This study was designed to compare body composition over the course of a season in several intercollegiate women's athletics teams. Four basketball (BB) players, 18 cross country (CC) runners, 9 gymnasts (GYM), 10 swimmers (SW), and 7 volleyball (VB) players from the University of Wisconsin-La Crosse, an NCAA Division III school, volunteered for the study. Body composition was determined through hydrostatic weighing, and a questionnaire examining the desire to lose or gain weight and aerobic activity pattern was given at the beginning and end of each athletic season. Using a 2-way mixed design ANOVA with repeated measures, the statistical analysis of the body composition variables showed the GYM and SW significantly (p < .05) decreased percent body fat over the course of their seasons. At the early season, CC runners and GYM had significantly (p < .05) less body weight and fat weight (FW) than VB players, SW, and BB players. CC runners also had significantly (p < .05) less fat-free weight (FFW) than all other teams. VB players had significantly (p < .05) greater FFW than the GYM and SW, whereas the BB players only had significantly (p < .05) greater FFW than the gymnasts. Late season differences were the same as early season differences with the exceptions that the BB players no longer had significantly (p > .05) greater FFW than GYM, nor significantly (p > .05) greater FW than the CC runners. The results of the study suggest that body composition among athletic teams varies, which may be a result of the unique training techniques and expertise required for different sports. Further research should involve the evaluation of body composition and its relation to athletes and their performance.
EFFECTS OF A COMPETITIVE SEASON ON BODY COMPOSITION
IN FEMALE INTERCOLLEGIATE ATHLETES

A THESIS PRESENTED
TO
THE GRADUATE FACULTY

IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE
MASTER OF SCIENCE DEGREE

BY
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COLLEGE OF HEALTH, PHYSICAL EDUCATION, AND RECREATION
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THESIS FINAL ORAL DEFENSE FORM

Candidate: Salena T. Williams

We recommend acceptance of this thesis in partial fulfillment of this candidate's requirements for the degree:

Master of Science in Adult Fitness/Cardiac Rehabilitation

The candidate has successfully completed her final oral examination.

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This thesis is approved by the college of Health, Physical Education, and Recreation.

[Signatures]

Associate Dean, College of Health, Physical Education, and Recreation  Date

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CHAPTER I
INTRODUCTION

Background

Athletes, as well as coaches, have often wondered how to increase speed, strength, and endurance in order to perform at top competitive levels. Some factors thought to influence athletic performance include body composition, nutrition, training levels, sleep patterns, self-confidence, and relaxation techniques.

Body composition, in particular, has been related to athletes and their performance in numerous research studies (Bale, 1991; Clarke, Wrenn, & Vaccaro, 1979; Loftin, Warren, & Mayhew, 1992; Siders, Lukaski, & Bolonchuk, 1993). What is an athlete's optimal percent body fat? Does an athlete's percent body fat change over a competitive season? These questions and many more have been researched in relation to several sports (Loftin et al., 1992; Meleski & Malina, 1985; Vercruyssen & Shelton, 1988; Wade, 1976), and often are related to the performance in these sports (Bale, 1991; Clarke et al., 1979; Loftin et al., 1992; Siders et al., 1993). However, there has been little research comparing the body composition of athletes from several different sports and how a competitive season influences those values.
Participation in different sports requires various abilities, activities, and expertise unique to the sport. Body composition also tends to vary as a result of these different requirements among sports. Once these differences are defined and understood, athletes and coaches will be more knowledgeable on the range of body fat optimal for training and competition within one’s particular sport.

**Purpose of the Study**

The purpose of this study was to compare early season and late season body composition levels within and among the women’s athletic teams of basketball, cross country, gymnastics, swimming, and volleyball at the University of Wisconsin-La Crosse (UW-L), an NCAA Division III school.

**Hypothesis**

The hypothesis for this study was there would be no significant differences between early and late season measurements of body composition within and among various UW-L women’s athletic teams during the 1994-95 season.

**Assumptions**

The following assumptions were made in this study:

1. All subjects felt comfortable throughout the hydrostatic weighing procedure, blew out all air possible both above and below the water, and were in a normal state of hydration.
2. The density of fat and lean body weight are known. Fat density is assumed to be .900 gm cc\(^{-1}\) and lean tissue density is assumed to be 1.100 gm cc\(^{-1}\) (Siri, 1956).

3. The density of both fat and lean body tissues are constant among all individuals.

4. All subjects abstained from food intake at least 4 hours prior to underwater weighing.

5. All subjects' data were collected in a similar and accurate method by the researcher.

Delimitations

Only the UW-L women's intercollegiate basketball, cross-country, gymnastics, swimming, and volleyball athletic teams participated in the study.

Limitations

Volunteers were asked to participate in the study rather than a true random sample of subjects. The athletes were also asked to complete a questionnaire for a coinciding thesis dealing with the topics of body image, menstrual function, and weight control methods. Due to the personal nature of the questionnaire, sample sizes within the athletic teams were lower than expected.

Definition of Terms

**Athlete** - an eligible member of one of the UW-L women's intercollegiate sport teams. This study included female athletes who trained and participated in meets or games.
throughout the season of their specific sport.

**Body Composition** - the various physical components of the human body as determined through hydrostatic weighing, including fat weight, fat-free weight, body density, and percent body fat.

**Body Density** - the specific gravity of the body as measured by hydrostatic weighing. Body density is a ratio of body mass to body volume.

**Competitive Season** - the time beginning with the first official practice and ending with the final conference meet or game in which the athletes are able to compete.

**Early Season** - the first two weeks of official coach-supervised, on-site practice for a sport, preceded by an eligibility meeting and a team meeting (i.e., beginning with the date of the first practice).

**Fat-Free Weight** - the weight of all materials excluding fat within the body (muscles, bones, water, tissues, and organs). Calculated as body weight minus fat weight as determined through hydrostatic weighing.

**Fat Weight** - the weight of fat within the body, including essential fat, sex-specific fat, and storage fat. Calculated as body weight times percent body fat as determined through hydrostatic weighing.

**Late Season** - the last 2 weeks of official coach-supervised, on-site practice before conference competition or equivalent competition representing the conclusion of the regular
season (i.e., the 2 weeks preceding the date of the last competition).

NCAA Division I - a college or university that may provide students the opportunity for full scholarships based on athletic ability (National Collegiate Athletic Association [NCAA], 1994).

NCAA Division II - a college or university that may provide students the opportunity for partial scholarships based on athletic ability (NCAA, 1994).

NCAA Division III - a college or university that may not allow student financial aid based on athletic ability (NCAA, 1994).

Percent Body Fat - the percent fat a person has in relation to their body weight as determined through hydrostatic weighing.
CHAPTER II
REVIEW OF RELATED LITERATURE

Introduction

Body fat is an essential component of the human body. It serves to protect vital organs, to preserve body heat, and give insulation (National Association for Sport and Physical Education [NASPE] et al., 1984). As a result of body fat serving these vital functions, there is a fat level that is considered to be essential. According to Smith and Worthington-Roberts (1989), the essential fat value for men is a minimum of 3% total body weight and for women a minimum of 12% total body weight. Women have a higher percent of essential fat due to child bearing functions and the inclusion of sex-specific fat in the breasts and other tissues (Smith & Worthington-Roberts, 1989). The essential fat percentages, however, do not include storage fat values for energy purposes. Therefore, in order to perform day to day physical activities, almost all men and women have a fat percentage greater than 3 and 12%, respectively.

Body composition can be influenced by many factors, including heredity and one’s social environment. It has been noted, however, that athletes on average are leaner than nonathletes (NASPE et al., 1984). Whereas everyone has
a range of body weight optimal for health reasons, athletes may have an optimal range of body weight which maximizes performance (Berning & Steen, 1991). High levels of body fat in some athletes may hinder performance, thus causing athletes to strive for lower body fat values.

In defining optimal levels of body fat for athletes, as well as for the general population, a range of fatness rather than one specific value should be recommended. The range for male athletes is 7-15% body fat and the range for female athletes is 12-25% body fat (Smith & Worthington-Roberts, 1989). Smith and Worthington-Roberts simplify the most effective weight for athletes as one with a healthy hydration level, optimal muscle mass, and a lack of excessive fat.

**Methods of Measuring Body Composition**

When measuring body composition, the two most popular techniques are hydrostatic weighing and skinfold measurements. Hydrostatic weighing has a variance of approximately ± 3.8% (Siri, 1956) resulting from four major sources: a variance in the water content of the body, a variance in protein to bone mineral ratio, a variance in the density of obesity tissue, and a variance in fat content (Katch & Katch, 1980). Skinfold equations are based on hydrostatic weighing, and have often been studied as to their reliability and validity in measuring percent body fat. Most studies involving skinfolds compare their results
to those of hydrostatic weighing. Katch and McArdle (1973) found a correlation value of .86 when using only skinfolds, whereas Jackson and Pollock (1980; 1978) found correlation values of .90, .91, and .89 for three separate equations for men and .85, .84, and .83 for three separate equations for women. The equations developed by Jackson and Pollock (1980; 1978), however, included both skinfolds and age.

Skinfold equations have been developed for both specific populations and generalized populations. The use of skinfold equations with athletes, however, may lead to overestimations of percent body fat due to their typically higher body densities and lower percent body fat (Brownell, Rodin, & Wilmore, 1992). In general, hydrostatic weighing is seen as the most accurate method for predicting or estimating body composition (Wilmore & Costill, 1982), especially for a variety of athletic populations.

**Basketball**

Basketball is a sport where several demands are placed on the players, including the use of anaerobic alactic, anaerobic lactic, and aerobic energy systems. Other aspects affecting performance are muscular strength, muscular power, flexibility, and body composition (Smith & Thomas, 1991).

Several studies have measured and described the physical characteristics of female basketball players (Bale, 1991; Berg, Blanke, & Miller, 1985; DeFrank, 1984; Smith & Thomas, 1991; Spurgeon, Spurgeon, & Giese, 1980). Smith and
Thomas (1991) studied 31 elite basketball players from the Canadian National Women’s Basketball Team. The average mass of the players was 74.5 kg and the average height was 181.8 cm. A similar study by Spurgeon et al. (1980) involved 84 elite players from around the world. The players had a mean age of 22.1 years, with weight and height averages of 70.1 kg and 179.2 cm, respectively. Fat percentages were calculated using the Sloan, Burt, and Blyth (1962) skinfold measurements with an average of 17.6%. The separate teams within the study ranged from 17.2 to 17.9% body fat. It was assumed that a body fat percentage between 17 and 18% could be considered an optimal range for female basketball players of elite, world-class ability due to the similar results seen among the teams.

Bale (1991) also studied a group of elite basketball players. Unlike the previously mentioned studies (Smith & Thomas, 1991; Spurgeon et al., 1980), Bale looked at younger players with an average age of 15.6 years. Mean body weight and height were 62.6 kg and 170.6 cm, respectively, with an average body fat of 18%. Fat weight was calculated at 11.5 kg, and lean or fat-free weight was calculated at 52.1 kg. Fat percentage, fat weight, and fat-free weight were all calculated through the use of skinfold measurements and using a generalized prediction equation developed by Jackson and Pollock (1985). These results were fairly similar to other studies of elite basketball players (Smith & Thomas,
1991; Spurgeon et al., 1980), considering the age difference of the subjects.

There have been studies of intercollegiate basketball teams as well. Berg et al. (1985) studied 13 members of the 1982-83 University of Nebraska-Omaha basketball team, an NCAA Division II team. The players were 20.4 years, weighed 69.5 kg, and were 176.9 cm tall. Hydrostatic weighing was used to determine percent body fat, lean body weight, and fat weight. The mean values were 22.5%, 52.2 kg, and 15.4 kg, respectively. Although the average weight of these collegiate basketball players was similar to elite basketball players, their percent fat was much greater (Spurgeon et al., 1980).

Johnson et al. (1989) compared the body composition of several university teams both pre- and postseason. Using the technique of hydrostatic weighing, eight NCAA Division I basketball players started the season with a 20.8% body fat average and ended the season with a 20.4% body fat average. Fat-free weight increased from 55.5 to 55.7 kg, whereas fat weight decreased from 14.9 to 14.3 kg. Body weight changed from 70.3 to 70.0 kg. None of the changes from pre- to postseason were significant.

Siders et al. (1991) did a similar study on both male and female NCAA Division II basketball teams. Seven female players with an average age of 19.8 years were included. Preseason measurements included an average height of
177.4 cm and an average weight of 68.8 kg. Hydrostatic weighing was used to compute percent body fat, fat-free weight, and fat weight, with results of 20.5%, 54.7 kg, and 14.1 kg, respectively. Over the course of the season, body weight nonsignificantly decreased by .6 kg, fat weight significantly decreased by 2.6 kg, and fat-free weight significantly increased by 2.0 kg. Although the early season values were extremely similar to those obtained by Johnson et al. (1989), the subsequent changes in data after completing a competitive season were found to be significant.

Cross Country

Cross country runners are athletes who possess one of the lowest percent body fat levels in athletics. Whereas lower fat levels are recommended for optimal athletic performance, the normal range for elite distance runners is 5-12% for males and 8-15% for females (Brownell et al., 1992).

As with basketball, there have been a number of studies focusing on cross country or long distance running. Graves, Pollock, and Sparling (1987) studied the body composition of both elite and good female runners. Elite runners were successful national and international competitors who trained an average of 64.5 ± 15.8 miles per week. Good runners competed on a local level and trained, on average, 39.1 ± 8.1 miles per week. Through underwater weighing, the
elite runners averaged 47.2 kg body weight, with a corresponding 14.3% body fat. The good runners had a mean weight of 49.4 kg and 16.8% body fat. Although there was a 2.5% difference in percent fat and a 2.2 kg difference in weight, there were no statistically significant differences between the body composition of elite and good distance runners.

Novak, Woodward, Bestit, and Mellerowicz (1977) studied female runners, swimmers, and gymnasts at the 1972 Olympic Games in Munich, Germany. The runners weighed an average of 57.0 kg and using the hydrostatic weighing method, had a mean body fat level of 13.3%. When compared to a similar study (Graves et al., 1987), the Olympic runners' weight corresponded to good runners, whereas their percent body fat corresponded closer to elite runners. This simply shows that these Olympic athletes had more lean body weight than the elite runners.

Similar results were found by Withers et al. (1987). Fourteen South Australian long distance runners weighed an average of 50.2 kg, and from the underwater weighing procedure averaged 13.5% body fat. They also had greater lean body weight than the elite runners from the study by Graves et al. (1987).

Loftin et al. (1992) studied five female runners from the University of New Orleans, an NCAA Division I school, throughout their competitive season. Their body weight
remained constant at 55.0 kg, with percent fat decreasing without significance (19.2 to 18.9%), and fat-free weight slightly increasing (44.5 to 44.7 kg) without significance. Body composition was measured using underwater weighing.

Larson (1984) studied 29 female cross country runners at the UW-L (NCAA Division III). Their body weight significantly increased from 55.1 to 55.9 kg throughout the season, whereas they decreased their percent body fat from 17.4 to 17.1%. This decrease, however, was not significant. Body composition was determined through hydrostatic weighing, and showed the runners to have a greater percent body fat than elite and Olympic level runners (Graves et al., 1987; Novak et al., 1977), yet lower percent body fat than the intercollegiate runners at the University of New Orleans (Loftin et al., 1992).

**Gymnastics**

Gymnasts require intense training, yet they do not use large expenditures of energy for competition. The rotation of events in gymnastics requires mostly short duration, explosive, and aesthetic qualities. As a result, weight control can be a major concern for gymnasts and gaining weight is a common problem. Gymnasts realize that becoming overweight can hinder their performance, which may subsequently lead to diet related problems. These problems, however, are much more prevalent among female gymnasts than male gymnasts (Smith & Worthington-Roberts, 1989).
Moffatt, Surina, Golden, and Ayres (1984) studied a group of high school gymnasts with a mean age of 15.2 years. Their weight averaged 50.4 kg and their body fat averaged 13.1% (through underwater weighing), corresponding to 6.6 kg fat weight and 43.8 kg fat-free weight.

Johnson et al. (1989) studied NCAA Division I collegiate gymnasts both before the competitive season and at the end of the competitive season. Early season measurements averaged 50.5 kg body weight and 18.3% body fat, which calculates to 9.5 kg fat weight and 41.0 kg fat-free weight. Body composition measurements were made using the underwater weighing technique. These values differ greatly from the high school gymnasts studied by Moffatt et al. (1984). Whereas the body weights in college and high school gymnasts were similar, the intercollegiate gymnasts had a level of body fat approximately 5.7% higher than the high school gymnasts. This difference in fat percentage may be due to maturation changes or differences in training intensity. Over the course of the season, the intercollegiate gymnasts decreased their average weight to 49.4 kg and their fat percent significantly decreased to 14.5%, which represents a decrease of 4.3%. As a result, their fat weight significantly decreased to 7.4 kg and their fat-free weight significantly increased to 42.1 kg.

Vercruysse and Shelton (1988) concentrated on the body composition changes over the course of a competitive season
of eight members from the University of Denver (NCAA Division II) women's gymnastics team. Weight and skinfold measurements were collected at three points throughout the season: pre-, mid-, and postseason. Body fat, body density, and lean body weight were computed using the Sinning and Lindberg (1972) regression equation for college female gymnasts. Weight changed from 55.1 to 53.6 to 53.9 kg, respectively. The weight change from pre- to midseason was significant, yet from mid- to postseason was not significant. Percent body fat measurements significantly declined from 21.4 to 17.4% and lastly to 13.3%. Although the body weights and percent fat values of these gymnasts were greater than other collegiate teams (Johnson et al., 1989), there was a more drastic decrease from early season to late season in regards to fat percentage.

Swimming

In relation to body composition, the sport of swimming has been thoroughly researched. The added factors of buoyancy and athletic divisions within swimming (i.e., sprint, middle distance, distance, and stroke specific swimmers) may be the justification of these numerous articles and studies. Most competitive swimmers train very intensely, causing proper diet and body composition levels to become especially important (Smith & Worthington-Roberts, 1989).
Spurgeon and Giese (1984) studied a group of world-class female swimmers in the aspect of body composition. They found 90 swimmers to have an average body weight of 62.5 kg, with sprint swimmers weighing the most (average of 64.5 kg) and 200-yard butterfliers weighing the least (average of 59.3 kg). In contrast, however, the skinfold equation developed by Sloan et al. (1962) showed the long distance swimmers had the highest percent body fat (19.2%) and the backstrokers had the lowest percent body fat (16.9%). The mean body composition for all 90 subjects was 17.7% fat.

Meleski, Shoup, and Malina (1982) studied 19 intercollegiate women from the University of Texas-Austin swim team (NCAA Division I). Their average weight was 56.0 kg and their average percent body fat was 16.1% using the underwater weighing method. Although the swimmers were not divided into their specialty events, their average weight and body fat percentage were both lower than the elite swimmers studied by Spurgeon and Giese (1984).

Siders et al. (1993) studied 23 sprint swimmers from the University of North Dakota, an NCAA Division II school, over the course of their competitive season. These swimmers averaged 63.3 kg body weight and 24.4% body fat as determined through hydrostatic weighing, which corresponded to 15.6 kg fat weight and 47.7 kg fat-free weight. By the end of the season, their weight increased by .2 kg, body fat
percentage decreased by 1.1%, fat weight decreased by .6 kg, and fat-free weight increased by .9 kg. Only the fat-free weight increase, however, was significant.

Meleski and Malina (1985) also studied competitive swimmers over the course of a season. The 15 subjects from the University of Texas-Austin averaged a body weight of 60.4 kg and a fat percentage of 18.3% when using the hydrostatic weighing procedure. At the end of the season, these numbers significantly decreased to 59.9 kg and 15.7%, respectively. These results were lower and demonstrated a greater change throughout the season when compared to Siders et al. (1993). This study differed in that measurements were taken three times over the course of the season: early, middle, and end. Fat percentages were significantly different both from early to middle season and from middle to late season. It was found, however, that the most significant changes occurred during the first part of the season when training was more intense and covered more yardage.

A similar study across a swimming competitive season was done by Johnson et al. (1989). Sixteen NCAA Division I female swimmers were found to have a mean weight of 62.3 kg and body fat of 22.0% during preseason. Fat weight and fat-free weight, therefore, averaged 13.8 and 48.6 kg, respectively. Postseason results for body weight was 62.6 kg and for body fat 22.2%. All body composition
measurements were taken by the underwater weighing method. The slight gain in weight reported by Johnson et al. (1989) has been reported by others (Siders et al., 1993; Siders et al., 1991), whereas the increase in percent body fat has not been seen in previous research. The increase in percent body fat subsequently caused the fat weight to increase to 14.0 kg and the fat-free weight to decrease to 48.6 kg. Although changes in body composition were seen over the course of a season, none were significant.

**Volleyball**

Body composition and its relation to volleyball has not been researched in the depth it has with several other sports. There have, however, been a few authors who included volleyball in their investigation of sports and its effect on body composition.

Through underwater weighing, Sady and Freedson (1984) compared the male and female body compositions from several different sports. Twenty-four female volleyball players averaged a body weight of 66.5 kg and body fat percentage 18.6%. Their fat weight and fat-free weight were 12.4 and 54.2 kg, respectively.

Johnson et al. (1989) studied volleyball players from pre- to postseason. Fourteen NCAA Division I players were studied, with a mean weight of 67.7 kg and body fat of 19.4% through hydrostatic weighing. This equated to 13.3 kg fat weight and 54.5 kg fat-free weight. These preseason figures
were slightly higher than those previously reported by Sady and Freedson (1984). The postseason results showed nonsignificant increases in percent body fat (1.5%) and fat weight (.9 kg), whereas there was a significant decrease in fat-free weight (1.05 kg).

**Summary**

Body composition levels are important indicators of health and physical fitness. Athletes also realize the competitive edge or benefit to certain levels of body composition. Research involving athletes, however, can be difficult in that there is no one correct definition of an athlete. For example, the NCAA divides schools and their athletes into three main divisions: I, II, and III. In general, Division I is seen as the group with the highest level of overall performance, with Divisions II and III following in respective order. As a result, most studies dealing with athletes include either elite level or Division I athletes. Division II athletes will sometimes be studied, whereas studies on Division III athletes are seldom seen.

As with any regular physical fitness, body composition should change over the course of a competitive season for athletes at all levels. By studying these changes throughout the season of several sports, athletes and coaches may be able to identify what level of body composition is optimal for maximal performance.
CHAPTER III
METHODS

Introduction

The purpose of this study was to identify any body composition changes that occur over the course of a season among the women's athletics teams of basketball, cross country, gymnastics, swimming, and volleyball at the University of Wisconsin-La Crosse (UW-L). The present study on body composition coincided with another study which investigated body image, menstrual function, and weight control methods in athletes.

Subject Selection and Preparatory Procedures

Subjects volunteered for the study from the UW-L women's intercollegiate basketball, cross country, gymnastics, swimming, and volleyball teams during the 1994-95 season. Explanations of the testing procedures and confidentiality of the study were given to all interested athletes. Subjects interested in participating were asked to complete both the underwater weighing for the present study, as well as the questionnaire for the coinciding study at early and late season. Unfortunately, the questionnaire required by the corresponding study dealt with some personal issues (i.e., body image, menstrual function, and weight
control methods), which possibly reduced the number of subjects willing to participate in the present study.

Upon volunteering, subjects were required to sign an informed consent (see Appendix A) which had received approval from the University Human Subjects Review Board. Subjects then signed up for a testing date and time (see Appendix B) and received a reminder slip of their scheduled test (see Appendix C). If any subjects were under the age of eighteen, an informed consent (see Appendix A) was sent home to be signed by their parent or guardian prior to any testing procedures.

Test dates varied in accordance with the competitive season for the five teams. The early season test was conducted within the first 2 weeks of official practices, and the late season test was completed within the last 2 weeks of practices and conference competition. Each subject's name, age, height, weight, and sport were initially recorded. The heights and weights were measured with dry swim suits on, without shoes, and to the nearest .25 cm and kg, respectively. All subjects were also asked to complete a questionnaire pertaining to weight loss, weight gain, and exercise activities (see Appendix D) at both the early and late season testing periods.

**Residual Volume**

Each subject performed two vital lung capacity tests prior to any residual volume or hydrostatic weighing tests.
A Collins (Braintree, MA) 9 L vitalometer was used to obtain the vital lung capacity values. Subjects were instructed to maximally inhale, seal their lips around the cardboard tube connected to the spirometer, and exhale maximally into the tube. The average value acquired from the two trials was rounded up to the nearest liter in order to obtain the bag volume for the residual volume test.

The residual volume test occurred while the subjects were immersed in the hydrostatic weighing tank at shoulder level. Residual volume was obtained through the closed circuit oxygen dilution method (Wilmore, 1969). An electric nitrogen analyzer (Med Science 505 Nitralyzer, Needham Heights, MA) was used to accurately measure the gas expired and respired throughout the testing procedure. The nitrogen content level was recorded by a chart recorder over the entire testing period. Prior to each residual volume test, the chart recorder was calibrated and the rebreathing bag was flushed with oxygen and emptied with a vacuum pump. A predetermined oxygen bag volume was selected from the results of the vital lung capacity test and filled to that level. The subject indicated when they were ready with a noseclip in place, and were instructed to forcefully expire all air possible. The subject raised a finger which signaled the researcher to connect the subject to the rebreathing bag. Once the connection was made, the subject was instructed to deeply breathe in and to follow with very
deep, rapid breaths in and out. This process continued until the chart recorder displayed a relative state of equilibrium. The residual volume (RV) was calculated using the following equation (Wilmore, 1969):

\[
RV = \frac{(VO_2)(EN - IN)}{AN - FN - RVDS}[1.1]
\]

\(VO_2\) = initial volume of \(O_2\) in spirometer system including dead space between breathing valve and spirometer bell (.034L)

\(EN\) = percent nitrogen at equilibrium

\(IN\) = impurity of nitrogen

\(AN\) = percent of alveolar nitrogen

\(FN\) = percent of final nitrogen

\(RVDS\) = mouthpiece dead space (.070L)

Hydrostatic Weighing

The hydrostatic weight was measured by electronic load cells that suspend the underwater chair. The voltage measured at the load cell is converted into weight through an automated computer program. The value used to represent the subject's weight was an average of 100 readings per trial by the computer.

The weight of the hydrostatic weighing chair was calibrated before each subject went through the testing procedure. Once the subject completed the residual volume tests, the subject knelt down with the water level at their neck and with very little water motion. At this time, the computer zeroed the hydrostatic weighing chair. Two 2 kg weights were then placed on each side of the chair, and the computer calibrated the load cell reading to 4 kg. After
this calibration, the weights were removed and the subject moved to a sitting position on the chair.

Subjects removed any possible trapped air within their swim suits and hair, which helps to obtain more accurate results. Each subject was instructed to grab the lower sides of the chair with both hands, and to slowly exhale all air possible while lowering their head to their legs until the entire body was submerged. When no more air could be expired, the subject pointed both index fingers forward, signaling the researcher to have the computer read the weight of the subject. Once this value was displayed on the computer screen, the subject was told to come up for air. This process was repeated a minimum of five times in order for the subject to become accustomed to the testing procedure as well as to obtain several similar trial results. The average of 2 to 4 trials which were within .05 kg of each other was used in the body density equation as the subject’s mass underwater. Body density (BD) and percent fat (Siri, 1956) were calculated using the following equations:

\[
BD = \frac{MA}{MA - MW} - \frac{RV}{DW} + .1L
\]

MA = mass in the air (kg)
MW = mass under water (kg)
DW = density of water (kg/L)
RV = residual volume (L)

\[
% \text{ fat} = \frac{495}{BD} - 450
\]
Statistical Treatment

In addition to standard descriptive statistics, a two-way ANOVA with repeated measures was used to determine whether significant differences existed between early and late season body composition variables (body weight, percent fat, fat-free weight, and fat weight) among the basketball, cross country, gymnastics, swimming, and volleyball athletic teams. Tukey post hoc tests were used to distinguish which means were significantly different from each other. An alpha level of .05 was used for significance.
CHAPTER IV

RESULTS AND DISCUSSION

Introduction

The purpose of this investigation was to compare body composition over the course of a season in several intercollegiate women's athletic teams. Each subject completed two hydrostatic weighing tests: one during the first 2 weeks of official practice (early season) and one during the last 2 weeks of practice prior to conference competition (late season). Variables examined during both tests included body weight, percent body fat, fat-free weight, and fat weight.

Subjects

Forty-eight subjects from the UW-L intercollegiate women's athletic teams volunteered as subjects: 4 basketball players, 18 cross-country runners, 9 gymnasts, 10 swimmers, and 7 volleyball players. Subject characteristics are presented in Table 1.

The low numbers of participants in the present study may be attributed to the coinciding study on body image, menstrual function, and weight control methods. These personal issues may have deterred some athletes from participating in the body composition study. Other possible
Table 1. Means and standard deviations for subjects' physical characteristics

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Age (yrs)</th>
<th>Height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basketball</td>
<td>4</td>
<td>18.8*</td>
<td>169.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.5**</td>
<td>3.1</td>
</tr>
<tr>
<td>Cross Country</td>
<td>18</td>
<td>19.1</td>
<td>165.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.4</td>
<td>6.9</td>
</tr>
<tr>
<td>Gymnastics</td>
<td>9</td>
<td>19.3</td>
<td>161.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.3</td>
<td>4.9</td>
</tr>
<tr>
<td>Swimming</td>
<td>10</td>
<td>18.9</td>
<td>167.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0</td>
<td>8.3</td>
</tr>
<tr>
<td>Volleyball</td>
<td>7</td>
<td>19.6</td>
<td>170.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.4</td>
<td>6.3</td>
</tr>
</tbody>
</table>

* mean
** standard deviation

reasons for low subject participation include fear of water, lack of coach encouragement, and lack of interest.

Although 66 athletes participated in the early season testing, only 48 subjects completed both the early and late season testing. One basketball player, four cross country runners, two gymnasts, seven swimmers, and four volleyball players did not return for late season testing. Reasons for dropping out of the study included quitting their athletic team, getting injured throughout the season, lack of time availability, and loss of interest in the study.
Results

A two-way ANOVA with repeated measures was utilized to determine whether significant differences existed between the early season and late season body composition variables among the basketball, cross country, gymnastics, swimming, and volleyball athletics teams. Table 2 summarizes the variable means and standard deviations at early and late season within each intercollegiate team.

Early season differences among teams showed the cross country runners and gymnasts to have significantly (p < .05) lower body weights and fat weights than volleyball players, swimmers, and basketball players. Cross country runners also had significantly (p < .05) less fat-free weight than any other teams. In addition, volleyball players had significantly (p < .05) greater fat-free weights than both the gymnasts and swimmers, whereas the basketball players only had significantly (p < .05) greater fat-free weights than the gymnasts. Early season percent body fat showed no significant (p > .05) differences among the five teams.

All teams with the exception of volleyball showed a decrease in body weight from early to late season. A decrease in percent body fat and fat weight, and an increase in fat-free weight were seen across the course of all their respective seasons. All seasonal changes, however, were minimal and nonsignificant (p > .05) with the exception
Table 2. Means and standard deviations of body composition variables for all teams early and late season

<table>
<thead>
<tr>
<th>Team</th>
<th>n</th>
<th>Weight (kg)</th>
<th>Percent Fat (%)</th>
<th>FFW (kg)</th>
<th>FW (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basketball (BB) Early</td>
<td>4</td>
<td>63.2&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>22.4</td>
<td>49.1</td>
<td>14.1&lt;sup&gt;b,c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.8**</td>
<td>2.8</td>
<td>4.3</td>
<td>1.9</td>
</tr>
<tr>
<td>Late</td>
<td>4</td>
<td>61.9&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>20.1</td>
<td>49.6&lt;sup&gt;c&lt;/sup&gt;</td>
<td>12.4&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cross Country (CC) Early</td>
<td>18</td>
<td>56.5&lt;sup&gt;f,e&lt;/sup&gt;</td>
<td>21.1</td>
<td>44.5&lt;sup&gt;b,d,e,f&lt;/sup&gt;</td>
<td>12.0&lt;sup&gt;f,e&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.7</td>
<td>4.5</td>
<td>4.4</td>
<td>3.1</td>
</tr>
<tr>
<td>Late</td>
<td>18</td>
<td>56.4&lt;sup&gt;f,e&lt;/sup&gt;</td>
<td>20.9</td>
<td>44.6&lt;sup&gt;b,d,e,f&lt;/sup&gt;</td>
<td>1.9&lt;sup&gt;f,e&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.5</td>
<td>4.0</td>
<td>4.3</td>
<td>2.8</td>
</tr>
<tr>
<td>Gymnastics (GYM) Early</td>
<td>9</td>
<td>58.4&lt;sup&gt;h,g&lt;/sup&gt;</td>
<td>19.6&lt;sup&gt;e&lt;/sup&gt;</td>
<td>46.8</td>
<td>11.6&lt;sup&gt;h,g&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.7</td>
<td>5.6</td>
<td>4.8</td>
<td>3.7</td>
</tr>
<tr>
<td>Late</td>
<td>9</td>
<td>58.1&lt;sup&gt;h,g&lt;/sup&gt;</td>
<td>17.1</td>
<td>48.1</td>
<td>10.0&lt;sup&gt;h,g&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.8</td>
<td>4.5</td>
<td>5.5</td>
<td>2.6</td>
</tr>
<tr>
<td>Swimming (SW) Early</td>
<td>10</td>
<td>63.9</td>
<td>24.3&lt;sup&gt;e&lt;/sup&gt;</td>
<td>48.2&lt;sup&gt;i&lt;/sup&gt;</td>
<td>15.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.2</td>
<td>5.6</td>
<td>5.7</td>
<td>5.0</td>
</tr>
<tr>
<td>Late</td>
<td>10</td>
<td>63.2</td>
<td>21.9</td>
<td>49.3&lt;sup&gt;i&lt;/sup&gt;</td>
<td>13.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.8</td>
<td>4.2</td>
<td>5.7</td>
<td>3.2</td>
</tr>
<tr>
<td>Volleyball (VB) Early</td>
<td>7</td>
<td>65.1</td>
<td>22.0</td>
<td>50.6&lt;sup&gt;h&lt;/sup&gt;</td>
<td>14.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.6</td>
<td>4.7</td>
<td>3.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Late</td>
<td>7</td>
<td>65.7</td>
<td>21.3</td>
<td>51.6&lt;sup&gt;h&lt;/sup&gt;</td>
<td>14.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4</td>
<td>3.4</td>
<td>3.1</td>
<td>3.2</td>
</tr>
</tbody>
</table>

* mean  
** standard deviation  
FFW = fat-free weight  
FW = fat weight

Significant (p < .05) differences  
a = early season v. late season  
b = BB vs. CC  
c = BB vs. GYM  
d = CC vs. GYM  
e = CC vs. SW  
f = CC vs. VB  
g = GYM vs. SW  
h = GYM vs. VB  
i = SW vs. VB  

of a significant \((p < .05)\) decrease in percent body fat for the swimmers and gymnasts.

Late season differences among teams changed slightly from the early season differences. Basketball players no longer had a significantly \((p > .05)\) greater fat-free weight than gymnasts, nor a significantly \((p > .05)\) greater fat weight than cross country runners. As with the early season, there were no significant \((p > .05)\) differences among the teams for percent body fat.

The questionnaire results presented in Table 3 gave information on athletes trying to lose or gain weight, and whether aerobic activity was done prior to or during the competitive season. With the exception of one gymnast, none of the subjects within the five athletic teams were trying to gain weight either prior to or during the season. Fifty percent of the basketball players, however, were trying to lose weight, and all players had been participating in other exercises prior to the season.

Sixty-seven percent of the cross country team was trying to lose weight, with all but one of the runners performing aerobic exercises prior to the start of the season. Approximately half of the cross country subjects continued extra activities throughout their season, and at the late season testing, those continuing to attempt to lose weight dropped to 56\%.
Table 3. Percentage and number of athletes trying to gain or lose weight and performing aerobic exercise both prior to and during their competitive seasons

<table>
<thead>
<tr>
<th>Team</th>
<th>n</th>
<th>Desire to Gain Wt.</th>
<th>Desire to Lose Wt.</th>
<th>Aerobic Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0%* (0)**</td>
<td>50% (2)</td>
<td>100% (4)</td>
</tr>
<tr>
<td>Basketball</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior</td>
<td>4</td>
<td>0% (0)</td>
<td>25% (1)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>During</td>
<td>4</td>
<td>0% (0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross-Country</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior</td>
<td>18</td>
<td>0% (0)</td>
<td>67% (12)</td>
<td>94% (17)</td>
</tr>
<tr>
<td>During</td>
<td>18</td>
<td>0% (0)</td>
<td>56% (10)</td>
<td>44% (8)</td>
</tr>
<tr>
<td>Gymnastics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior</td>
<td>9</td>
<td>11% (1)</td>
<td>67% (6)</td>
<td>56% (5)</td>
</tr>
<tr>
<td>During</td>
<td>9</td>
<td>11% (1)</td>
<td>44% (4)</td>
<td>44% (4)</td>
</tr>
<tr>
<td>Swimming</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior</td>
<td>10</td>
<td>0% (0)</td>
<td>50% (5)</td>
<td>60% (6)</td>
</tr>
<tr>
<td>During</td>
<td>10</td>
<td>0% (0)</td>
<td>30% (3)</td>
<td>10% (1)</td>
</tr>
<tr>
<td>Volleyball</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior</td>
<td>7</td>
<td>0% (0)</td>
<td>57% (4)</td>
<td>86% (6)</td>
</tr>
<tr>
<td>During</td>
<td>7</td>
<td>0% (0)</td>
<td>14% (1)</td>
<td>43% (3)</td>
</tr>
</tbody>
</table>

* percentage  
** number of athletes

Sixty-seven percent of the gymnasts were trying to lose weight prior to the start of their season, which dropped to 44% over the course of their season. Approximately 50% of the gymnasts were performing aerobic activities both prior to and during their competitive season.

Fifty percent of the swimmers were trying to lose weight before their season began, with only 30% trying to
lose weight once their season had started. Six out of the 10 subjects were aerobically training prior to the season, whereas only one member was aerobically training beyond the requirements of her sport during the season.

At the early season, over 50% of the volleyball players were trying to lose weight, with nearly all the participants having performed aerobic training beforehand. Only one member of the team was still concerned with losing weight at the late season questionnaire. Three of the seven subjects were still exercising beyond their sport requirements throughout the season.

Discussion

Body fat is an essential component of the human body, and can be influenced by many different factors. The results of this study investigated differences in body composition variables among five intercollegiate women's athletic teams, as well as how they change over the course of a season.

Basketball

Basketball performance requires a combination of technical and tactical abilities and a high degree of physical fitness, with the play characterized as efforts of various intensities and durations (Smith & Thomas, 1991). Basketball players in this study were found to have less body weight, yet similar percent body fat when compared to corresponding studies (Berg et al., 1985; Johnson et al.,
Changes in body composition over the season were much more noticeable when compared to the findings of Johnson et al. (1989). The present study showed a drop of 2.3% body fat and 1.3 kg body weight, whereas Johnson et al. (1989) found a drop of .4% body fat and .3 kg body weight.

Differences seen between the present study and previous studies may be a result of a more rigorous preseason conditioning program at a Division I school as compared to a Division III school at the UW-L. A more rigorous preseason conditioning program may cause decreases in percent body fat prior to the start of the competitive season, resulting in less of a decrease throughout the season. The small sample size of four basketball players in this study also may have attributed to these differences. It is difficult to compare the results of the basketball team in the present study to similar studies which had much larger sample sizes.

Cross Country

Runners and marathoners are among the leanest individuals in the world, and train with frequent endurance mileage. The average body weight obtained from cross country intercollegiate athletes was quite similar to that of Loftin et al. (1992). Percent fat, however, was approximately 2% higher in the present study at both early and late season, with both studies finding a drop of .2 to .3% body fat over the course of the competitive season.
Considering the difference in percent body fat, it is interesting to note that both studies showed similar fat-free weights at both the early season and late season.

Larson (1984) studied cross country runners at the UW-L approximately 10 years earlier than the present study. A lower percent body fat was found in the earlier study, yet body weights were similar. In addition, Larson (1984) found significant differences from pre- to postseason for body weight and lean body weight, whereas the present study resulted in no significant changes over the course of the season. The differences seen between these two similar studies may be due to a higher sample size in Larson’s (1984) study (29 vs. 18 subjects) and/or the fact that the 1984 cross country team at the UW-L won the Division III National title. Small sample sizes can contribute to the lack of significant results, and a more intense training program may have led to the significant increases in body weight and lean body weight in the study by Larson (1984).

When compared to elite or Olympic level runners (Graves et al., 1987; Novak et al., 1977; Withers et al., 1987), the subjects in this study were much heavier and also had a higher percent body fat. These differences are most likely due to the higher level of training done at the elite and Olympic level.
Gymnastics

The sport of gymnastics is one of short duration, powerful movements, and beauty. As a result of its aesthetic qualities, female gymnasts are often concerned about body composition values. Johnson et al. (1989) and Vercruysse and Shelton (1988) reported lower body weights and percent body fats of college female gymnasts when compared to the present study. Whereas the gymnasts in the present study significantly decreased their percent body fat over the course of the competitive season, previous studies have shown more dramatic drops, as well as much lower percents at postseason (Johnson et al., 1989; Vercruysse & Shelton, 1988). These differences in body weight and percent body fat may be a result of a higher level of overall performance at a Division I or II school when compared to a Division III school, as in the present study.

Swimming

In competitive swimming, differences in body composition alters buoyancy, which therefore changes the resistance against the water (Wade, 1976). The swimmers in this study had similar body weights to those reported by Siders et al. (1993), Meleski and Malina (1985), and Johnson et al. (1989), yet were greater than those reported by Meleski et al. (1982). As with the gymnasts in the present study, the swimmers significantly decreased their percent body fat over the course of the competitive swim season.
This decrease was consistent with the findings of Meleski and Malina (1985), yet contrasted the slight decrease seen by Siders et al. (1993) and the increase in percent body fat in the study by Johnson et al. (1989).

**Volleyball**

The volleyball players in this study interestingly gained weight throughout the season. Percent body fat, however, decreased slightly but was not significant. Sady and Freedson (1984) reported similar body weights, yet lower percent body fats in their volleyball players. The study by Johnson et al. (1989) showed heavier players who stayed the same weight over the course of the season, yet increased percent body fat. The increase in weight and decrease in percent fat found in the present study may result from an increased need for fat-free weight in volleyball players and the development of muscle throughout the season.

**Overall**

The among group differences seen at both early and late season are typical of similar studies (Johnson et al., 1989; Siders et al., 1991; Novak et al., 1977). Cross country runners and gymnasts are seen to have the lower body weights and percent body fats, whereas swimmers, basketball players, and volleyball players are typically heavier with higher percent body fats. Participation in different sports, however, requires different training techniques, abilities,
and expertise. Body composition tends to vary as a result of these requirement differences among sports.

Summary

Although there were significant differences in body weight, fat-free weight, and fat weight among the five athletic teams, there were no differences in the percent fat among the five teams. As a result of these among group differences, the hypothesis of no significant differences among the women's athletic teams was rejected.

Significant early to late season changes were seen only in percent body fat for the swimming and gymnastics teams. All other body composition variables were not significant. Again, the hypothesis of no significant differences between early season and late season was rejected due to these season changes.
CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to compare early and late season body composition variables (body weight, percent body fat, fat-free weight, and fat weight) in the basketball, cross country, gymnastics, swimming, and volleyball intercollegiate teams at the UW-L during the 1994-95 season.

Four basketball players, 18 cross country runners, 9 gymnasts, 10 swimmers, and 7 volleyball players completed early and late season testing. The testing sessions included the completion of a questionnaire surveying weight gain, weight loss, and activity level, as well as body composition analysis through hydrostatic weighing.

A two-way ANOVA with repeated measures was used to determine significant differences between early and late season body composition variables, as well as differences among the five intercollegiate teams. The only significant (p < .05) changes over the course of a season were decreases in percent body fat in the swimming and gymnastics teams.

Early season differences revealed cross country runners to have significantly (p < .05) less fat-free weight than all other teams, and cross country runners and gymnasts to
have significantly \((p < .05)\) lower body weight and fat weight than volleyball players, swimmers, and basketball players. Fat-free weight was shown to be significantly \((p < .05)\) higher in the volleyball players when compared to the gymnasts and swimmers, and significantly \((p < .05)\) higher in the basketball players when compared to the gymnasts alone.

Late season differences were the same as those seen in the early season, with the exceptions that the basketball players no longer had significantly \((p > .05)\) greater fat-free weights than the gymnasts, nor significantly \((p > .05)\) greater fat weights than the cross country runners.

Although there were significant differences noted between early and late season, as well as among the teams at early and late season, the small sample sizes within the athletic teams led to limitations within the study. Larger sample sizes are necessary in order to validate the results seen in the present study.

**Conclusions**

Body composition changes over the course of a competitive season were found to be nonsignificant, with the exception of percent body fat in gymnasts and swimmers. Differences among the five intercollegiate teams showed several significant differences in body weight, fat-free weight, and fat weight. In respect to the body composition
of female athletes, these results lead to two major conclusions.

The lack of change from early to late season with respect to the majority of body composition variables shows that the athletes in the present study may have started their respective seasons at optimal levels of percent body fat, body weight, fat-free weight, and fat weight, with little room for change. The second conclusion is a result of several significant differences seen among the five intercollegiate teams with respect to body composition. These findings show athletes of different sports may have different levels of optimal body composition, including body weight, percent body fat, fat-free weight, and fat weight. The results strengthen the view that all athletes possess body composition variables optimal for their individual needs. Coaches, parents, and athletes need to be reminded of these facts to prevent self-esteem problems, eating disorders, and other detrimental consequences.

**Recommendations**

Based on the conclusions, the following recommendations for future studies were made:

1. Examine similar variables with larger sample sizes to strengthen the significance of the results.
2. Examine similar body composition variables in male athletes.
3. Examine body composition variables among several sports at different divisions of competition (Division I, II, and III).

4. Examine body composition variables among different divisions within one sport (i.e., sprint swimmers vs. distance swimmers).

5. Examine the effects of body composition on athletic performance in different sports.
REFERENCES


APPENDIX A

INFORMED CONSENTS
INFORMED CONSENT FOR WOMEN’S INTERCOLLEGIATE ATHLETICS STUDY

Title of Projects:
"Effects of a competitive season on body composition in female intercollegiate athletes"
"Prevalence of disordered eating behaviors and menstrual dysfunction in female intercollegiate athletes"

Principal Investigators:
Nancy K. Butts, PhD; Kris McLenahan; Salena Williams

Subjects will be asked to complete a survey and an underwater weighing procedure during the early season (first two weeks of practice) and late season (final two weeks of practice before conference competition).

Subject questions will address the following topics: weight, height, physical activity, body image, methods of weight control, and menstrual history. Some questions address topics that are personal in nature. Answers will be confidential and used solely for the purpose of this study; answers will not be shared with coaches, teammates, parents.

The underwater weighing procedure will require each subject to maximally exhale while completely submerging themselves under the water. This procedure may cause minimal discomfort, anxiety, or choking. The results of body composition testing will be shared with coaches.

Subjects will receive an accurate estimate of their percent body fat, and will be able to see how this figure changes during the competitive season.

The testers will answer any and all questions regarding procedures, risks or benefits.

I agree to participate in this study and allow the testers named above to administer the survey and perform the underwater weighing procedures described above.

I have read the information above, and have been informed of the proposed procedures and possible risks.

I acknowledge that no guarantees or assurances of any kind relating to the procedures have been made to me by the University of Wisconsin-La Crosse or any of its students or staff. I understand that I may withdraw from the study at any time.

Signed: _____________________________ Age: _____
Date: ___________________ Witness: ______________________
Date: ___________________ Witness: ______________________
INFORMED CONSENT FOR WOMEN'S INTERCOLLEGIATE ATHLETICS STUDY

Title of Projects:
"Effects of a competitive season on body composition in female intercollegiate athletes"
"Prevalence of disordered eating behaviors and menstrual dysfunction in female intercollegiate athletes"

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I acknowledge that no guarantees or assurances of any kind relating to the procedures have been made to me by the University of Wisconsin-La Crosse or any of its students or staff. I understand that I may withdraw from the study at any time.

Signed: ___________________________ Age: ______
Date: ________________ Witness: __________________________
Date: ________________ Witness: __________________________

I, ___________________________, parent or guardian of the above subject, have read the information above, and consent to participation of __________________________ in this study.
Signed: ___________________________ Date: ______
Witness: ___________________________ Date: ______
APPENDIX B

TESTING SIGN-UP SHEET
Women’s Intercollegiate Athletics Study
Basketball Posttesting Sign-Up

Time slots below are for one hour, with 2 individuals each hour. The first half hour is for the survey and the second half hour is for the underwater weighing procedure. Both will be held in Room 225 Mitchell Hall, the Human Performance Lab. Please report at your scheduled time with a swim suit, towel, hairbrush, etc.

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<th>NAME</th>
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APPENDIX C

TESTING REMINDER SLIP
Thank you for participating in the Women's Athletic Intercollegiate Study.

You are scheduled for testing on ________________, at ____________ p.m.

Please report to the HPL Lab (225 Mitchell Hall) at this time.

It is extremely important that you keep your scheduled appointment, as times to reschedule are limited. If you cannot make your appointment, please call Salena at 785-7195. You may trade times with a teammate if desired.

Again, thank you for your time and cooperation with my study.
APPENDIX D

SUBJECT QUESTIONNAIRES
EARLY SEASON QUESTIONNAIRE

1. Have you been watching your food intake or changing your eating habits in the last two months in order to gain weight?  
   Y_____ N_____

2. Have you been watching your food intake or changing your eating habits in the last two months in order to lose weight?  
   Y_____ N_____

3. Have you participated in any strenuous aerobic activities for more than three days per week in the last two months?  
   Y_____ N_____  
   If yes: a) What type of activities?____________________________  
   ___________________________  
   b) How many days per week?____________________________  
   ___________________________  
   c) How long were the activities performed at each session?____________________________

LATE SEASON QUESTIONNAIRE

1. Have you been watching your food intake or changing your eating habits over the course of your competitive season in order to gain weight?  
   Y_____ N_____

2. Have you been watching your food intake or changing your eating habits over the course of your competitive season in order to lose weight?  
   Y_____ N_____  

3. Have you participated in any strenuous aerobic activities other than the requirements of your sport throughout the competitive season?  
   Y_____ N_____  
   If yes: a) What type of activities?____________________________  
   ___________________________  
   b) How many days per week?____________________________  
   ___________________________  
   c) How long were the activities performed at each session?____________________________