analysis.

The multiple t test showed significant differences between all three groups. The lower group differed from the upper group at the .001 level. The middle group differed from the upper group at the .01 level, and the lower group differed from the middle weights at the .05 levels. Differences seemed to be greatest when the upper weight group was involved in the comparison.

Table 15. ANOVA table for mesomorphy by weight group

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Weight Groups</td>
<td>2</td>
<td>24.39</td>
<td>12.20</td>
<td>15.24*</td>
</tr>
<tr>
<td>Within Weight Groups</td>
<td>155</td>
<td>124.02</td>
<td>.80</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>157</td>
<td>148.41</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Note: Significant at the .01 level F .01 (df 2, 155) = 4.75
**Ectomorphy**

Ectomorphy was expected to decrease as the weight of the wrestlers increased. By looking at Table 10, one can see that this was the case. Between the lower and the upper weight divisions ectomorphy decreased by 1.05 points. The one-factor analysis of variance showed that significant differences were present at the .01 level of significance. Table 16 gives a summary of the analysis.

The multiple t test showed that no differences existed between the lower and the middle weight groups. However, the upper weights were significantly lower in ectomorphy than both of the other groups at the .001 level. Again, as in endomorphy and mesomorphy, the differences were greatest when the upper weight group was in the comparison.

**Table 16. ANOVA table for ectomorphy by weight group**

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Weight Groups</td>
<td>2</td>
<td>32.84</td>
<td>16.42</td>
<td>23.27*</td>
</tr>
<tr>
<td>Within Weight Groups</td>
<td>155</td>
<td>109.37</td>
<td>.71</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>157</td>
<td>142.21</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Note: Significant at the .01 level F .01 (df 2, 155) = 4.75
Somatochart Distribution by Weight Level

Figures 6, 7, 8, and 9 show the weight group distributions on the somatochart. From the lower to the upper weight the distributions move upward and to the left until many in the upper weights are of the normal bounds of the chart. Figure 10 shows the means for each weight group. The mean for the heavyweights was also included to show the extreme value obtained for them.

The Heavyweights

A total of 15 heavyweights were somatotyped. They were not included in the analysis by competition level because of their extreme scores. Their data were not included in the analysis by weight group because heavyweights are not required to be at any specific weight. The heavyweights measured in this study ranged from 181 to 345 pounds in weight. Not one of the heavyweights could be found in the normal bounds of the somatochart. The mean somatotype for the heavyweight division was 5.6 - 8.0 - 0.6. A presentation of the heavyweight distribution on a somatochart can be seen in Figure 9. A comparison of the average heavyweight somatotype to the lower, middle, and upper weight divisions can be seen in Figure 10.

Discussion of the Findings

The results, having been presented earlier in the present chapter, will be reviewed. The findings will be related to the literature and, where applicable, the acceptance or rejection of the null hypothesis will be evaluated.
Figure 6. Somatochart distribution of the lower weight group
Figure 7. Somatochart distribution of the middle weight group
Figure 8. Somatochart distribution of the upper weight group
Figure 9. Somatochart distribution of the heavyweight division
Figure 10. Somatochart distribution of weight group means

= Lower Weight Group
= Middle Weight Group
= Upper Weight Group
= Heavyweight Division
Comparison of Endomorphy to Percent Fat

The correlation of .72, and the coefficient of determination of .52, were exactly the same as that obtained by Wilmore (1970). The correlation indicated only a moderate relationship between the endomorphic component and the percent fat of the wrestlers in this study.

The results of the correlation between body weight and the value of the totalled skinfolds indicate that as the subjects increase in body weight the skinfold values tend to increase. This increase in the skinfold total would cause a corresponding increase in the endomorphic rating. At times these increases in endomorphy were not reflected by an increase in the percent of body fat. A heavyweight in the study that was somatotyped and hydrostatically weighed had an endomorphic rating of 6. However, his relative body fat was only 16.1%. It is doubtful that a 150 lb. wrestler with 16.1% body fat would have an endomorphic rating as high.

The wrestlers weighed underwater had a range in percent fat of only 12.3%. The relatively high homogeneity of the group may have been a factor in the correlation between the endomorphic component and the percent fat. Further testing with groups of subjects with greater variance in relative fat is needed.

Variance Changes Within Competition Levels

It was hypothesized that variance would decrease as the level of competition increased. In endomorphy the upper level of competition was found to be significantly lower in variance than both the middle and lower levels of competition. No difference was found between the middle and lower levels. The null hypothesis was rejected.
In endomorphy the upper level of competition was found significantly lower in variance than both the middle and the lower levels of competition. No difference was found between the middle and lower levels. The null hypothesis was rejected.

Concerning mesomorphy, the null hypothesis could not be rejected. The upper competition level was significantly lower in variance than the middle but not the lower level. The middle and lower groups showed no differences from each other.

No significant differences were found among any of the groups with respects to ectomorphy. The null hypothesis could not be rejected. Carter (1970) stated that champion athletes at various levels of a certain sport exhibit similar patterns in body size and physique. He stated that as the level of performance increased the patterns became narrower. In this study the upper level had the lowest within group mean in each component. Only in endomorphy was the difference significant from both of the other groups. In mesomorphy the Division I group had a significantly lower variance than the junior college but not the Division II group. In each component the lower level was in between the upper and middle groups with regards to variance, although not significantly with endomorphy. In mesomorphy the variance of the lower group being smaller than the middle group created a situation where the null hypothesis could not be rejected.

Component Changes Between Competition Levels

As the level of competition increased it was hypothesized that the endomorphic component would decrease, the mesomorphic component
would increase and the ectomorphic component would remain stable. Both significant differences and directionality were considered.

In the cases of mesomorphy and ectomorphy no significant differences were found. The F test did show differences in endomorphy at the .01 level. However, the differences were not all in the direction stated by the hypothesis. The high level of competition had the lowest rating in endomorphy at 2.3. This rating was significantly lower than both other competition levels. Therefore, the null hypothesis was rejected. However, when comparing the middle to the lower level of competition, it was found that the junior college group had a lower endomorphic rating than the Division II group.

Throughout the analysis by competition level, the junior college group fell between the WAC and MIAA wrestlers. This happened in all three components in the analysis for difference in variance and in all three groups in the analysis of component changes between competition levels. A weakness in the study could be the lack of evidence for classifying the junior colleges somatotyped as a lower level of competition than the MIAA teams. Clear cut criteria based on national championship qualification establishes the WAC teams as being a higher level of competition than the MIAA teams. No such criteria exists to classify the competitive level of the junior college teams. Analysis of the data using only the WAC and MIAA teams could possibly yield different results.
Component Changes Between Weight Groups

The research hypothesis stated that as the weight divisions increased, the endomorphic and mesomorphic components would increase, and the ectomorphic component would decrease. The somatotype data were arranged into lower, middle, and upper weight groups of three intercollegiate weight divisions each. Each component was analyzed independently. Both significant differences and directionality were considered. The analysis of variance indicated significant differences for all three components. Multiple t tests were used to determine the directionality of the differences and where the differences occurred.

In endomorphy no difference was found between the lower and middle weight groups. The lower group had a 2.4 rating compared to the 2.4 rating for the middle weights, but the difference was not significant. However, the upper weights had a significantly higher endomorphic component than both the other groups at the .001 level. The endomorphic component was shown to increase as the weight division increased, and the null hypothesis was rejected.

The multiple t test indicated significant differences between all three groups in mesomorphy. The upper weight group was greater in mesomorphy at the .01 level compared to the middle weight and the .001 level compared to the lower weight group. The middle weights were greater in mesomorphy at the .05 level when compared to the lower weights. The mesomorphic component was shown to increase as the weight divisions increased, and the null hypothesis was rejected.

With ectomorphy significant differences were found between the upper weight group and the middle weight group at the .001 level, and
the upper and lower weight group at the same level. No difference were found between the lower and middle weights. Predominantly due to the low ectomorphic ratings of the upper weights, the third component was shown to decrease as the weight division increased, and the null hypothesis was rejected.

Both endomorphy and mesomorphy increased and ectomorphy decreased as the wrestlers became heavier. Earlier in the study it was demonstrated that the skinfold total increased as the absolute weight of the wrestlers increased. This would cause an increase in the endomorphic component. Also, an increase in endomorphy and mesomorphy would necessitate a decrease in ectomorphy because the components are not independent of each other. Wilmore (1970) suggested that a lack of discrimination existed between the first and second component. Slaughter and Lohman (1976) found that the mesomorphic component was significantly related to lean body mass for a given height. In this study it was noted that extreme cases of endomorphy usually were associated with extreme cases of mesomorphy. This was common among the heavyweights. Perhaps converting the skinfold measures to centimeters and subtracting them from the circumferences is not adequate for extreme cases.

The overall mean somatotype for the subjects was 2.7 - 5.6 - 2.5. However, this mean would not be representative of the upper weights whose mean was 3.4 - 6.1 - 1.8, or the lower weights whose mean was 2.4 - 5.1 - 2.9. The overall mean would be even less representative for all the wrestlers in general had the heavyweights been included with their mean somatotype of 5.6 - 8.0 - 0.6. Wrestlers at different weight divisions tend to have different physiques, and these differences become
greater as the weight divisions move farther apart on the continuum. The weight divisions are distinct and different. Any study involving the physique of wrestlers should take the weight divisions into account. Katch and Michael (1971) studied the body composition of wrestlers by weight division. He found that as the weight divisions increased so did the percent fat of the wrestlers competing in those weight divisions. Two of the skinfolds he utilized were the scapula and iliac skinfolds. An increase in the size of these skinfolds would show an increase in the estimation of the percent fat or if one were somatotyping an increase in the endomorphic rating. The two studies are consistent with each other.

A study by Rasch (1958) on Olympic freestyle wrestlers showed that the ponderal index of the wrestlers decrease as the weight division increased in size. This decrease in the ponderal index would have caused a decrease in the ectomorphic rating had the wrestlers been somatotyped using the Heath-Carter method. A study by Hirata (1966) yielded similar results.

The Heavyweights

The heavyweight divisions displayed large differences when compared to the other weight groups. The same component changes which covaried with weight division increases, carried into the heavyweight division. The mean heavyweight somatotype was 5.6 - 8.0 - 0.6. Continuing in the pattern set by the other groups, the heavyweights were higher in endomorphy and mesomorphy and lower in ectomorphy.
Summary

This chapter presented the results of the statistical analysis of the data pertaining to the three levels of competition and the three weight levels. Analysis of variance computations, tests of independent variances, and multiple t-tests were performed on the groups to determine if significant differences existed. The relationship between relative body fat and the endomorphic component was estimated. A correlation was presented between totalled skinfold values and absolute body weight.

A moderate relationship was found between relative fat and the endomorphic component. A moderate positive relationship was also shown between absolute body weight and skinfold thickness.

Statistically significant differences were shown in variance from the within-group mean for endomorphy. The variance was lower at higher levels of competition. No differences were found for mesomorphy and ectomorphy.

Significant differences were found in the endomorphic component between competition levels but not in the direction hypothesized. No differences were found for mesomorphy and ectomorphy.

It was determined that as the weight divisions become heavier the endomorphic and mesomorphic components increase and the ectomorphic component decreases.
CHAPTER 5

SUMMARY, MAJOR FINDINGS, CONCLUSIONS,
AND RECOMMENDATIONS

The present chapter will briefly outline the organization of the study. A summary of the study will be presented. The major findings will also be presented and conclusions will be drawn. Recommendations for further research will be submitted.

Summary

The present study was designed to determine if somatotypes among populations of wrestlers differed between levels of competition or weight divisions.

The literature revealed that athletes differ from non-athletes in somatotype distribution. The literature also revealed that the body types of athletes differ between sports and specialties within a single sport. Body composition and somatotype studies of wrestlers were presented. The "physique prototype" for wrestlers tended to be either endomorphic mesomorph or balanced mesomorph.

A comparison was made between the endomorphic component and the percent fat of 14 wrestlers who were both somatotyped and weighed underwater. The correlation was .72, with a .52 coefficient of determination. The investigator then related absolute body weight to the total of four skinfolds. The correlation was .75 with a .56 coefficient of
determination. This indicated only a moderate relationship of percent fat to the endomorphic component and that the value for total skinfolds tended to increase as the body weight increased.

The investigator somatotyped 173 varsity wrestlers from the Western Athletic Conference, The Missouri Intercollegiate Athletic Association, and seven junior colleges during the 1977-78 wrestling season. The wrestlers were divided into upper, middle, and lower competition levels and upper, middle, and lower weight groups.

Differences in the within-group variance between levels of competition were tested through the use of a one-factor analysis of variance and a test of independent variances. No differences were found in variance with the mesomorphic and ectomorphic components between levels of competition. Variance was found to be significantly less in higher competition levels with the endomorphic component.

Component differences between competition levels were tested through the use of a one-factor analysis of variance. If significant differences were found with the F test, a multiple t test was utilized to indicate where the differences were. No significant difference in the direction hypothesized were determined for any of the mean values of the components.

Differences between components at various weight groups were determined in the same manner as was used for competition level. It was determined that as the size of the weight group increased, the first and second component increased and the third component decreased.
Major Findings

The endomorphic component is moderately related to percent body fat. The value of totalled skinfolds tends to increase as the absolute weight of the subjects increase.

The within-group variance for endomorphy tends to decrease as the level of competition increases.

No difference was found between mean somatotype components at the various competition levels.

As the weight divisions in wrestling become heavier, the wrestlers competing in those divisions are higher in endomorphy and mesomorphy, and lower in ectomorphy.

Conclusions

The Heath-Carter first component has been described as referring to the relative fatness or leanness of an individual. The component is actually only moderately related to relative fatness of an individual. As the weight of subjects increase the skinfold totals also tend to increase, thereby, increasing the first component rating. The definition of the rating should reflect these distortions.

Wrestlers at high levels of competition vary less from their group mean for endomorphy than other competition levels. Coaches should attempt to recruit wrestlers whose endomorphic components do not vary a great deal from the mean endomorphic value for their weight level.

Wrestlers vary in their physiques at various weight levels. Coaches should recruit balanced mesomorphs to compete at the lower and middle weight levels. An endomorphic rating of 2.5, a mesomorphic rating
of 5 or 5.5, and an ectomorphic rating of 3 or 2.5 appears to be the physique prototype of lower and middle weight wrestlers.

There is an increase in mesomorphy and endomorphy at the upper weight levels. Here the coach should recruit wrestlers with an endomorphic mesomorph physique. The 3.5 - 6.0 - 2.0 physique appears suitable for this weight level.

The extreme endomorphic mesomorph appears to be the dominant physique for heavyweights. Extreme bulk is prevalent at the heavyweight division.

**Recommendations for Further Study**

Further study on the physique of wrestlers at various levels of competition is recommended. The following ideas for future research are suggested.

1. A study similar to the present study could be conducted. However, criteria should be determined to more accurately pinpoint the level of competition for all of the groups.

2. A study similar to the present study could be conducted using a modified Behnke Somatogram (Behnke, Guttentag, and Brodsky, 1959) instead of the Heath-Carter somatotyping method. Somatographic representation could pinpoint physique differences to particular parts of the body.

3. A somatotype comparison could be conducted in a test-retest situation. Wrestlers could be somatotyped during the off-season and re-somatotyped during the competitive season. Differences could be determined.
4. A longitudinal study could be conducted to determine if appropriate body types for a particular sport evolve as a result of training or whether a "weeding out" process occurs eliminating inappropriate physiques.
APPENDIX A

SAMPLE SUBJECT'S CONSENT FORM
ADVISED SUBJECT'S CONSENT

As a subject for the project entitled, "An Analysis of Somatotypes in Wrestlers at Various Competition Levels and Weight Divisions," I understand the following elements of the project.

The project is a Master's thesis to determine if variance from the average body type of wrestlers decreases as the level of competition increases. A secondary purpose if to determine if the average body types vary between weight divisions.

Cooperation in the project is completely voluntary. All that is involved is the measuring of height, weight, knee and elbow diameters, bicep and calf circumferences, and tricep, scapula, waist, and calf skin-folds. The entire procedure should take 3 to 5 minutes.

No physical, psychological or other personal harm can be realized due to participation in the project.

No monies or other compensation will be given, no cost or expense incurred and no benefits, other than the knowledge of my somatotype, shall result from participation in the project.

Any questions I have will be answered promptly and honestly, and I keep the option to withdraw at any time.

All data collected and any information relative to me shall be confidential and known and used only by John Williamson and members of his thesis committee. Final results will be presented using a numbered roster. A possibility exists the study may be published.

I have read the above, "Advised Subject's Consent." I fully understand the nature of my participation and responsibilities in the project. I also understand that this consent form will be filed in an area designated by the Human Subjects Committee with access restricted to the principle investigator or authorized representatives of the particular department.

SUBJECT'S SIGNATURE _______________________________ DATE __________

WITNESS' SIGNATURE _______________________________ DATE __________
APPENDIX B

SAMPLE SUBJECT'S UNDERWATER WEIGHING

CONSENT FORM
OPTIONAL UNDERWATER WEIGHING CONSENT

If time and facilities permit, a measurement of underwater weight would enhance the study. This would involve 10 trials of underwater weighing taking a total of 5 to 7 minutes.

All the elements in the, "Advised Subject's Consent," hold true for the underwater weighing.

I understand that this part of the study is completely optional and is not a requirement for participation in the study.

SUBJECT'S SIGNATURE ___________________________ DATE ___________

WITNESS' SIGNATURE ___________________________ DATE ___________
RAW DATA

NAME __________________________ COLLEGE __________________________

WEIGHT DIVISION__________

HEIGHT __________________________ cm. __________________________ in.
WEIGHT __________________________ kg. __________________________ lb.

SKIN-FOLDS

Tricep __________________________ mm.
Scapula __________________________ mm.
Suprailiac __________________________ mm.
Calf __________________________ mm.

DIAMETERS

Humerus __________________________ cm.
Femur __________________________ cm.

CIRCUMFERENCES

Biceps __________________________ cm.
Calf __________________________ cm.
APPENDIX D

MEANS AND STANDARD DEVIATIONS BY

COMPETITION LEVEL AND WEIGHT DIVISION
<table>
<thead>
<tr>
<th>Wt. Div.</th>
<th>Division I</th>
<th>Division II</th>
<th>Junior College</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>118</td>
<td>2.00</td>
<td>5.08</td>
<td>2.92</td>
<td>2.50</td>
</tr>
<tr>
<td></td>
<td>.55</td>
<td>1.16</td>
<td>1.56</td>
<td>.79</td>
</tr>
<tr>
<td>126</td>
<td>2.40</td>
<td>5.20</td>
<td>2.50</td>
<td>2.43</td>
</tr>
<tr>
<td></td>
<td>.42</td>
<td>.27</td>
<td>.61</td>
<td>.35</td>
</tr>
<tr>
<td>134</td>
<td>1.90</td>
<td>5.80</td>
<td>2.50</td>
<td>2.79</td>
</tr>
<tr>
<td></td>
<td>.42</td>
<td>.27</td>
<td>.61</td>
<td>1.04</td>
</tr>
<tr>
<td>142</td>
<td>2.00</td>
<td>5.67</td>
<td>2.75</td>
<td>2.71</td>
</tr>
<tr>
<td></td>
<td>.32</td>
<td>.52</td>
<td>.69</td>
<td>.91</td>
</tr>
<tr>
<td>150</td>
<td>2.20</td>
<td>5.60</td>
<td>3.00</td>
<td>3.00</td>
</tr>
<tr>
<td></td>
<td>.57</td>
<td>.42</td>
<td>.71</td>
<td>.45</td>
</tr>
<tr>
<td>158</td>
<td>2.10</td>
<td>5.60</td>
<td>2.60</td>
<td>2.60</td>
</tr>
<tr>
<td></td>
<td>.42</td>
<td>.22</td>
<td>.42</td>
<td>.22</td>
</tr>
<tr>
<td>167</td>
<td>2.83</td>
<td>5.92</td>
<td>2.08</td>
<td>3.42</td>
</tr>
<tr>
<td></td>
<td>.75</td>
<td>.74</td>
<td>.86</td>
<td>.74</td>
</tr>
<tr>
<td>177</td>
<td>2.40</td>
<td>6.00</td>
<td>2.20</td>
<td>4.00</td>
</tr>
<tr>
<td></td>
<td>.42</td>
<td>.79</td>
<td>.57</td>
<td>1.35</td>
</tr>
<tr>
<td>190</td>
<td>3.13</td>
<td>6.88</td>
<td>1.50</td>
<td>4.00</td>
</tr>
<tr>
<td></td>
<td>.48</td>
<td>.75</td>
<td>.41</td>
<td>.76</td>
</tr>
<tr>
<td>Overall</td>
<td>2.31</td>
<td>5.71</td>
<td>2.48</td>
<td>3.05</td>
</tr>
<tr>
<td></td>
<td>.59</td>
<td>.75</td>
<td>.85</td>
<td>.97</td>
</tr>
<tr>
<td>Hwt.</td>
<td>5.88</td>
<td>8.50</td>
<td>.63</td>
<td>6.00</td>
</tr>
<tr>
<td></td>
<td>1.93</td>
<td>1.87</td>
<td>.25</td>
<td>1.08</td>
</tr>
</tbody>
</table>
LIST OF REFERENCES


