AN ABSTRACT OF THE THESIS OF

Brian J. Hoberecht for the Master of Science

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Title: THE RELATIVE FACTORS ASSOCIATED WITH REBOUNDING PERFORMANCE IN BASKETBALL

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The purpose of this study was to determine the factors associated with rebounding performance in basketball. The participants in this study were high school males (N=12) and females (N=10) and collegiate males (N=7) and females (N=9). The teams were from Emporia High School and Emporia State University in the 1994-95 school year. The participants were tested during sessions on three occasions during the season. Testing included a one repetition maximum lift on the bench press and squat, a vertical jump test and a measurement of the athletes height and weight. Rebounding was assessed by taking the total number of rebounds during each concurrent time frame and dividing this number by the total number of minutes played. A multiple regression analysis was used to evaluate the factors predicted to affect rebounding performance. The factors in this study included: height, weight, position played, level of competition, bench press, squat, vertical jump, and coach's

evaluation. All data was analyzed at the ($p<.05$) level of significance. Results of the tests yield multicollinearity or high correlations among the predicting variables. No relationship was found among the predicting variables and the dependent variable rebounding performance.

# THE RELATIVE FACTORS ASSOCIATED WITH REBOUNDING PERFORMANCE IN BASKETBALL

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A Thesis

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# CHAPTER I

## INTRODUCTION

Rebounding is an aspect of the game of basketball that is critical to the success of the team. "Rebounding has been called an art just like shooting, passing, dribbling, and other aspects of the game" (Smith, 1990, p. 2). Bonnette (1980) stated that, "although the emphasis on rebounding has never diminished, the fundamental skills have reverted back to original or earlier forms. For example, a recent theory has been to develop or recruit the leaper and teach 'go to the basket,' where in earlier years most coaches taught specific blockout skills" (p. 16). However, the "go to the basket" theory has returned to an emphasis on the skills of rebounding. Coaches have realized the importance of technique in rebounding and the lack of players with exceptional height or jumping ability.

There is an old coaching adage that says, "the team that controls the backboards controls the game" (Black, 1975, p. 15). Since it is impossible to score without the ball, the number of ball possessions for a team becomes very important. Statistics indicate that 45% to 60% of field goal attempts are missed (Jeremiah, 1979). Missed field goals increase a team's opportunity to gain possession through rebounding. Field (1974) determined that every possession is worth approximately one point. Coaches need to put a premium on converting ball possessions into points

and developing ways to gain possession of the ball. Rebounding is a skill that can be taught and used to gain possession of the ball.

In addition to turning defensive rebounds into points, offensive rebounds provide a team with a second and third chance to score and increase a team's chance to score more points in a contest. It also relieves some of the pressure of having to score on the initial shot on every possession.

Rebounding is a skill that should be practiced every day. Teams will mirror the fundamentals that a coach puts the most emphasis on in practice (Schnabel, 1987).

Rebounding is an art, just as shooting with correct form is an art of the game. Few coaches can find the players with exceptional talent and the ability to attack the glass. These exceptional players seem to always know where the ball is going to come off the rim. They are said to have a "nose for the ball" (Smith, 1990, p. 2). They know when to go hard to the backboard and when to lie back for a long rebound.

At clinics, coaches teach rebounding according to positions (Bonnette, 1980; Field, 1974; May, 1993; Apple, 1983). A post player would be expected to learn how to blockout and close to the basket while keeping contact with the opponent. A guard would be expected to make contact, know the location of the opponent and release to the ball. George Raveling, a retired University of Southern California

coach, described the importance of rebounding the best; "A player can dribble too much, he can shoot too much, he can even pass too much, but he can never rebound too much" (Masters, 1987, p. 6).

The purpose of this study will be to identify the factors that significantly relate to rebounding performance. This study will also attempt to indicate the factors that enhance an athlete's abilities to rebound effectively.

## STATEMENT OF HYPOTHESES

The following will serve as the hypotheses for this study:

1. Height and weight are predictive of an athlete's position played.
2. Height and weight are predictive of an athlete's level of competition.
3. Position played, weight, and level of competition are predictive of an athlete's bench press.
4. Position played, level of competition, and weight are predictive of an athlete's squat.
5. Level of competition, height, weight, position played and squat are predictive of an athlete's vertical jump.
6. Height, weight, position played, level of competition, bench, squat, and vertical jump are predictive of an athlete's coach's evaluation.

7. Height, weight, position played, level of competition, bench, squat, vertical jump and the coach's evaluation are predictive of the athlete's rebounding performance.

Exogenous variables (height and weight) appear on the periphery of the model and are not directly influenced by variables associated with this study. These variables do not help predict the other variables and the rebounding performance of athletes. The endogenous variables are affected by other variables within this study.

## DEFINITIONS

The following terms are defined in order to clarify frequently used terms and to establish a common basis for discussion of terms throughout the study.

Season: The length of time between the first day of practice and the last day of testing.

Strength: The maximal amount an athlete can lift in one repetition. Two tests were used to assess strength, the bench press and squat.

Power: The athletes greatest velocity as measured by a series of vertical jump trials.

Rebounds: The number of rebounds each athlete had during a given time divided by the number of minutes played during that same time period.

Coach's Evaluation: In this study coaches were asked to rate their players rebounding ability, position and technique on a ten point scale.

## SIGNIFICANCE OF THE STUDY

The value of offensive and defensive rebounding ability is unquestionable. This study will attempt to determine the factors associated with rebounding performance. As a result, coaches and athletes will have information to assist them in ways to improve rebounding performance. From the results, coaches can implement drills and/or strength training that will help increase an athlete's ability to rebound. Priorities can be placed on the factors that are the most influential to individual and team performance. Athletes will have more information on how the little things can give them an edge in rebounding.

## DELIMITATIONS

This study was delimited to college male and female NCAA Division II basketball players male (N=7) and female (N=9) and High School male (N=12) and female (N=10) 6A basketball players. The ages of the high school athletes ranged from 15 to 18 and the college athletes from 18 to 29.

## LIMITATIONS

In any study involving human participants, certain limitations exist. The findings of this study were limited by the following factors.

1. Participants in this study were volunteers.
2. Statistical information on playing time was established by the coaches for some players due to a lack of information kept by statisticians at game sites.

## ASSUMPTIONS

This study was based on the following assumptions.

1. Participants were motivated to give their best effort during all strength and vertical jump testing.
2. Participants were able to refrain from strenuous physical activity the day of testing.

## SUMMARY

The purpose of this study was to determine if the factors of height, weight, strength, power, position played, level of competition, and a coach's evaluation were predictive of rebounding performance. Rebounding has been established as an integral part of the game of basketball. It can make a good team better or a weak team stronger. Defensive rebounds can add pressure to the offensive team and offensive rebounds can add pressure to the defense team.

Chapter II will discuss the literature that directly affects rebounding performance and its relationship to the factors being tested in this study. Chapter III will discuss the methodology, procedures, sampling and the statistical design of the testing. Chapter IV will include the results of the testing and conclusions of the hypotheses. Chapter V will include a discussion of the results and a conclusion to this study with further recommendations and considerations for study.

## CHAPTER II

## REVIEW OF LITERATURE

The purpose of this study was to determine the factors associated with rebounding performance in basketball. This chapter will examine the relevant literature in the areas of rebounding performance. These areas include physiological factors and technical factors associated with rebounding.

### PHYSIOLOGICAL FACTORS

Height, weight, strength, power, vertical jump, and position played can be an indication of an athlete's potential to rebound. These factors are believed to have a direct influence based on their physical relationship with rebounding.

#### HEIGHT AND WEIGHT

There may be differences in rebounding performance between genders. What characteristics of each gender make up the best potential rebounder? A study on sexual differences examined the biological and behavioral differences between males and females in athletic performance (Wells, & Plowman, 1983). The average male is taller and heavier than the average female: the average male is 68.5 inches tall and 173 28 pounds, the average female is 64.5 inches tall and 149 33.8 pounds. These researchers suggest that even at identical heights, the male is heavier

than the female. This weight difference is not fat. The average male is 12% to 16% body fat while the female is 22% to 27% body fat. Men have more lean body mass than women.

> The effects on women of this additional 10 to 15 pounds of adipose tissue is twofold. Women have less muscle mass with which to exert force in situations that require muscular strength, power, speed and endurance. Fat increases the metabolic cost of weight-bearing activities without correspondingly increasing the body's ability to produce energy, thus having a detrimental influence on performance in endurance events. (Wells, & Plowman, 1983,p. 55).

Essential fat is also found in a smaller amount in males. The average male is composed of 3% essential fat and 12% storage fat while the female is 12% essential fat and 15% storage fat. Essential fat is used by the body to produce energy and storage fat is used by the body for protection. "In brief, the sexual differences in athletic performance are largely due to variations in body size, body composition, aerobic power and muscular strength" (Wells, & Plowman, 1983, p. 52).

In previous studies, the factors of height and weight have been used to compare their influence to athletic performance (Riezebos, Paterson, & Yuhasz, 1983; Latin, Berg, & Baechle, 1994; Brooks, Boleach, & Mayhew, 1987). In this study, these factors are believed to have an influence on rebounding performance.

STRENGTH

While previous studies have examined the effects of pre-season and in-season training on individual performance, there are few articles that specifically focus on rebounding performance (Hoffman, Maresh, Armstrong, Kraemer, 1991).

> The simple act of grabbing a rebound requires a great deal of muscular coordination. The body must drive itself off the floor against its own weight. While extended the body must be prepared to intercept the ball, then prepare itself to land and absorb the shock under the base of support. The major muscle groups used in this skill are located in the lower extremities and the shoulder girdle (Richardson, Schmotzer, Brandenburg, & Kraemer, 1983, p.6).

Thus the goal of strength and power training is to increase the areas of the upper and lower extremities.

In a training program set up by the Wyoming basketball coaching staff, the emphasis of strength and power training was placed on structural lifts (Richardson, Schmotzer, Brandenburg, & Kraemer, 1983). Emphasis was placed on structural lifts due to a greater correlation of increasing muscular output by using the larger multi-jointed muscles.

In basketball the muscles used most frequently deal with multi-joint body parts. Testing of these muscles should parallel the same joints used during competition. In numerous studies associated with basketball performance, the two tests used most frequently to test upper and lower body strength were the bench press for the upper extremities and the squat for the lower extremity test (Groves, & Gayle, 1993; Ford, & Puckett, 1983; Smith, 1988).

A study by Hoffman, Fry, Howard, Maresh, & Kraemer, (1991) examined the strength, speed and endurance changes that occur over the course of a Division I basketball season. The tests used were the bench press and the squat. Nine athletes associated with a NCAA Division I men's basketball team volunteered to be evaluated. Testing was administered four times throughout the season; the first testing session was done before a five week resistance training program (RTP), the second session was before preseason practice, the third session occurred midway through the season, and the final testing session was done two days following the conclusion of tournament play. Testing consisted of a bench press and a squat that was performed after a light warm-up. The athletes achieved the one repetition max in three to five attempts. No strength training was done during the length of the season. Increases ($p<.05$) were observed only for the squat after the RTP. At midseason, a significant decrease in strength was observed in the squat. Final testing shows no significant increase in either the bench or squat. The authors suggested that most athletes can maintain a pre-season conditioning level throughout the length of a college basketball season without continuing a strength program during the season (Hoffman, Fry, Howard, Maresh, & Kraemer, 1991).

The bench and squat were used to study the effects of off-season and in-season resistance training programs on collegiate male basketball teams (N=437) (Latin, Berg, & Baechle, 1994). The athletes were grouped by position (guards, forwards, centers). Surveys were sent to a strength and conditioning coach or athletic trainer at 297 Division I NCAA Universities. Return was requested for only the ten top athletes on each team. All data was collected between the fall of 1989 and the fall of 1990. Requested data included: height, weight, sprint time, agility, aerobic capacity, vertical jump, percent body fat, bench, squat, and power clean. Scores were divided by body weight and multiplied by 100 to express bench, squat, and power clean as a percentage. Vertical jump was expressed in centimeters and converted to power. Data was examined by comparing variables across teams and by position. The three positions differed on all variables except bench press, 1.5 mile run and agility. The guards were the smallest and leanest, yet had the best vertical jump, speed and strength relative to body weight. Centers were the largest athletes, had the largest body composition, the poorest agility, 40 yard dash and mile run times. Forwards and centers were similar in the bench. Results and discussion concluded further research was needed to describe traits of athletes in successful programs. There was also a statement about the numerous differences in the variables reported in comparison

of playing position, which probably reflected the specific demands of each position.

POWER

In rebounding, vertical jump plays an important role. The athlete's aim in jumping is to attain the best possible takeoff velocity. This is accomplished by coiling the body and firing the muscles involved with the vertical jump. Those athletes who have a higher center of gravity at the moment of takeoff will jump higher if they generate the same amount of force as another athlete (Semenick, & Adams, 1987).

Athletes can increase their vertical jump with a combination of weight training and plyometric exercise. High school male basketball players (N=26) were randomly assigned to two different groups (Brown, Mayhew, & Boleach, 1986). After a three week introduction to basketball, the athletes participated in two vertical jump tests; one with use of the arms and the second without the use of the arms. Each athlete was then placed in either a control group or a training group. The control group participated only in practice and the training group participated in 12 weeks of plyometric training. The training group was split into one group using arms and one group who could not use arms. The training sessions consisted of three sets of ten repetitions at a depth jump of 45 centimeters. The training group

improved significantly over the control group in vertical jump with arms. The two plyometric groups, one using arms and one not using arms, were not significantly different in their improvement. The plyometric groups improvement was due to a 57% gain in technique and a 43% gain in strength. This led the researcher to conclude that plyometric training enhances coordination and strength development which provides a convenient in-season training method (Brown, Mayhew, & Boleach, 1986).

A second study discussed the relative effects of isokinetic and plyometric training on vertical jump performance (Blattner, & Noble, 1979). Participants were 48 volunteer males who were randomly assigned to one of three groups. Group one trained with isokinetic exercises, group two trained with plyometric exercises, and group three was the control group. Training groups met three times per week for eight weeks. Isokinetic exercise included three sets of ten repetitions on the leg press. Plyometric exercise included three sets of ten repetitions of depth jumps from a 34 inch box. Resistance was added in weeks 3,5, and 7. Resistance included the addition of 10, 15 and 20 pounds during the plyometric exercise. Following the conclusion of training, each participant was tested on a vertical jump and reach test. Covariance analysis was used to compare the posttest to the pretest. Results showed significant improvement in vertical jump capacity in both experimental

groups one and two. However, there was not a significant difference between these two groups. Results led the researchers to state that plyometric training and isokinetic training will increase vertical jump performance (Blattner, & Noble, 1979).

Since it is possible to increase an athlete's vertical jump performance, there is also a distinct possibility that this increase could affect rebounding performance. Importance was placed on finding a test that would measure the athlete's jumping ability. Along with the previous studies discussed, many researchers have established the vertical jump as a valid and reliable test for jumping ability (Hoffman, Fry, Howard, Maresh, & Kraemer, 1991; Latin, Berg, & Baechle, 1994; Riezebos Paterson, & Yuhasz, 1983; Grove, & Gayle, 1993).

## POSITION PLAYED

Important characteristics will show what strengths and weaknesses athletes may possess according to the position they play. A study on body composition and performance variables of young elite female basketball examined the physique and body composition of young athletes in relationship to their playing position (Bale, 1991). The researcher tested 18 members of an under 17 national basketball squad on weight, height, sitting height, lower and upper limb length, shoulder, hip, extended hand, humeral

epicondylar and femoral epicondylar widths were made using a Harpenden anthropometer and chest, abdomen, relaxed and flexed arm and calf circumferences were measured using a constant tension steel tape. Finally biceps, triceps, subscapular, suprailiac, anterior thigh and medial calf skinfolds were measured using Harpenden skinfold calipers.

Means and standard deviations were calculated for the total group. The basketball players were then subgrouped according to position by the coaches. Analysis of variance and Duncan's multiple range tests were calculated between groups for all variables. Results showed that centers generally had the largest measures of physique and body composition followed by the forwards and the guards. The centers were significantly heavier, taller, and had longer sitting heights, longer upper and lower limb lengths, hip widths and abdominal, chest and flexed arm circumferences than the guards. Height and lean body weight showed the greatest variability in measurements. The centers were taller and more muscular than the forwards and guards. The centers possessed superior anaerobic power scores, but the vertical jump for all three groups was similar. According to this study and the results, centers are the most likely athletes to lead the team in rebounding. They play closest to the basket, and are heavier and more powerful athletes. The vertical jump was similar in all groups.

## TECHNICAL FACTORS

An athlete's level of competition, coach's evaluation, and rebounding performance are all associated with the athlete's potential to rebound. These factors give feedback and influence coaches on what is expected of an athlete's rebounding performance.

### LEVEL OF COMPETITION

An athlete's level of competition will help emphasize what strengths are necessary to be successful while competing at different levels. In the literature, previous articles that relate to skills testing have shown the relationships of skills necessary to be successful at one level of competition (Brooks, Boleach, & Mayhew, 1987; Riezebos, Paterson, Hall, & Yuhasz, 1983; Latin, Berg, & Baechle, 1994).

One study tested NCAA Division I male basketball teams on height, weight, strength, speed, power, agility, body fatness, and aerobic capacity. Selected means were measured in all categories. Guards, forwards and centers differed on all variables except bench press, the mile run and agility. Results concluded that due to numerous differences in the variables reported in comparison to playing positions, this reflects the specific demands of each position (Latin, Berg, & Baechle, 1994).

In a second article, Riezebos (1983) examined the relationship of selected variables to performance in women's basketball. Twenty collegiate women from the University of Western Ontario were participants in this study. These women were tested on physiological, anthropometric, motor fitness and skill-related variables used to describe a profile of elite female basketball players. Profiles for the elite players consisted of superior aerobic power and anaerobic capacity, they were more accurate shooters and possessed less body fat. These factors were considered the best predictors in the selection and development of potential basketball players.

COACH'S EVALUATION

This was used to establish a player's ability rating for rebounding. This factor will allow coaches to evaluate their personal criteria for a good rebounder.

In an article about the relationship of specific and nonspecific variables to successful basketball performance among high school players, a coach's rating was used to measure a player's basketball ability (Brooks, Boleach, Mayhew, 1987). Also examined were the nonspecific tests of height, weight, skinfold, hand and foot reaction times, depth perception and vertical jump. Specific tests included varsity playing experience, shooting accuracy, dribbling, wall passing, and a knowledge test. Means for all variables

were recorded and significance was measured at the ($p<.05$) level. Multiple regression was used to predict the player's ability rating with the best combination of specific and nonspecific tests. The best possible predictor of a single athlete was jumping ability. For a team the best predictors were ball handling, shooting accuracy, and knowledge of the game. Weight was significant in a coach's rating of ability while height was a factor in identifying team membership.

## REBOUNDING

By definition, to rebound means "to recover" (Smith, 1990). There is an old coaching adage that says, "the team that controls the backboards, controls the game" (Black, 1975). Articles that relate to rebounding discuss the importance that this factor has over the influence of a basketball game. The articles discuss techniques, drills and motivational ways to improve your team's potential to rebound. There are articles for men and women, for collegiates and high school teams, and also for special situations like a coach who has a small or less talented team (Brennan, 1980; Black, 1975). Most articles discuss the offensive and defensive strategies that have produced success and are used by the authors teams.

In an article about rebounding, importance was placed on both offensive and defensive rebounding (Jeremiah, 1979). Strategies were shared by the author to increase performance

of the athletes. Blocking out was discussed in detail and a memory aid was introduced using the word "rebound" (Jeremiah, 1979).

In a study by Masters (1987), a mental philosophy for rebounding was introduced. This mental technique was CAD (courage, aggressiveness, and desire) of the athlete to rebound. The researcher also discussed blocking out and its importance. Once a defensive person has blocked out, he/she has control over the offensive man and has an advantage to rebound the ball. According to Masters, 75% of shots missed will come off the opposite side of the basket from which the shot is taken. The time it takes the ball to hit the rim after the shot leaves the shooter's hand is about three seconds from outside 12 feet. This leaves the defense the time necessary to blockout the opponent. As the shot is taken closer to the basket, the amount of time to blockout diminishes.

## SUMMARY

In conclusion, the factors associated with an athlete's rebounding performance go beyond the height and jumping ability of an individual. The height, strength, power, position played, weight and level of competition all factor into an athlete's rebounding performance. Coach's evaluations can give added information into what is expected of an athlete during competition. Studies examined in this

literature review have given information into what tests yield better results and how to improve areas that are weak. Tests that involve multi-jointed performance relate more to game situations than isolated muscle tests. Consistent, monitored workouts can increase an athlete's strength and power to help perform at his/her highest level during competition. Based on this, results can give coaches a better idea of what factors play a significant role in rebounding performance and how to increase maximum efficiency in these areas.

## CHAPTER III

## METHODS AND PROCEDURES

The purpose of this study was to determine the factors associated with rebounding performance in basketball. These factors include jumping ability, strength, height and weight, position played, level of competition and a coach's evaluation of performance. This chapter describes the methods and procedures used in this study. Information on population and sampling, and statistical design will also be discussed.

### POPULATION AND SAMPLING

The target population for this study was male (N=12) and female (N=10) high school and male (N=7) and female (N=9) college basketball players. Participants in this study ranged from 16 to 29 years old. Four varsity basketball teams were asked to participate in this study: two high school teams, one male and one female, from Emporia High School and two college teams, one male and one female from Emporia State University. The accessible population was established varsity players on the roster of Emporia High School and Emporia State University basketball teams. Forty-three athletes agreed to being a part of this study. However, due to personal or medical reasons, five participants dropped out of this study.

## PROCEDURES

Permission to use human participants was obtained from Emporia State University's Human Participant Committee (Appendix A). An initial meeting was set up with each coach prior to the beginning of his/her basketball season. This meeting was used to provide a detailed explanation of the study to each coach. After permission was granted by the coach, the researcher attended each team's initial meeting of the season. At this meeting, the researcher explained the study and testing procedures to each athlete. Participants were given the opportunity to ask questions about the study and then read and sign an informed consent document (Appendix C).

Participants were tested at three different times over the length of the basketball season. The first testing session was administered one-third of the way through the season, the second session was administered two thirds of the way through the season and the third session was administered within four days following the conclusion of each team's final game. All testing sessions were slightly different for each team due to different practice schedules. Some athletes were tested during physical education classes and other athletes were tested as a group before basketball practice. During each testing session team members were paired for safety reasons. All testing was conducted by the author or a certified strength and conditioning instructor

at Emporia High School. All results of the tests were recorded on data forms (Appendix D and E).

Each testing session began as the athletes entered the weight room ready for practice or class to begin. The participants were paired for safety and then given the opportunity to warm-up independently. Each athlete was asked to give a one repetition maximal lift on the bench and squat. Prior to the first lifting session, the participants were instructed on the proper lifting technique and what qualifications were needed to obtain a successful maximal lift.

In the bench press, a full range of motion was required. The athletes were instructed to lower the bar to the chest and successfully push it back up until the arms were completely extended. The squat consisted of balancing the bar behind the head on the tops of the shoulder blades. The athletes were instructed to lower the bar until the quadricep muscles of the legs were parallel to the floor. From the parallel position, the athlete needed to return to a standing position. Each athlete began with a lighter weight and continued to add weight until his/her maximum lift was reached.

After the strength testing was complete, the athletes were asked to take a vertical jump test. The athlete began this test by extending his/her hand next to the tape. Without taking a step, the athlete was given three attempts

to jump as high as possible. The vertical jump was measured as the distance between the reach of the athlete and their highest jump. The recorded number was the best of the three jumps. The athlete's height and weight were recorded using scales located at Emporia High and Emporia State University. The participant was asked to remove his/her shoes and step onto the scales. A height measurement, in inches, standing as erect as possible, and a weight measurement, in pounds, were then recorded. Equipment used in this study consisted of a free weight bench press, a free weight squat rack and weight belt for back support, a tape measure for the vertical jump, and scales for the measurement of height and weight.

Following each testing session, each coach was asked to rate his/her athlete's rebounding performance. Coaches rated individual players based on a scale from 1 to 10. A rating of 1 was a poor rebounder and a rating of 10 was an excellent rebounder. This evaluation established a personal rating of rebounding performance. Coaches were asked to take into consideration the athlete's rebounding techniques and attitude towards rebounding.

Rebounding performance was evaluated through information obtained from game settings. There were three time frames that paralleled the testing sessions. For the Emporia High men, the first time frame consisted of 6 games, the second time frame consisted of 7 games and the third

time frame consisted of 12 games. The 12 games included post season competition. For the Emporia High women, the first time frame consisted of six games, the second time frame consisted of seven games and the third time frame consisted of nine games. The nine games included post season competition. The Emporia State men's first time frame consisted of seven games, the second time frame consisted of ten games and the third time frame consisted of seven games. For the Emporia State women, the first time frame consisted of eight games, the second time frame consisted of nine games and the third time frame consisted of nine games.

During each period of time, the athlete's total number of rebounds were divided by the athlete's total minutes played. This rating gave an average number of rebounds per minutes played. This procedure was used to equalize the rebounds of the athletes since there was an advantage to those players who played more minutes in games. Individual performances on testing and rebounding during the three given time frames were then grouped together for analysis. These results yielded information that was compared to the eight predicted variables used in this study pertinent to rebounding performance.

## STATISTICAL DESIGN

Statistical design was a series of multiple regression tests using path analysis. A series of multiple regression tests were run using the endogenous variables. The endogenous variables consisted of the variables that had a direct influence on another variable within the hypotheses (position played, level of competition, bench, squat, vertical jump, coaches evaluation and rebounding performance). The exogenous variables (height and weight) existed on the periphery of the hypothesis and were not directly influenced by other variables associated in this study. Multiple regression permits the researcher to compare all variables not only with the predictability of rebounding performance, but the other nine variables to see if there is a direct correlation between two or more variables and rebounding performance.

## SUMMARY

This study investigated the relationship between the variables associated with rebounding performance in basketball. The variables used in this study included: upper and lower body strength and power, height and weight, vertical jump, level of competition, position played, and a coach's evaluation of performance. A multiple regression was used to determine the predicted value of the variables to rebounding performance.

# CHAPTER IV

# RESULTS

## DESCRIPTION OF SUBPOPULATION

These tables were added to allow the reader the opportunity to see how the participants were divided among their position played and gender for each of the variables they were tested upon. Tables 1 thru 5 will define the population for the endogenous variables: bench, squat, vertical jump, coach's evaluation and rebounding performance.

DESCRIPTION OF SUBPOPULATION

Table 1

Summaries of BENCH
By levels of POSITION PLAYED
GENDER

| VARIABLE | VALUE LABEL | | MEAN | STD DEV | CASES |
|---|---|---|---|---|---|
| FOR ENTIRE POPULATION | | | 160.8333 | 46.1900 | 114 |
| POSITION | (guard) | 1 | 167.6491 | 50.1339 | 57 |
| GENDER | (male) | 1 | 211.1111 | 30.9880 | 27 |
| GENDER | (female) | 2 | 128.5333 | 25.5164 | 30 |
| POSITION | (forward) | 2 | 155.6410 | 43.2280 | 39 |
| GENDER | (male) | 1 | 183.3333 | 27.6887 | 24 |
| GENDER | (female) | 2 | 111.3333 | 19.8626 | 15 |
| POSITION | (post) | 3 | 150.5000 | 37.3430 | 18 |
| GENDER | (male) | 1 | 199.1667 | 9.7040 | 6 |
| GENDER | (female) | 2 | 126.1667 | 13.2104 | 12 |

TOTAL CASES = 114

DESCRIPTION OF SUBPOPULATIONS

Table 2

Summaries of SQUAT
By levels of POSITION PLAYED
GENDER

| VARIABLE | VALUE LABEL | | MEAN | STD DEV | CASES |
|---|---|---|---|---|---|
| FOR ENTIRE POPULATION | | | 240.9035 | 72.5471 | 114 |
| POSITION | (guard) | 1 | 239.2456 | 76.3447 | 57 |
| GENDER | (male) | 1 | 304.2593 | 56.6315 | 27 |
| GENDER | (female) | 2 | 180.7333 | 30.0447 | 30 |
| POSITION | (forward) | 2 | 247.0769 | 70.1575 | 39 |
| GENDER | (male) | 1 | 289.7917 | 52.1803 | 24 |
| GENDER | (female) | 2 | 178.7333 | 27.4681 | 15 |
| POSITION | (post) | 3 | 232.7778 | 67.9364 | 18 |
| GENDER | (male) | 1 | 295.8333 | 60.7797 | 6 |
| GENDER | (female) | 2 | 201.2500 | 46.9102 | 12 |

TOTAL CASES = 114

DESCRIPTION OF SUBPOPULATIONS

Table 3

Summaries of VERTICAL JUMP
By levels of POSITION PLAYED
GENDER

| VARIABLE | VALUE LABEL | | MEAN | STD DEV | CASES |
|---|---|---|---|---|---|
| FOR ENTIRE POPULATION | | | 21.3596 | 3.4797 | 114 |
| POSITION | (guard) | 1 | 21.2632 | 3.2322 | 57 |
| GENDER | (male) | 1 | 23.5926 | 2.8991 | 27 |
| GENDER | (female) | 2 | 19.1667 | 1.7436 | 30 |
| POSITION | (forward) | 2 | 21.3590 | 3.6382 | 39 |
| GENDER | (male) | 1 | 23.3333 | 3.1851 | 24 |
| GENDER | (female) | 2 | 18.2000 | 1.3732 | 15 |
| POSITION | (post) | 3 | 21.6667 | 4.0439 | 18 |
| GENDER | (male) | 1 | 26.5000 | 3.0166 | 6 |
| GENDER | (female) | 2 | 19.2500 | 1.4222 | 12 |

TOTAL CASES = 114

DESCRIPTION OF SUBPOPULATIONS

Table 4

Summaries of COACH'S EVALUATION
By Levels of POSITION PLAYED
GENDER

| VARIABLE | VALUE LABEL | | MEAN | STD DEV | CASES |
|---|---|---|---|---|---|
| FOR ENTIRE POPULATION | | | 6.0000 | 1.9778 | 114 |
| POSITION | (guard) | 1 | 5.4912 | 1.9284 | 57 |
| GENDER | (male) | 1 | 6.0000 | 2.1304 | 27 |
| GENDER | (female) | 2 | 5.0333 | 1.6291 | 30 |
| POSITION | (forward) | 2 | 5.7436 | 1.6970 | 39 |
| GENDER | (male) | 1 | 5.4583 | 1.5874 | 24 |
| GENDER | (female) | 2 | 6.2000 | 1.8205 | 15 |
| POSITION | (post) | 3 | 8.1667 | 1.1504 | 18 |
| GENDER | (male) | 1 | 8.8333 | .7528 | 6 |
| GENDER | (female) | 2 | 7.8333 | 1.1934 | 12 |

TOTAL CASES = 114

DESCRIPTION OF SUBPOPULATIONS

Table 5

Summaries of REBOUNDING PERFORMANCE
By Levels of POSITION PLAYED
GENDER

| VARIABLE | VALUE LABEL | | MEAN | STD DEV | CASES |
|---|---|---|---|---|---|
| FOR ENTIRE POPULATION | | | .1857 | .0991 | 110 |
| POSITION | (guard) | 1 | .1414 | .0832 | 56 |
| GENDER | (male) | 1 | .1466 | .0923 | 26 |
| GENDER | (female) | 2 | .1369 | .0758 | 30 |
| POSITION | (forward) | 2 | .1977 | .0897 | 36 |
| GENDER | (male) | 1 | .2023 | .1083 | 21 |
| GENDER | (female) | 2 | .1914 | .0572 | 15 |
| POSITION | (post) | 3 | .2998 | .0587 | 18 |
| GENDER | (male) | 1 | .3282 | .0546 | 6 |
| GENDER | (female) | | .2856 | .0575 | 12 |

TOTAL CASES = 110 MISSING CASES = 4

## RESULTS

The following will serve as the results of the predicted hypotheses.

1. Height and weight are predictive of an athlete's position played is rejected (see table 6).
2. Height and weight are predictive of an athlete's level of competition is rejected (see table 7).
3. Position played, weight, and level of competition are predictive of an athlete's bench press is rejected (see table 8).
4. Position played, level of competition, and weight are predictive of an athlete's squat is not rejected (see table 9).
5. Level of competition, height, weight, position played and squat are predictive of an athlete's vertical jump is rejected (see table 10).
6. Height, weight, position played, level of competition bench, squat, and vertical jump are predictive of an athlete's coach's evaluation is rejected (see table 11).
7. Height, weight, position played, level of competition bench, squat, vertical jump and coach's evaluation are predictive of an athlete's rebounding performance is rejected (see table 12).

VARIABLE RESULTS

Table 6

DEPENDENT VARIABLE: Position Played

TEST: Restricted Model

| VARIABLE | BETA SCORE | SIGNIFICANT T |
|---|---|---|
| Height | -.054136 | .5744 |
| Weight | .901078 | .0000 |

VARIANCE: R Square .74666

VARIABLE RESULTS

Table 7

DEPENDENT VARIABLE: Level of Competition

TEST: Full Model

| VARIABLE | BETA SCORES | SIGNIFICANT T |
|---|---|---|
| Pos 2 | .569516 | .0103 |
| Height | 1.197723 | .0001 |
| Weight | -.243626 | .1649 |
| Pos 1 | 1.161074 | .0003 |

VARIANCE: R Square .27505

VARIABLE RESULTS

Table 8

DEPENDENT VARIABLE: Bench Press

TEST: Restricted Model

| VARIABLE | BETA SCORE | SIGNIFICANT T |
|---|---|---|
| Pos 2 | .099389 | .2577 |
| Weight | 1.209632 | .0000 |
| Pos 1 | 1.288788 | .0000 |

VARIANCE: R Square .89686

VARIABLE RESULTS

Table 9

DEPENDENT VARIABLE: Squat

TEST: Restricted Model

| VARIABLE | BETA SCORES | SIGNIFICANT T |
|---|---|---|
| Pos 2 | -.651498 | .0000 |
| Weight | .530573 | .0012 |
| Pos 1 | -.526602 | .0056 |

VARIANCE: R Square .76228

VARIABLE RESULTS

Table 10

DEPENDENT VARIABLE: Vertical jump

TEST: Restricted Model

| VARIABLE | BETA SCORE | SIGNIFICANT T |
|---|---|---|
| Pos 2 | -.302361 | .2480 |
| Height | 1.872272 | .0005 |
| Squat | -.665361 | .0131 |
| Pos 1 | .138127 | .7040 |
| Weight | -1.384887 | .0001 |

VARIANCE: R Square .72020

VARIABLE RESULTS

Table 11

DEPENDENT VARIABLE: Coach's Evaluation

TEST: Full Model

| VARIABLE | BETA SCORE | SIGNIFICANT T |
|---|---|---|
| Pos 2 | -.397830 | .2016 |
| Height | -.510638 | .4735 |
| Bench | .029253 | .9483 |
| Vertical Jump | .243499 | .3707 |
| Squat | -.579695 | .0986 |
| Pos 1 | -.873651 | .2096 |
| Weight | 1.114752 | .1082 |

VARIANCE: R Square .67170

VARIABLE RESULTS

Table 12

DEPENDENT VARIABLE: Rebounding Performance

TEST: Full Model

| VARIABLE | BETA SCORE | SIGNIFICANT T |
|---|---|---|
| Pos 2 | .042904 | .8829 |
| Height | .985674 | .1449 |
| Bench Press | -.160685 | .6973 |
| Coach's Evaluation | -.023571 | .9117 |
| Vertical Jump | .037024 | .8829 |
| Squat | -.147109 | .6593 |
| Pos 1 | .023828 | .9703 |
| Weight | -.003701 | .9955 |

VARIANCE: R Square .74050

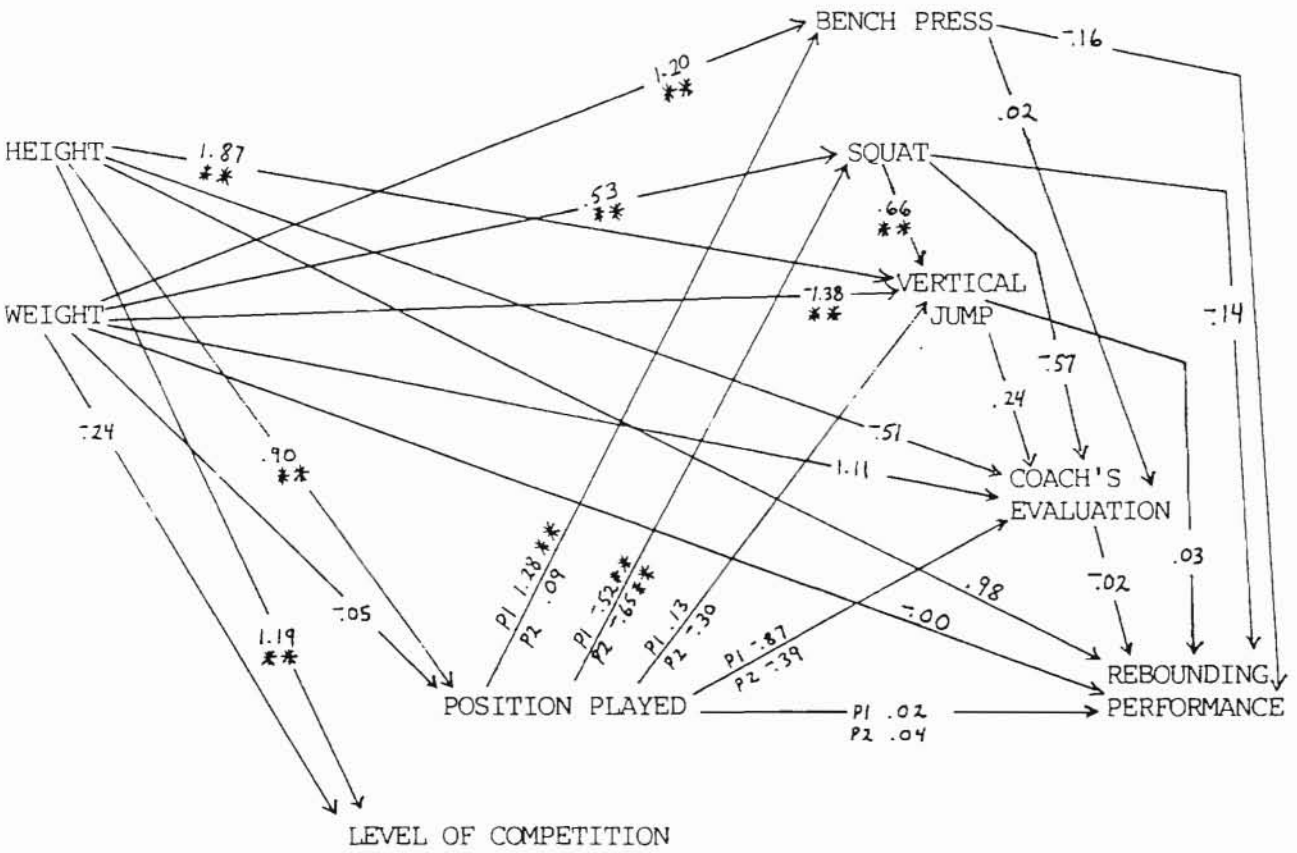
Six of the seven hypothesis above were rejected. If the predictability of one variable was not significant, then the entire hypothesis was rejected. Chapter five will discuss the results of the hypothesis and go into detail with the variables that had a significant predictability to rebounding performance.

## FINDINGS

The findings of this study were as follows (see figure 1):

1. Height significantly predicted vertical jump, such that the greater the participants height the higher they could jump.
2. Height significantly predicted position played, such that the taller the participant the closer they played to the basket.
3. Weight significantly predicted bench press, such that the heavier the body composition of the participant the more that individual could bench press.
4. Weight significantly predicted squat, such that the heavier the body composition of the participant the more that individual could squat.
5. Weight significantly predicted vertical jump, such that the lighter the body composition of the participant the higher that individual could jump.
6. Position played significantly predicted bench press, such that the participants who played closer to the basket could bench press more weight.
7. Position played significantly predicted squat, such that the participants who played closer to the basket could squat more weight.

REBOUNDING PERFORMANCE
Figure 1
Beta scores/p<.05*/p<.01**




+ P1 and P2 are a result of categorical coding using two variables to identify three groups

8. Squat significantly predicted vertical jump, such that the more weight the participant could squat the higher their vertical jump.

## CHAPTER V

## DISCUSSIONS AND RECOMMENDATIONS

The purpose of this study was to determine the factors associated with rebounding performance in basketball. The subjects for this study were collegiate males (N=7) and females (N=9) and high school males (N=10) and females (N=12). These athletes were tested during three sessions throughout the length of the basketball season. Testing included a vertical jump test, a one rep max bench press and squat and a record of the athletes height and weight. The factors used in this study to predict rebounding performance were height, weight, position played, level of competition, bench squat, vertical jump and a coach's evaluation.

The statistical design included a series of multiple regression tests. Significant correlations were recorded at ($p<.05$) for all variables predicting rebounding performance.

### DISCUSSION

Although the results of testing indicate no probability in predicting the variables associated with rebounding performance, there are some factors that have influenced this result. The following discussion will identify the positive and negative factors that influenced the results of this study.

The variance was used in each multiple regression analysis to test the validity of the full and restricted

model. The full model included all variables associated with this study when testing an endogenous variable. The restricted model included just the variables predicted to influence the endogenous variable. For the coach's evaluation and rebounding performance only a full model test was performed due to all predicting variables being associated with these two endogenous variables. If the models predicted an equal amount of variance, the more parsimonious model (i.e. the restricted model) is preferred as it predicts the same amount of variance with fewer variables. However, if the full model predicts a larger portion of the variance, then it is preferred over the less predictive restricted model. In this study, the level of competition was the only endogenous variable which was predicted better by the full model (see table 14). This is due to an unequal number of participating individuals on each team's roster. The high school teams out numbered the collegiate teams by six causing inequality in the statistical analysis.

VARIANCE

Table 13

| Endogenous Variable | Restricted Model | Full Model |
|---|---|---|
| Position Played | .746 | .746 |
| Level of Competition | .069 | .275 |
| Bench Press | .896 | .900 |
| Squat | .762 | .770 |
| Vertical Jump | .720 | .754 |
| Coach's Evaluation | | .671 |
| Rebounding Performance | | .740 |

In this study, the researcher used eight variables to predict rebounding performance. The results of the multiple regression analysis yields multicollinearity. This means that the eight predicting variables have a high correlation among themselves. The cause of multicollinearity is the high correlations among exogenous and endogenous variables. This raises the standard error of the B. The evaluation of the dependent variable rebounding performance is based on the standard error of the B. So when the exogenous and endogenous variables raise this statistic, the correlation between the predicting variables and rebounding performance cannot be observed.

The researcher believes that given the high correlation among the predicting variables, it is a strong possibility that there is significant correlation between the predicting variables and rebounding performance. This could be seen given a larger participant population or fewer variables tested during the length of the study.

## PRACTICAL APPLICATIONS

Based on the findings of this study, the areas of recruiting, strength training and conditioning can be addressed. In this study, the taller athletes with a larger body mass were consistently stronger in the upper and lower body which results in the good make-up of a potentially

solid rebounder. Utilizing the talent you have will influence how you position or play the athletes on the team. The point guard is most likely to be quick but not as tall or as big as a post player. The post player who is powerful will not be as quick or agile as the forward. Recruiting is position specific and deals with the characteristics that individual coaches look for in an athlete.

A successful strength training program is a result of dedicated athletes. Individualizing workouts in the off-season will allow athletes to increase their strength in areas that are weak. During the season use a program that will allow the athlete to maintain the strength they have built, but not overwork them during the course of a season. Since the bench, squat and vertical jump are influenced by an athlete's weight, try to encourage proper eating habits or a training table to allow athletes the best possible nourishment for competition. In turn, vertical jump is affected by the athlete's squat. Thus, encouraging proper strength training will increase the athlete's ability to jump. This can be done with a combination of weights, plyometrics and conditioning.

Working with a properly conditioned athlete will help utilize the strengths and develop the weaknesses, thus reaching the optimal potential of each athlete. Conditioning can include foot work, drills running short distances, sprints, and plyometrics.

Recruiting is a vital tool in collegiate athletics. When used correctly, a coach can add new players who can increase a teams potential in weak areas. When dealing with athletes who are well-rounded in strength training and conditioning, it is often easier to teach the skills of rebounding and expect positive results from the athletes involved with a team. Rebounding is an art and not every athlete can be a great rebounder. Coaches can implement drills, conditioning, and strength training to improve an athlete's potential to rebound.

## FUTURE CONSIDERATIONS

The following are recommendations for further study:

1. Increase the sample size to allow for a larger population of athlete participation.

2. Decrease the number of predicting variables involved in the study. Try to condense variables into two studies.

3. Increase the length of the study from one season to multiple seasons.

4. Discriminate between males and females the factors that predict rebounding performance.

5. Discriminate between high school and college athletes the factors that predict rebounding performance.

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# APPENDIX A

# HUMAN PARTICIPANT APPROVAL

EMPORIA STATE UNIVERSITY
1200 COMMERCIAL EMPORIA, KANSAS 66801-5087 316/341-5351
RESEARCH AND GRANTS CENTER - BOX 48

October 19, 1994

Brian Hoberecht
Physical Education
Box 20

Dear Mr. Hoberecht:

The Institutional Review Board for Treatment of Human Subjects has evaluated your application for approval of human subject research entitled, "To determine the factors relative to individual and team rebounding performance in basketball." The review board approved your application which will allow you to begin your research with subjects as outlined in your application materials.

Best of luck in your proposed research project. If the review board can help you in any other way, don't hesitate to contact us.

Sincerely,

John Schwenn, Dean
Office of Graduate Studies
and Research

JS:pf

cc: Mark Stanbrough

# APPENDIX B

## APPLICATION FOR APPROVAL TO USE HUMAN PARTICIPANTS

APPENDIX B

APPLICATION FOR APPROVAL TO USE HUMAN PARTICIPANTS

This application should be submitted, along with the Informed Consent Document, to the Institutional Review Board for Treatment of Human Participants, Research and Grants Center, Campus Box 4048.

1. Name of Principal Investigator or Responsible Individuals:
Brian Hoberecht

2. Department Affliation: Physical Education

3. Person to whom notification should be sent: Pysical Education
Address: Box 4020

4. Title of Project: TO DETERMINE THE FACTORS RELATIVE TO INDIVIDUAL AND TEAM REBOUNDING PERFORMANCE IN BASKETBALL

5. Funding Agency: N/A

6. Project Purpose(s):

To determine the factors relative to individual aand team rebounding performance in basketball.

7. Descibe the proposed subjects: (age, sex, race, or other special characteristics, such as students in a specific class, etc.)

Men's and women's varsity basketball athletes will be tested. They will be selected from high school and college varsity teams ages 16 to 30.

8. Describe how the subjects are to be selected:

Coaches will be contacted and informed of procedures and testing. On a volunteer basis, the varsity athletes will be presented the topic and asked to participate.

9. Describe the propsed procedures in the project. Any proposed experimental activities that are included in evaluation, research, development, demonstration, instruction, study, treatments, debriefing, questionaires, and similar projects must be described here. Copies of questionaires, survey instruments, or tests should be attached. (Use additional page if necessary.)

See attached copy

10. Will questionaires, tests, or related research instruments not explained in question #9 be used ? _____Yes __X__No (If yes, attach a copy to this application)

11. Will electrical or mechanical devices be used? ____Yes __X__No
(If yes, attach a detailed description of the device(s).)

12. Do the benefits of the research outweigh the risks to human subjects?
__X__Yes ____No This information should be outlined here.

The research in this topic will give beneficial information to athletes and coaches about the relative factors of rebounding. The risk to human participants is possible minor muscle soreness after each testing session. Injury could only occur if athletes perform tests under improper supervision of peers and coaches. Results of injury could be pulled muscles or sprained ankles.

13. Are there any possible emergencies which might arise in utilization of human subjects in this project? ____Yes __X__No Details of these emergencies should be provided here.

14. What provisions will you take for keeping research data private?

Each athlete will receive a letter to ensure that the data is kept private to the principal investigator and supervising instrutor.

15. Attach a copy of the Informed Consent Document, as it will be used for your subjects.

STATEMENT OF AGREEMENT: I have acquainted myself with the Federal Regualtions and University policy regarding the use of human subjects in research and related activities and will cinduct this project in accordance with those requirements. Any changes in procedures will be cleared through thee Institutional Review Board for Treatment of Human Subjects.

Brian Hohrecht — Oct. 19, 1994

Signature of Principal Investigator — Date

Mark Hartman — Oct. 19 1994

Signature of responsible individual (Faculty Advisor) — Date

**THESIS TOPIC**
**Brian Hoberecht**
**1994-1995**

TOPIC: To determine the factors relative to the individual and team rebounding performance in basketball.

METHOD: The basketball season will be divided into four sections. The first section, at the beginning of the season, will be a base for all testing. The second section will include all games before Christmas break. The third section will be based on games after Christmas to approximately three-fourths of the way through the season. The last section will include the remaining games of the season. The athletes first testing session will include: base strength measurements, position, technique and height and weight. The tests will be administered four times during the season and then compared to the minutes each athlete played. Results will be used to see if there is a relative significance in the factors associated with rebounding performance.

TESTING: Rebounding results will be based upon a mean of total team rebounding performance and individually as a correlation coefficient. Individual results will be based on the following tests that will be administered at each session:

-Total number of rebounds in relation to minutes played
(minutes played will be established by coaches, athletes and game statistics)
-Strength and Power
1) one rep max bench
2) one rep max squat
3) vertical jump
-Height and Weight
-Position Played
-Rating Scale (1 to 10)

PARTICIPANTS: Varsity athletes on three different men's and women's basketball teams. Approximately 60 high school and college athletes will be the participants.

# APPENDIX C

# INFORMED CONSENT DOCUMENT

APPENDIX C

INFORMED CONSENT DOCUMENT

The Department/Division of Physical Education supports the practice of protection for humans participating in research and related activities. The following information is provided so that you can decide whether you wish to participate in the present study. You should be aware that even if you agree to participate, you are free to withdraw at any time, and that if you do withdraw from the study, you will not be subjected to reprimand or any other form of reproach.

**Procedures to be followed in the study, as well as identification of any procedures which are experimental**

Each athlete will be asked to perform a series of three tests during four sessions throughout the year. The athletes will receive time to stretch the muscles being used and then perform one warm-up set with a low weight. The tests will include:

1) height and weight
2) one rep max bench
3) one rep max squat
4) vertical jump

**Description of any attendant discomforts or other forms of risk involved for subjects taking part in this study.**

Athletes could experience minor muscle discomfort following a testing session. Injury could only occur if the athletes perform tests without proper supervision from peers and coaches.

**Description of benefits to be expected from the study or research.**

The results of this test should allow athletes and coaches to evaluate the relative factors and techniques that are beneficial to an individuals and teams rebounding performance.

**Appropriate alternative procedures that would be advantageous for the subject.**

"I have read the above statement and have been fully advised of the procedures to be used in this project. I have been given sufficient opportunity to ask any questions I had concerning the procedures and possible risks involved. I understand the potential risks involved and I assume them voluntarily. I likewise understand that I can withdraw from this study at any time without being subjected to reproach."

_____ _____

Subject and/or authorized representative Date

_____ _____

Parent or Legal Guardian Date

# APPENDIX D

# STATISTICAL RECORDING SHEET

THE RELATIVE FACTORS ASSOCIATED WITH
REBOUNDING PERFORMANCE IN BASKETBALL

STATISTICAL RECORDING SHEET

TEAM_____

TEST NUMBER_____ DATE_____

| PARTICIPANTS | HEIGHT | WEIGHT | BENCH | SQUAT | VERTICAL | RANK |
|---|---|---|---|---|---|---|
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# APPENDIX E

# REBOUNDING RECORDING SHEET

THE RELATIVE FACTORS ASSOCIATED WITH
REBOUNDING PERFORMANCE IN BASKETBALL

REBOUNDS/MINUTES PLAYED/AVERAGE

TEAM_____

GAMES_____ DATES_____

| PARTICIPANTS | REBOUNDS | MINUTES PLAYED | AVERAGE |
|---|---|---|---|
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I, Brian Hoberecht, hereby submit this thesis/report to Emporia State University as partial fulfillment of the requirements for an advanced degree. I agree that the Library of the University may make available for use in accordance with its regulations governing materials of this type. I further agree that quoting, photocopying, or other reproduction of this document is allowed for private study, scholarship (including teaching) and research purposes of a nonprofit nature. No copying which involves potential financial gain will be allowed without written permission of the author.

Brian Hoberecht

Signature of Author

12-7-95

Date

The Relative Factors Associated with Rebounding Performance in Basketball

Donna Cooper

Signature of Graduate Office Staff Member

12-7-95

Date Received