EXPLORING THE MOTIVATIONS OF NCAA WOMEN'S ARTISTIC GYMNASTS TO PARTICIPATE IN STRENGTH AND CONDITIONING TRAINING

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ABSTRACT

This is the known first study completed on NCAA gymnastics motivations to participate in strength and conditioning. The study was open to all NCAA women's artistic gymnastics participants. Research included the completion of an online survey (n = 141) with the opportunity to volunteer for a follow up phone interview (n = 5). Three research questions were examined:

1. What are the motivations of student-athletes in NCAA Women's Artistic Gymnastics to participate in strength and conditioning training?
2. How does motivation to participate in strength and conditioning training influence the performance level of the student-athletes?
3. How does motivation to participate in strength and conditioning training influence the injury rate of the student-athletes?

Overall, this study did not identify significant findings in the relationship with motivation to participate in strength and conditioning training with level of performance or injury rates. Qualitative phone interviews provided additional insight on experiences and feelings toward strength and conditioning training, which can be utilized by both researchers and practitioners. In order to further explore the relationship between strength and conditioning and gymnastics performance more research needs to be completed.

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CHAPTER 1: INTRODUCTION

Strength and conditioning training is an important part of the training of National Collegiate Athletic Association (NCAA) student-athletes at numerous universities. Strength and conditioning coaches are responsible for building strength, power, and athleticism while also preventing injuries of NCAA student-athletes. A wide variety of NCAA sports teams utilize the services of strength and conditioning professionals in the training of student-athletes. Strength and conditioning professionals use various training methods in the development of student-athletes. An overarching aspect of strength and conditioning training is the use of weights to develop student-athletes' overall strength, power, and athleticism.

Women's artistic gymnastics is a dynamic sport requiring strength, power, and overall athleticism. Artistic gymnastics is the type of gymnastics that is most common and, for women, involves the events of vault, bars, balance beam, and floor. Additionally, gymnasts are at a high risk of injuries due to the dynamic nature of their sport. Therefore, it is essential for these athletes to build and maintain their strength levels using weight training. However, there is a common belief that weight training will cause gymnasts to "bulk up" and gain weight, making the gymnast too heavy to perform. Because the judging of gymnastics is subjective and based on aesthetics, body image and weight are factors in performance. Looking "bulky" is a negative aesthetic perception in women's gymnastics and coaches/athletes may worry about receiving poor scores due to body shape. The common misconception that weight training leads to weight gain can be debated by the results of anthropometric data taken on elite level gymnasts participating in weight training prior to the 2000 Olympics. These data showed that gymnasts who

incorporated weight training neither gained weight nor became bulky (Sands, McNeal, Jemni, & Delong, 2000).

NCAA gymnastics teams may not be fully utilizing the resources provided by the strength and conditioning staff at their respective universities. Lack of participation in strength and conditioning sessions could potentially have a negative impact on performance was well as increase risk of injury in NCAA student-athletes. An important primary step to incorporating training programs developed by strength and conditioning coaches into the training of NCAA gymnasts is to determine the athletes' attitudes toward strength and conditioning training and why they believe it may or may not be beneficial to them. In addition to this, comparing the rankings of different gymnastics programs with the motivations and extent of experience in strength and conditioning training may provide meaningful data as to how this type of training impacts performance. Moreover, determining injury rates of NCAA gymnasts may show a relation between injury rate in relation to participation in strength and conditioning training.

However, there is a paucity of current research on strength training programs for gymnastics, especially for NCAA gymnastics in terms of choosing weight and training volume to optimally enhance performance and power output (French et al., 2004). This research will help strength and conditioning coaches, especially at the university level, who have contact with women's gymnastics teams, understand the values and perceptions of the athletes. This knowledge would allow strength and conditioning coaches to explain to gymnastics teams how strength and conditioning training is beneficial and increase the buy-in factor of said teams.

Statement of Problem

Due to misconceptions, NCAA gymnastics may not be utilizing the resources provided by strength and conditioning professionals at their respective universities. Strength and conditioning coaches are able to train athletes to be stronger and more powerful athletes, and also prevent future injuries by implementing year round training programs. The purpose of this study is to determine the motivations of NCAA Women's Artistic Gymnastics Student-Athletes to participate in strength and conditioning training. A second purpose is to relate these motivations to performance and injury rates of NCAA gymnasts.

Research Questions

The following research questions were examined in this study:

1. What are the motivations of student-athletes in NCAA Women's Artistic Gymnastics to participate in strength and conditioning training?
2. How does motivation to participate in strength and conditioning training influence the performance level of the student-athletes?
3. How does motivation to participate in strength and conditioning training influence the injury rate of the student-athletes?

Delimitations

The following delimitations to the research were present in this study:

1. Participation is limited to current (2015-2016) NCAA Women's Artistic gymnasts.
2. A self- developed survey was used in this study.

Limitations

The following limitations to this research were present in this study:

1. Participants' responses to the survey are assumed to be honest answers.
2. Acquirement of participants was dependent upon response rate of university administrators and coaches.
3. Data collection relied on the response rate of student-athletes.
4. Lack of Strength and Conditioning Departments at some colleges/universities led to limited ability by athletes of those colleges/universities to answer some survey questions.

Definition of Terms

Motivation: The reasons, willingness, or drive to complete a certain activity.

NCAA: "The National Collegiate Athletic Association is a membership-driven organization dedicated to safeguarding the well-being of student-athletes and equipping them with the skills to succeed on the playing field, in the classroom and throughout life" ("About",n.d.).

Ranking: Determined by the Regional Qualifying Score as reported by GymInfo, "the official NCAA National Rankings for Collegiate Men's and Women's Gymnastics" (2015).

Regional Qualifying Score: "Qualification for regional competition is based on a team's and an all-around competitor's six best regular-season-meet scores, of which three must be away. To obtain the regional qualifying score (RQS), the high score is eliminated and the remaining five scores are averaged. Division III uses the SAS which is computed by

averaging the best home score, the two best away scores, and then the next highest score" (GymInfo, 2015).

Serious Injury: An injury is considered serious if multiple meets were missed due to one injury, surgery was required to repair it, it ended your competitive career, etc.

Strength and Conditioning Training: Training sessions designed and led by the Strength and Conditioning staff of the university.

Strength and Conditioning Coach: Coach who utilizes science based information in order to improve athleticism and sport performance (CSCS Certification, n.d.). It is the responsibility of a strength and conditioning coach to develop all physical aspects of an athlete, such as speed, power, agility, aerobic endurance muscular endurance, and flexibility as is required by the sport (Kontor, 1989). This coach is hired by the university to serve the athletic teams by designing and implementing training programs.

Team Total: The sum of the top five scores on each event from a competition, with the highest possible score totaling 200.00 ("Road to the Women's Gymnastics Championships", 2014).

Women's Artistic Gymnastics: A genre of the sport of gymnastics in which women train and compete in any or all of the following apparatuses: Vault, Balance Beam, Uneven Bars, and Floor Exercise.

CHAPTER 2: LITERATURE REVIEW

The purpose of this research was to determine the motivations of NCAA Women's Gymnastics Student-Athletes to participate in strength and conditioning training. A second purpose was to relate these motivations to performance and injury rates of collegiate gymnasts. The literature review is presented in the following sections: History of Collegiate Strength and Conditioning Training, History of Artistic Gymnastics, NCAA Gymnastics, Physiological Demands of Gymnastics Performance, Increasing Physiological and Artistic Demands of Gymnastics, Psychological Aspects of Strength and Conditioning Training, and Incorporating Strength and Conditioning Programs within NCAA Women's Artistic Gymnastics Programs.

History of Collegiate Strength and Conditioning Training

Strength and conditioning training is a type of training utilizing science based research to improve overall performance and health of athletes (CSCS Certification, n.d.). The incorporation of strength and conditioning training as an integral part of collegiate athletics dates back to 1969.

On August 15, 1969 the University of Nebraska Football Coach and Athletics Director, Bob Devaney, hired Boyd Epley as the first full time, NCAA strength and conditioning coach. From this point on more and more universities began creating full time strength and conditioning coaching positions. Throughout the 1970's these positions grew at the collegiate level. By 1978 the field had grown enough that Boyd Epley realized the need for an organized institution for strength and conditioning professionals. This led to the creation of the National Strength and Conditioning Association (NSCA). As the organization and profession grew a certification was created in the 1980's. This

initial certification was the Certified Strength and Conditioning Specialist (CSCS). Beyond the professional development and certification opportunities the organization also encouraged education by generating a text book, *Essentials of Strength Training and Conditioning*, released in 1990. To date this text book has had three editions, and the organization also distributes other numerous resources. These resources range from various certifications, books, videos, and peer reviewed journals (National Strength and Conditioning Association, n.d.).

Another, more recent, organization has been created to improve strength and conditioning strictly on a collegiate and professional level. The Collegiate Strength & Conditioning Coaches Association (CSCCa) was formed in 2000 by a group of collegiate strength and conditioning coaches. This group of coaches felt the need for a new organization for collegiate strength and conditioning coaches in order to promote the progression of the profession throughout the country. The mission statement of the CSCCa is:

> As an organization of distinction, consisting of the world's leading strength & conditioning professionals, we promote education, unity, and respect for all strength and conditioning coaches of collegiate and professional athletic programs by establishing standards of excellence for coaches that teach athletes how to maximize athletic performance through safe and effective exercise prescription and by certifying coaches that meet those standards. (Collegiate Strength and Conditioning Coaches Association, n.d.)

In accordance with this mission statement, the CSCCa offers a certification and an annual conference for strength and conditioning coaches. Over the years the organization opened up their membership requirements to also allow strength and conditioning coaches from professional organizations (NFL,NBA, MLB, etc.) as well.

Throughout the last 50 years the demands of strength and condition coaches has evolved. At first, the profession started out in the NCAA as a resource for football teams. Currently, strength and conditioning departments are commonplace at many colleges and universities throughout the country, and coaches are responsible for the training of any and all sports teams offered by the university. As the demands for strength and conditioning coaches grew, the responsibilities of coaches also grew. Today, strength and conditioning coaches are responsible for the development of strength, power, speed, agility, quickness, aerobic endurance, muscular endurance, flexibility, recovery process, and injury prevention of NCAA student-athletes in a wide variety of sports.

History of Artistic Gymnastics

The sport of gymnastics has evolved dramatically since its original development. As women's gymnastics is known today, it consists of four events: vault, bars, beam, and floor. The exact origins of these events is not known as there are various worldwide accounts of acrobatic gymnastics being performed throughout history.

As early as 4000 BC, Egyptian hieroglyphics convey the performance of numerous sports, including gymnastics and acrobatics. Moving to 2700 BC, the emergence of gymnastics skills can be found in the Chinese culture. Furthermore, in the 700's AD, the Persians were known to participate in dancing and acrobatic exercises as well (Frantzopoulou, Douka, Kaimakamis, Matsaridis, & Terzoglou, 2011).

However, ancient Greece is perhaps the most commonly credited origin of gymnastics. The ancient Greeks placed great value on physical development; therefore, both men and women were educated and participated in gymnastics. In 2800 BC on Crete, a Grecian island, athletes were known to practice bull leaping (origin of the vault)

and perform acrobatic skills such as leaping and dancing on large courts (origin of the floor exercise). These performances were completed by men, women, and children (Frantzopoulou et al., 2011).

Stepping into the modern era, gymnastics has been a constant sport in the modern Olympics since 1896. Originally, only men were allowed to compete. Finally, the 1928 Olympics allowed for female participation (History of modern gymnastics, 2014). Gymnastics continuously receives a considerably high amount of attention each Olympic Games. The growing media attention of gymnastics dates back to 1976 when Nadia Comaneci scored the first known "perfect 10" (History of modern gymnastics, 2014).

NCAA Gymnastics

The NCAA added women's gymnastics as a sport in 1982. The first NCAA women's gymnastics championships were held in 1982 as well. Since then a championship has been held each year (NC Women's Gymnastics, n.d.). Currently, there are 82 NCAA Women's Gymnastics Programs among Divisions I, II and III (GymInfo, 2015).

High school aged gymnasts throughout the country are recruited by colleges. A vast majority of the gymnasts that continue to participate in gymnastics are of the two highest levels in gymnastics (CollegeGymFans, n.d.). These levels are known as Level 10 and elite, with elite being the higher of the two. This knowledge allows strength and conditioning coaches to evaluate needs of the athletes based upon the demands of the sport in relation to the high level of skills being performed by NCAA gymnasts.

Physiological Demands of Gymnastics Performance

It is important to note that gymnastics is an anaerobic sport. The longest routine in gymnastics lasts a maximum of 90 seconds. During those 90 seconds anaerobic metabolic systems are mostly responsible for all energy produced. While all metabolic systems, both aerobic and anaerobic, are constantly in use, the main systems being stressed in gymnastics performances are anaerobic. The systems producing a majority of the energy for gymnasts are phosphagen and fast glycolysis (Table 1). The aerobic metabolic system does not become the main producer of energy until after approximately two to three minutes of activity (Baechle & Earle, 2008). Knowing that a gymnast will not perform a routine for this length of time, it is important to train the anaerobic system in order to improve performance.

Table 1: Effect of Event Duration & Intensity on Primary Energy System Used

Duration of event	**Intensity of event**	**Primary energy system(s)**
0-6 seconds	Extremely High	Phosphagen
6-30 seconds	Very High	Phosphagen and fast glycolysis
30 seconds to 2 minutes	High	Fast glycolysis
2-3 minutes	Moderate	Fast glycolysis and oxidative system
>3 minutes	Low	Oxidative system

(Baechle & Earle, 2008, p. 32)

The sport of gymnastics has many physical demands beyond which metabolic system is in use. However, due to lack of acceptable equipment and specific tests for the complex sport of gymnastics there is a limited amount of sport specific research and science based evidence. While research may be limited, there are still some studies that have shown the physiological demands of gymnasts. Among these demands are power,

flexibility, and high relative strength to bodyweight ratio (Jemni, 2013; Sands et al., 2000).

Power is the primary factor of concern for gymnastics performance. The key to optimal performance is peak power output (Brooks, 2003; Jemni, 2013). In a study by Jemni, Sands, Friemel, Stone, and Cooke (2006) on the power output of male gymnasts, it was found that gymnasts exhibit power outputs from both the upper and lower body that place them at the top tier of power athletes. The importance of the peak power output implies that the aerobic output of gymnasts would be low. This low demand for aerobic output is supported by Jemni's book, *The Science of Gymnastics*, which compared V02max, the maximal aerobic capacity, of gymnasts to varying factors. One comparison of gymnasts' V02max was made between gymnasts and other sports. This led to the finding, for gymnastics, of a significantly lower V02max of gymnasts than athletes of other anaerobic sports, such as swimming, sprinting, and cycling. Some of the gymnasts' V02max outputs were comparable to sedentary individuals. Jemni (2013) also found that the average V02 max of gymnasts has not significantly changed over the last 50 years. This shows that as the demands of the sport have changed over time, the metabolic needs, especially those of the aerobic system, have not changed. Therefore, endurance training should not be a main training method utilized by gymnasts. However, there is a desire for many gymnastics coaches and gymnasts to want to train endurance and aerobic capacity with the desired goal of weight maintenance and calorie burning (Jemni et al., 2006). There is research that counteracts the common misbelief that shows aerobic training can lead to decreases in maximal power output (Baechle & Earle, 2008). Combining the research on power output and aerobic capacity of gymnasts, along with the fact that

endurance training inhibits power output, it is recommended that gymnasts limit aerobic training.

In addition to power, another key component is relative strength to bodyweight (James, 1987; Sands et al., 2003). Gymnastics skills are completed by moving, jumping, and flipping one's own bodyweight through the air. These skills require a high level of strength. For gymnasts to be successful at skills, their strength to bodyweight ratio must be high. The utilization of weight training is one way to improve the strength to bodyweight ratio.

Another demand of gymnastics is flexibility. Gymnasts are required to show full splits during their leaps and jumps on beam and floor. This requires mobility of the hips. Gymnasts spend a great deal of time training to improve their flexibility in order to reach 180 degree splits. Additionally, performing skills on the uneven bars and balance beam can require great shoulder flexibility. Finally, ankle flexibility is needed to achieve the desired toe point, as well as land skills safely.

Increasing Physiological and Artistic Demands of Gymnastics

The sport of gymnastics has evolved drastically over the years. The sport has evolved from a focus on artistry and dance to a focus on skill, strength, and power (James, 1987). The sport continues to progress, leading to increased difficulty of skills for all levels and ages of gymnasts. This occurs due to the altering to the International and Junior Olympic Codes of points that occurs following each Olympic Games. After each Olympic Games the skill requirements and values are reevaluated. The changes at the international and national level, in turn, affect the Code of Points for the NCAA as well.

With these ever evolving demands, athletes are continuously at a high risk for injury. One study of 15 collegiate sports examined injury rates over the course of 16 years. Women's gymnastics was found to have the second highest rate of injuries occurring in practice and the sixth highest rates of injuries during competition (Hootman, Dick, & Agel, 2007). Gymnasts spend significantly more hours practicing than competing. The high risk of injury during practice is a concern for these athletes and is depicted by Brooks, 2003 when it was stated that,

> The National Athletic Trainers' Association Task Force to Establish Appropriate Medical Coverage for Intercollegiate Athletes (AMCIA) recently identified women's gymnastics as the collegiate sport requiring the most medical attention per student-athlete based on data concerning injury frequency, injury severity, and time lost from practice and competition participation. (p. 23)

There are various reasons for this high risk of injury in relation to the sport demands and biomechanics. As demands of the sport increase, skills continue to become more complex and take a greater toll on the body. The most risk for gymnasts occurs during the landing phase of performance. Landings create high ground reaction forces which the athletes must absorb with their lower bodies (Seegmiller & McCaw, 2003). The highest risk may occur on the floor exercise. The parts of the body most at risk for injuries during this time are the ankles and knees (Kirialanis, Malliou, Beneka, & Giannakopoulos, 2003).

Another important aspect of landing mechanics is using the proper landing mechanics to absorb force with the proper muscles. Findings in research by Seegmiller and McCaw (2003) show that gymnasts experience higher ground force reactions when performing a depth jump from the same height as athletes in other sports. The inability to absorb force efficiently puts gymnasts at a higher risk of injury with each landing. This is

another way in which the demands of landings in gymnastics are putting gymnasts at risk of lower body injuries.

It is clear that collegiate gymnasts are at an extremely high risk for injury due to the dynamic nature and increasing demands of their sport. Therefore, any action that can be taken to reduce risk of injury is necessary. Ensuring that gymnasts are strong and performing exercises to prevent future injuries is important. Participating in strength and conditioning sessions led by the strength and conditioning staff, who are experts in their field of work, is a way to keep gymnasts healthy, strong, and participating in competitions.

Psychological Aspects of Strength and Conditioning Training

A common concern among gymnasts and their coaches is the fear of gaining weight, or "bulking up" as a result of weight training. This fear can lead to a mindset that will prevent the athletes from fully committing to training with a strength and conditioning coach. Various psychological variables will come into play when implementing a program with athletes.

The initial component is getting athletes to commit and believe in strength and conditioning training. The use of the Sport Commitment Model can be helpful when overcoming this challenge. The Sport Commitment Model can be applied to strength and conditioning training in order to determine why athletes buy in to this type of non-sport specific skills training. A survey of athletes' commitment to strength and conditioning training found that female athletes are more likely to buy in to a program when they enjoy it, have invested time or effort, and have little attraction to alternate training methods (Brooks, 2003). Overall, creating an environment of education and enjoyment is

one way to encourage buy-in and a positive psychological perspective towards strength and conditioning training.

Incorporating Strength and Conditioning Programs within NCAA Artistic Gymnastics Programs

The first step a strength and conditioning professional will take in creating a program for any athletic team is to complete a needs analysis. This needs analysis consists of movement analysis, physiological analysis, and injury analysis (Baechle & Earle, 2008). Table 2 is a representation of a needs analysis a strength and conditioning professional would complete for the sport of gymnastics. This analysis is broken down into movement and physiological requirements on an individual event basis. This format will allow the strength and conditioning professional to see the demands of each event individually, as well as analyze which movements are performed most frequently across all events.

A key aspect that is important for strength and conditioning professionals to consider when implementing programs for gymnasts is the high risk of injury associated with landings, and the excess force gymnasts experience from drop landings compared to other athletes. In combining this knowledge, the strength and conditioning professional can gather that gymnasts perform numerous landings for their sport, and that the athletes are not landing in the safest manner (Seegmiller & McCaw, 20003). A component of the training will then include the teaching of proper landing mechanics for the purpose of injury prevention, without compromising the form needed for maximum scoring potential. The safest landing is one in which the posterior chain is the dominant source for force absorption. A conclusion can be drawn that gymnasts are mainly performing

"quad dominant landings." Quad dominant landings increase the risk of knee injury, especially to the ACL (Hauschildt, 2002). Other research has shown that quad dominant athletes are less explosive as well (Kirialanis et al., 2003). Therefore, professionals can draw the inference that teaching gymnasts proper landing mechanics may prevent future injuries, as well as teaching them to activate the posterior chain muscles in order to be more explosive.

The next component for strength and conditioning professionals to examine is the need to be strong and powerful and explosive. As previously mentioned, quad dominant athletes are less powerful. Therefore, coaches need to incorporate exercises that are explosive and develop the glutes and hamstrings (Kirialanis, 2003). In choosing exercises, professionals must also choose whether to incorporate weights into training. "Repeated gymnastics training alone does not seem to provide a sufficient overload to the muscles to facilitate a substantial increase in the gymnast's strength level in a relatively short time" (James, 1987, p. 28).

In order for NCAA gymnasts to increase strength during their limited training time, it is important to use weights as a tool in increase strength as efficiently as possible. Exercises recommended for gymnasts would include squats, deadlifts, and presses/pulls (Sands et al., 2000). The squats and deadlift place great emphasis on posterior chain development, which is needed for power and injury prevention. The presses are demanded by the sports due to the pushing and blocking repeatedly performed. The pulls are needed to ensure muscle balance and prevent shoulder injuries.

Table 2: Gymnastics Needs Analysis

Vault	Bars

• Maximum Power
  o Single Effort
  o Upper and lower body
  o Single Leg
• Hip extension
• Acceleration/Deceleration
• Sprinting
  o Approximately 25 yards
• Overhead shrugging
• Landing mechanics
  o Narrow landing
  o Ankle mobility
• Core
  o Anti-rotation
  o Flexion
	• Muscular Endurance
	• Power
	  o Multiple Effort
	  o Upper body
	• Hip Extension
	• Acceleration/Deceleration
	• Shoulder mobility
	• Hip mobility
	• Overhead shrugging
	  o Single arm skills
	• Overhead throwing
	• Grip
	• Landing Mechanics
	  o Narrow landing
	  o Ankle mobility
	• Core
	  o Stability
	  o Flexion
	  o Anti-rotation

Beam	**Floor**

• Power
  o Multiple Effort
  o Single Leg
• Balance
  o Single Leg
• Hip extension
• Acceleration/Deceleration
• Jumping/rebounding
• Overhead
  o Shrugging
  o Strength (Narrow hand placement)
  o Mobility (Narrow hand placement)
• Landing mechanics
  o Narrow landing
  o Ankle mobility
  o Single Leg
• Core
  o Stability
  o Flexion
  o Anti-rotation
	• Power
	  o Upper and lower body
	  o Single leg
	• Muscular endurance
	  o Multiple Effort Power
	  o Upper and lower body
	• Hip extension
	• Hip mobility
	• Acceleration/Deceleration
	• Overhead shrugging
	• Sprinting
	  o 3 steps
	• Jumping/rebounding
	  o Single leg
	• Landing mechanics
	  o Ankle Mobility
	  o Single Leg
	• Core
	  o Flexion
	  o Anti-rotation

Injury Analysis	**Metabolic Demands**

• Knee
• Ankle
• Shoulder
• Elbow
• Concussion
• Back
• Wrist
• Groin
	• Anaerobic
	  o Longest Routine = 90 sec
	• Systems Used in Sport
	  o Phosphagen and Glycolysis

Moreover, in order to develop power and explosiveness, gymnasts would ideally complete any or all of the Olympic lifts, which are the Clean, Jerk, Snatch, and their variations. These exercises demand acceleration, deceleration, strength, mobility, and body awareness. As stated by Jemni (2013), "Gymnast's ability to be explosive in his/her movement is often dependent on the ability to accelerate. Although rapid movement may be desirable, the gymnast is constrained by the time limits of foot contact with the floor…" (p. 60).

Jemni (2013) describes the need for rapid acceleration in a limited time. The Olympic lifts require rapid acceleration to lift the bar, followed by deceleration, or landing, to complete the skill. The Olympic lifts train triple extension, which is extension of the hips, knees, and ankles. This triple extension is seen in a gymnastics take-off. The kinetic chain sequence for take-offs, as described by Gerald (2010), is hip-knee-ankle extension. This sequence of joint extension is key to ideal take-offs. The previously mentioned Olympic lifts will develop the extent to which a gymnast can create power through hip-knee-ankle extensions. This will then contribute to improved quality of jumps and rebounds performed in gymnastics.

Beyond the benefits of power and explosiveness, the Olympic lifts have other possible benefits for gymnasts. One of these is mobility. In order to perform the Olympic lifts, athletes need ankle and hip mobility to reach the starting positions. Gymnastics requires high mobility in the ankles during landings, and also in the hips to perform dance skills. Additionally, the lifts require body awareness. Gymnastics requires a high level of body awareness in relation to the ground/bar/beam. The Olympic lifts are skills demanding the athletes to move their body around the bar and maintain proper form.

However, this is only one example of an exercise that can help gymnasts. There are numerous ways to develop gymnasts' athletic abilities that directly relate to learning new skills in the sport.

A final aspect a strength and conditioning professional needs to consider when programming for gymnasts is training volume. Gymnasts generally need to train in a range that minimizes hypertrophy and optimizes strength and power. Specific guidelines can be found in Table 3. These numbers are solely guidelines. It is not necessary to strictly follow the repetitions, loads, and sets when creating a program. The needs of athletes may differ depending on the season and training age.

When creating strength and conditioning programs, it is important for the strength and conditioning professional to address the demands of the sports and the common injuries of the sport. From there, incorporating strength and conditioning programs that develop power and strength while preventing injuries in the most efficient and effective manner is the key to training NCAA gymnasts.

Table 3. Training Variable Based on Goal

Training Goal	Load (%1RM)	Repetitions	Sets
Strength	≥85	≤6	2-6
Power			
Single-Effort	80-90	1-2	3-5
Multiple Effort	75-95	3-5	3-5
Hypertrophy	67-85	6-12	3-6

(Binkley, 2002, p.15)

CHAPTER 3: METHODOLOGY

The purpose of this study was to determine the motivations of NCAA Women's Artistic Gymnastics Student-Athletes to participate in strength and conditioning training. A second purpose is to relate these motivations to performance and injury rates of NCAA gymnasts. The methodology is presented in the following sections: Research Design, Participants, Research Timeline, Instrumentation, Procedures, Data Analysis, and Bias Statement.

Research Design

The approach to the research was mixed methods. Quantitative data were collected by survey results and rankings of NCAA women's artistic gymnastics programs from the 2015-2016 competitive season. Qualitative data consisted of answers from a phone interview completed after the survey.

Participants

The population of interest was all NCAA Women's Artistic Gymnastics programs. This includes Divisions I, II, and III. There are 82 such programs in the NCAA (See Table 4) (GymInfo, 2015). Participation in the research was open to any Fall 2015 NCAA gymnast.

Instrumentation

The instruments utilized to attain the desired information included an online survey and a qualitative follow-up phone interview. The online survey, created on Qualtrics, contains questions mostly developed by the researcher. The idea for the theme of the survey, and several of the questions, came from the Sport Motivation Scale (Pelletier et al., 1995). The questions are asked with the intention of learning the

parameters of NCAA gymnasts' participation in weight training and their feelings and motivations toward weight training. The survey contains demographic questions, fill in the blanks questions, multiple choice questions, and Likert Scale questions. The survey ended by asking participants to further volunteer for a potential follow up phone interview with the researcher (see Appendix A).

An expert panel of coaches was developed to provide feedback on the instruments used in this study. The coaches who reviewed the survey were Patrick Dolan, Clare Kaufman, Tim Teefy, Robert Wagner, Samuel Whitney, and Tracy Zimmer.

The researcher also created the follow up questions (see Appendix B). The questions are to help delve into further discussion with athletes. Using a phone interview allowed for greater understanding behind the motivations to participate in strength and conditioning training. The previously mentioned expert panel examined the follow-up questions, along with Dr. Catherine Schifter.

Procedures

The timeline for this research began in the summer of 2015. The first step of emailing Senior Woman Administrators (SWAs) of all universities with an NCAA Women's Artistic Gymnastics team was taken at the beginning of August (see Appendix C). If necessary, a follow-up email was sent two weeks later. After receiving approval from the SWAs, the head gymnastics coaches were contacted by email in early August through September requesting athlete participation and providing a school unique link to the online survey (see Appendix D). If needed, follow-up emails were sent to coaches. With coaches' approval, athletes completed the online survey at the between August and October of the Fall 2015 semester.

Table 4. All schools with an NCAA Women's Gymnastics Program in 2015-16

Division I	Division II	Division III
University of Alabama	University of Bridgeport	Gustavus Adolphus College
University of Alaska Anchorage	Lindenwood University	Hamline University
University of Arizona	Seattle Pacific University	Ithaca College
Arizona State University	Southern Connecticut State University	Rhode Island College
University of Arkansas	Texas Woman's University	Springfield College
Auburn University	West Chester University	State University of New York at Brockport
Ball State University		State University of New York at Cortland
Boise State University		Ursinus College
Bowling Green State University		Winona State University
Brown University		University of Wisconsin- Eau Claire
Brigham Young University		University of Wisconsin- La Crosse
University of California - Berkeley		University of Wisconsin- Oshkosh
University of California- Davis		University of Wisconsin- Stout
University of California - Los Angeles		University of Wisconsin- Whitewater
California State University- Sacramento		
Centenary College		
Central Michigan University		
College of William & Mary		
Cornell University		
University of Denver		
Eastern Michigan University		
University of Florida		
George Washington University		
University of Georgia		
University of Illinois		
University of Illinois - Chicago		
Illinois State University		
University of Iowa		
Iowa State University		
Kent State University		
University of Kentucky		
Louisiana State University		
University of Maryland		
University of Michigan		
Michigan State University		
University of Minnesota		
University of Missouri		
North Carolina State University		
University of Nebraska		
University of New Hampshire		
University of North Carolina		
Northern Illinois University		
Ohio State University		
University of Oklahoma		
Oregon State University		
University of Pennsylvania		
Pennsylvania State University		
University of Pittsburgh		
Rutgers University		
San Jose State University		
Southeast Missouri State University		
Southern Utah University		
Stanford University		
Temple University		
Towson University		
United Stated Air Force Academy		
University of Utah		
Utah State University		
University of Washington		
West Virginia University		
Western Michigan University		
Yale University		

Participants who volunteered for a follow-up phone interview were contacted in November-December 2015. The process of selecting phone interviews was randomized. The participants were stratified into two groups depending upon school ranking. Group 1 consisted of participants in the top half of participating schools, and Group 2 contained the lower ranked schools. Participants from each group were randomly selected by drawing names. Five participants from each group were contacted at a time to request further participation in the order in which they were randomly selected. This would lead to a total of 10 phone interviews, if all participants chose to complete the follow up interview.

The purpose of the follow-up interview was to further understand the athletes' motivations towards weight training from an emic viewpoint, and understand the culture and beliefs of NCAA gymnasts. This portion of data collection is qualitative in nature. This qualitative tool was used to apply the research paradigm of interpretivism. Interpretivism focuses on examining and understanding a culture's actions and behaviors. According to interpretivism, meaning and value are subjective. Therefore, the meaning put upon strength and conditioning training is unique to each individual. This is because each program has its own culture, and therefore creates its own meanings and values (Lichtman, 2012).

Data Analysis

Data analysis consisted of both quantitative and qualitative methods. Correlations between the answers to the Likert responses and injury as well as correlations between the Likert response and performance level determined by team rankings were made to answer the research questions.

The phone interviews were audio recorded. The transcripts from the interviews were reviewed by the interviewees to allow for clarification. The transcripts were analyzed using Atlas.t to examine preliminary codes the research anticipated, as well as additional codes and themes that arose within the interviews that were not anticipated (Table 9). In order to aid this process and eliminate researcher bias, another graduate student reviewed the coding framework as well.

Bias Statement

The motivations for NCAA women's artistic gymnastics student-athletes to participate in strength and conditioning training provided by the Strength and Conditioning Department of the respective university are explored in this study. I was a competitive gymnast for 14 years and have substantial knowledge about the sport and how gymnasts train. I may be biased due to how I was coached and trained. My coaches instilled values and training philosophies in me that other coaches may not have.

In addition to previous experiences with gymnastics coaches, I had the opportunity to have a private strength training professional work with my gymnastics team during my teenage years. This experience taught me how important it is to have a strength training plan that is implemented by a strength and conditioning professional.

Another possible bias is that I am a Graduate Assistant Strength and Conditioning Coach. I believe that strength and conditioning training is beneficial to all athletes. I am biased in my belief that gymnasts will benefit from, and should participate in, strength and conditioning training. While my overarching goal is to understand how the athletes feel about strength and conditioning training, my status as a strength and conditioning

coach could influence participants' responses. Participants may answer the survey questions in a manner they believe I want or expect.

Finally, I had expectations for what I would discover. I expected that many athletes will not be highly motivated to participate in strength and conditioning training because of fear of gaining weight, looking bulky, or losing flexibility. I also expected that athletes who participate in strength and conditioning training will perform at a high level.

CHAPTER 4: RESULTS AND DISCUSSION

The purpose of this study was to determine the motivations of NCAA Women's Artistic Gymnastics Student-Athletes to participate in strength and conditioning training. A second purpose is to relate these motivations to performance and injury rates of NCAA gymnasts. The results and discussion are presented in the following sections: Demographics, Quantitative Results, Research Questions, Qualitative Results, Discussion, Implications for Research, and Implications for Practitioners.

Demographics

The survey was taken by student athletes between August 6, 2015 and October 31, 2015. A total of 141 student-athletes from 17 schools participated in this research. These 17 schools represent 21% of all NCAA Women's Artistic Gymnastics programs that were eligible to participate in this research. A majority of participants were from Division I schools (61%), while 39% were from either Division II or III schools.

Of these 141 student-athletes, 109 from 16 schools fully completed the survey. Regardless of completion status, there was no significant effect on answers to the research questions. For clarity of data analysis all following analyses and results will only include the 109 fully completed surveys. Table 5 lists a complete breakdown of participation frequency and both partial and full participation in relation to roster size.

Of the 109 participants, 60% are underclassmen (Freshmen and Sophomores) and 40% are upperclassmen (Juniors, Seniors, and Fifth Years). The year-by-year breakdown of percentages is depicted in Table 6.

Table 5. Participation by School

School	Roster Size	Participants	Percentage of Roster Participated	Fully Completed Surveys	Percentage of Roster Fully Completed
1	14	3	21%	3	21%
2	17	14	82%	10	59%
3	22	8	36%	6	27%
4	14	6	43%	5	36%
5	17	14	82%	12	71%
6	17	5	29%	4	24%
7	19	8	42%	4	21%
8	18	7	39%	4	22%
9	22	4	18%	4	18%
10	23	8	35%	8	35%
11	20	8	40%	6	30%
12	18	4	22%	4	22%
13	17	12	71%	10	59%
14	19	2	11%	2	11%
15	22	1	5%	0	0%
16	25	24	96%	17	68%
17	18	13	72%	10	56%
TOTAL	322	141		109	
Average			44%		34%
Minimum			5%		0%
Maximum			96%		71%

Table 6. Participants by Year in School & Years Participating in Strength and Conditioning

Year in School	Frequency	Percent	Years Participated	Frequency	Percent
Freshman	29	27%	0	30	28%
Sophomore	36	33%	1	26	24%
Junior	25	23%	2	23	21%
Senior	17	16%	3	22	20%
5th Year Senior	1	1%	4	8	7%
No Answer	1	1%	-	-	-

Quantitative Results

A majority of participants report participation in a strength and conditioning program (93%). The remaining 7% of participants are split into two categories which include no participation in a strength and conditioning program (4%) and not sure (3%). Of the student athletes not participating in a strength and conditioning program, four out of five respondents would like to be involved with a strength and conditioning program. The student athletes participating in a strength and conditioning program reported a varying number of coaches who lead their program. Strength and conditioning staff lead 21% of participants, gymnastics staff is in charge of 14% of participants, both strength and conditioning and gymnastics staffs lead 61% of participants, 2% of participants are unsure who leads the program, and 2% of participants are led by athletic trainers. The student athletes who reported not participating in strength and conditioning or that their gymnastics coaches or other lead their strength and conditioning programs were asked whether or not their school had a strength and conditioning department. Thirty-six percent of participants reported their school has a strength and conditioning department, 21% do not have a strength and conditioning department, and 43% are not sure if their school has a strength and conditioning department.

Participants also reported how many years they have completed a strength and conditioning program in college. Twenty-eight percent have participated for 0 years, 24% for 1 year, 21% for 2 years, 20% for 3 years, and 7% for 4 years. The participants have participated in an average of 2.56 years of training.

When asked about time spent focused on strength and conditioning training in season, answers varied widely, ranging from 0-208. A reported 23% of student athletes

do not/have not yet participated in strength and conditioning training in season. The majority (70%) participate between 1-6 hours each week. Student athletes were also asked about hours spent strength and conditioning training off season, with answers ranging from 0-80 hours. A reported 11% of student athletes do not/have not yet participated in strength and conditioning training in season. The majority (76%) participate between 1-6 hours each week.

When asked about a serious injury, 52% report no serious injuries, 42% report 1-2 serious injuries, 5% report 3-4, and 1% report having five or more serious injuries. On average, participants have had one or two serious injuries (with a standard deviation of .631)

When asked about exercises they have done with some variation of weights (e.g., barbell, kettle bell, or dumbbell), 77% have completed squats, 83% have done deadlifts or RDL's (Romanian Dead Lifts), 42% have done a variation of a power clean, 21% have done a variation of a power snatch, 17% have done a variation of a push or split jerk, and 7% have never completed any of the listed exercises.

Table 7 indicates the average and standard deviation to Likert scale questions about motivation and belief toward weight training. In Appendix E is a breakdown of each question by frequency of response as well.

Table 8 shows the average and standard deviation of the averages of all Likert scale questions pertaining to intrinsic motivation, extrinsic motivation, and belief. In Appendix E is also a table depicting the averages of all questions pertaining to intrinsic motivation, extrinsic motivation, and belief.

Research Questions

1. What are the motivations of student-athletes in NCAA Women's Artistic Gymnastics to participate in strength and conditioning training?

Table 7 depicts the mean and standard deviation for each Likert scale question about motivation to participate in strength and conditioning training. The range for averages for these questions was 2.47-4.22, with 2.0 being Disagree, and 4.0 being Agree. Most answers were within the neutral range (3.0). There are six questions with an average above 4.0, meaning the participants agreed with the statement. These questions display that, on average, the participants enjoy their time spent in strength and conditioning training, their coaches support it, and they find value in strength and conditioning training. Table 8 shows the averages and standard deviations for all questions related to extrinsic motivation, intrinsic motivation, and belief concerning strength and conditioning training. While all averages are within the neutral range, intrinsic motivation has the highest average.

2. How does motivation to participate in strength and conditioning training influence the performance level of the student-athletes?

In comparing school ranking and the three categories of motivation, the correlation with intrinsic motivation is -.051. The correlation of extrinsic motivation and school ranking is -.086. The correlation of belief and ranking is -.077. Therefore, no relationship between motivation to participate in strength and conditioning training and performance level was found in this study.

3. How does motivation to participate in strength and conditioning training influence the injury rate of the student-athletes?

In comparing injuries and the three categories of motivation, the correlation with intrinsic motivation is -.081. The correlation of extrinsic motivation and injury is .007. The correlation of belief and injury is -.059. Therefore, no relationship between motivation to participate in strength and conditioning training and performance level was found in this study.

Table 7. Mean, Standard Deviations and Frequency for All Likert Scale Questions

Question	Mean	Standard Deviation	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I receive rewards for participating in weight training	2.47	0.993	13	45	26	11	4
I would rather practice my sport than participate in weight training	2.82	0.944	8	32	45	20	4
Weight training is necessary to perform at my maximal potential	3.26	0.975	3	21	35	36	9
I feel 1 hour of weight training takes more of a toll on my body than 1 hour of gymnastics practice	3.37	1.024	3	23	23	47	11
I believe I am capable of lifting more weight than I am currently	3.43	0.979	2	17	34	38	14
I look forward to weight training sessions	3.46	1.029	3	17	30	39	16
I fear weight training will cause weight gain	3.48	1.072	4	18	26	42	18
There are negative consequences for missing a strength training session	3.54	1.079	1	23	20	39	21
I set my own goals in terms of weight training	3.56	0.943	2	15	24	53	13
I am concerned weight training will cause an injury	3.59	0.938	1	16	24	52	15
I feel weight training reduces the risk of injury that may occur while doing gymnastics	3.66	0.833	1	7	35	50	15
My teammates value weight training	3.68	0.775	0	10	24	62	10

I feel weight training improves gymnastics performance	3.82	0.852	1	6	27	53	22
I do not think weight training is needed for my sport	3.83	0.928	1	10	21	51	26
I will continue (or begin) weight training after retiring from gymnastics	3.86	1.077	4	10	16	44	33
I am self-motivated to participate in weight training	3.87	0.848	1	8	16	61	21
I am motivated by others to participate in weight training	3.88	0.696	0	4	21	66	16
I enjoy weight training	3.90	0.917	1	10	15	55	27
I feel personal satisfaction when participating in weight training	4.05	0.836	1	5	14	56	32
I find value in weight training	4.07	0.92	2	7	9	54	37
I enjoy working with the strength and conditioning staff	4.11	0.688	0	1	16	56	29
I enjoy participating in weight training during my time as a student athlete	4.12	0.929	3	3	13	47	41
I enjoy discovering new training methods	4.22	0.691	0	1	13	54	39
My coaches encourage participation in weight training	4.22	0.816	1	5	5	54	42

For all Likert scale question 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree.

Table 8. Averages for Intrinsic Motivation, Extrinsic Motivation, and Belief Based Likert Scale Questions

	Intrinsic	Extrinsic	Belief
Mean	3.8447	3.6667	3.6116
Std. Deviation	.73828	.42804	.55841
Minimum	1.57	2.67	2.09
Maximum	5.00	5.00	4.82

Qualitative Results

Participants choosing to volunteer for a follow-up phone interview were put into two groups depending upon school ranking. Group 1 had volunteers from schools 1-8, with a total of 24 participants, and Group 2 had volunteers from schools 9-17, with a total of 28 participants. The researcher attempted to complete 10 phone interviews, five from each group. A total of five interviews were completed due to lack of response and time limitations once participants started their competition season. Four participants from Group 2, and one participant from Group 1 completed the follow up phone interview. Year in school was not considered in the stratification process. Two participants were juniors, two participants were seniors, and one participant was a freshman. Interviews lasted from 11-20 minutes.

Transcripts were initially examined by codes determined by common themes and language throughout the interviews (Table 9). These codes were checked and edited by another graduate student. Based upon the initial analysis, five categories made relating to how the participants feels about weight training overall, if they work with a strength and conditioning coach, and if they see any specific benefits from weight training that relates to gymnastics. Each transcript was analyzed to determine if the participant should be placed in the family. Table 10 lists each participant and the school number (1-17) they are from, and Table 11 lists the categories and the participants in each category. Overall, all participants completed similar training programs. All utilized weights (barbell or dumbbell) and completed bodyweight circuits. Some use more weights than others, but, generally speaking, all participate in a strength and conditioning training program.

Table 9. Codes

Abs	Deadlift	Heavy	Power	Weight gain
Ankle	Difference	Help	Pull ups	Weight room
Barbell	Does not help	Injured	Push ups	Weightlift
Beam	Dumbbell	Injuries	Run	
Is beneficial	Easier	Injury	Sprint	
Bodyweight	Endurance	Jump	Squat	
Cardio	Faster	Knee	Stamina	
Circuit	Fatigue	Lift	Strength coach	
Conditioning	Floor	Muscle	Stronger	
Core	Handstands	Performance	Tiring	

Table 10. Phone Interview Participants

Participant	School
1	7
2	10
3	13
4	16
5	17

Table 11. Categories

Family	**Participants**
Works with a strength and conditioning (S&C) staff	1,2,3,4
Feels working with the S&C staff is beneficial	1,2,3,5*
Feels weight training improves gymnastics performance	2,3,5
Feels weight training is beneficial in preventing or limiting injuries	1,23,5
Enjoys weight training	1,2,3,5

*Participant 5 doesn't work with strength and conditioning staff due to the lack of the department at her school; instead she participates in strength and conditioning training that is designed by an athletic trainer. She does report that working with the athletic trainer in this function is beneficial.

The topic of weight gain or feeling heavy was a factor with the participants, although never directly asked about it, it came up in three interviews. Participant 1 doesn't think weight training is beneficial to gymnastics performance for this reason, even though she enjoys it and finds it beneficial in injury prevention. She stated:

> Specifically for gymnastics I don't think it's beneficial. Personally, for me, when I don't weightlift for a while I feel lighter which makes my tumbling easier. So I like weight lifting, but not specifically for gymnastics.

And then when asked to share anything she feels is important about her weight training experiences she explains:

> I think weights, it definitely didn't hurt it. It hasn't contributed to my injuries. It keeps me in shape when I can't do gymnastics. So I definitely, like it has helped me be a better gymnast. Or maintain my level because without it I wouldn't have gotten in as much conditioning. I wouldn't have stayed as strong. It would have taken me a lot longer to get back into full gymnastics after being injured. So in that way it was definitely a positive for me.

Participant 1 is the only one who mentioned the issue of feeling heavy with weight training. Other participants mentioned that they do not worry about weight gain or bulkiness with weight training. Participant 5 stated:

> A lot of people think that weight training or weight lifting builds your muscle too much and inhibits gymnastics performance. I haven't experienced since I've been weightlifting, I did it in high school too. It hasn't inhibited any of my gymnastics; it's actually made me stronger. I think it's good to get stronger and to work on building up on the different muscles in your body.

When reflecting on her collegiate weight training participant 3 mentioned, "I know the girls were nervous it would make them big and bulky, I wasn't worried about that."

Discussion

The results of this research do not show any correlation between motivation to participate in strength and conditioning training with performance or injury rate for NCAA gymnasts. In analyzing the data, the reliability of the student athletes' responses came into question. A majority of the participants were underclassmen, with a quarter of the participants being incoming freshmen. These participants have little to no

experience with strength and conditioning during their collegiate career due to their age. This inexperience may impact the results in different ways. One way is that the incoming freshmen do not know what exercises they do in strength and conditioning training, they may not know their coaches, and they may have only participated in strength and conditioning by completing a summer training packet from the college/university on their own time. Participant 2 was a freshman; although she had many insights and could discuss her experiences to date, she was unable to speak about an in-season training program, which limited our phone interview. Some of the surveys were taken early in August before school started, meaning incoming freshmen had not been on campus for training as of yet. It is difficult to measure the motivation of these participants who have little or no experience in collegiate strength and conditioning training.

Another aspect, which may have presented errors, is the exercises completed. Some athletes are unaware of the exercise they complete in strength and conditioning training, and they may not know the name of the exercise. The survey included pictures to aid student athletes in answering this question, but the listed exercises can be completed in various ways with various types of weights (dumbbell, barbell, kettle bell, weight plates, etc.) that the athletes may perform the exercise but differently than was pictured.

Additionally, the questions that asked about weekly time spent on strength and conditioning training have some responses that do not make sense. For example, the participant who listed 208 hours of strength and conditioning training is assumed to have entered a typographical error, and there are other answers that may be typographical errors as well. Specifically, the answers that are above six hours for off-season strength

and conditioning training, and answers above 20 hours for in-season are not plausible answers according to the NCAA manual. The NCAA dictates the number of hours student athletes are allowed to train and practice. Off-season teams have a maximum of six hours they can spend doing strength and conditioning training. In season student athletes are not to have more than a total of 20 hours of athletic activity, which is a combination of strength and conditioning and practice activities (National Collegiate Athletic Association, 2015). To further support that these are typographical errors is that during the phone interviews no participant reported more than three hours of weight training in or out of season. The phone interviews also provided insight to the student athletes' difficulties in providing a definition for strength training and a definition for conditioning .All phone interview participants struggled to provide definitions, and some even commented they view them as the same thing. This brings into question what the student athletes were thinking of when asked about hours spent on strength and conditioning training. Therefore, the answers that are drastically outside the aforementioned numbers may be typos, or may be instances where the participant was unsure what constitutes strength and conditioning training.

Another area in which participants from the same school reported conflicting answers was about which coach(es) implement strength and conditioning training. Participants from the same school reported different coaches in charge of their strength and conditioning training. This shows that student athletes within the same program have different perceptions on who is leading their strength and conditioning training. Therefore, it is difficult to determine the mindset the participants had when answering questions about their motivation to participate in strength and conditioning training

because student athletes from the same program may have been reflecting upon different coaches and experiences.

Moreover, the relationship with training and injury may not be clear. This research defined a serious injury as when the participant does not compete in multiple meets due to one injury, surgery was required to repair it, it ended your competitive career, etc. However, in the sport of gymnastics some people still compete through injury or may elect to not have surgery; therefore, there may be a downplaying in the reported injuries due to this mentality within the sport.

Finally, although no relationship between ranking and overall motivation to participate in strength and conditioning was found, there was an interesting and significant relationship with Division I schools and extrinsic motivation (shown in Table 8). The average extrinsic motivation in Division I is significantly higher than those of the of the Division II and III schools. This means that external sources for the Division I participants may have more influence on their motivation to participate in strength and conditioning training. Division I student athletes have more external sources of motivation due to more resources available. These resources may be a larger sport coaching staff, larger strength and conditioning coaching staff, rewards for participation in strength and conditioning training, and consequences for not participating in strength and conditioning training.

Implications for Research

This study was not able to find a significant relationship between motivation to participate in strength and conditioning training and NCAA female gymnasts' performance level or injury rates. However, the finding that Division I participants had

more external motivation could be of interest in research. This was the first known research on NCAA gymnasts' motivations to participate in strength and conditioning training. This research could be taken to other sports and levels of competition as well (i.e., high school, youth, recreation).

This study is not an overall representation of all NCAA gymnasts as only 17 of 82 programs chose to participate, and within those 17 programs that did participate not all student athletes chose to complete the survey. Future researchers should look to gain participation from as many programs as possible. It is not currently plausible for all 82 schools to participate due to some schools having rules against allowing student athletes to participate in research, while other schools have a research panel that hand picks which research studies they will participate in for the year. However, future researchers should be prepared for events such as administrative or coaching staffing changes, or submitting applications to other institutions' IRB during the initial contact process.

Another aspect for future researchers to consider is the development of the survey utilized. This study had 32 participants drop out mid-way through the survey. It may be beneficial to have participants answer Likert scale questions first, and talk with coaches to gather information to make the survey shorter (year in school, years participated in strength and conditioning, hours spent training). Also, some questions may have been unclear (i.e., years participated in strength and conditioning training, coaches who lead strength and conditioning training, number of serious injuries suffered) and there is a need to update and clarify questions. Additionally, eliminating the possibility of typos within the answers is needed for the future. This study had possible typos in the answers related to time spent on strength and conditioning training. Perhaps giving student

athletes ranges (i.e., 1-2 hours, 3-4 hours, etc.) could eliminate questions of data validity. One last consideration for updating the survey is to change the question asking about fear of weight gain to " I feel weight training will make me look bigger", as this phrasing may elicit a more relatable response to participants.

The final recommendation for future research is to consider having only sophomores – fifth year seniors eligible to participate. As previously discussed, the freshmen do not yet have knowledge of the training program or exercises utilized. Therefore they have little to no experience with strength and conditioning training to reflect upon when completing a survey at the beginning of the school year. It is not recommended to move the timing of the survey to the end of the school year when freshmen would have knowledge of their strength and conditioning program due to time constraints with final exams and fatigue with having just complete competition season.

This research provides insight into the motivation that NCAA student athletes have toward various activities athletes partake in that are not sport specific. This is a step toward looking at all the demands placed on NCAA student athletes outside of their specific sport participation, and analyzing what motivates them to participate in such activities.

Implications for Practitioners

Practitioners, specifically collegiate strength and conditioning coaches, strive to make student athletes stronger, more athletic, decrease injury rates, and positively motivate student athletes. In order to achieve the numerous goals of a collegiate strength and conditioning coach, the student athletes need to believe that strength and conditioning coaches can help them to perform at a higher level in their chosen sport.

Achieving buy in is the first step in developing athletes who are committed to participate in strength and conditioning training.

One way to promote commitment is to teach the athletes why each exercise is being completed and how it will translate to improved performance or decreased injury. This can be one way to limit the attraction to alternate methods (Brooks, 2003). An example is communicating with gymnasts that the power clean is a tool utilized to develop power that they need in tumbling during floor exercise. Another helpful example is that depth jumps are a time for the gymnasts to focus on landing technique, and ensure they are decelerating and absorbing the force with their posterior chain, rather than their knees and quads, and is a way to help prevent knee pain and injury (Hauschildt, 2002). This can be used on any other exercises throughout the training program as well. Helping the student athletes realize how their effort in strength and conditioning training will translate to sport can have great impact, not only in helping the student athletes realize the physical translation, but also that the strength and conditioning coach is aware of the needs and movement within the sport.

Another teachable moment for strength and conditioning coaches can be describing how the volume of training is beneficial to training and will limit hypertrophy, and the need for anaerobic/sprint training over aerobic/cardio training (Jemni et al., 2006). This can go a long way in comforting the athletes that they will neither gain weight nor bulk up by lifting weights. Teaching the student athletes the information from Table 3 may be beneficial when explaining the chosen number of repetitions and intensity in weights.

Also, when looking to teach student athletes the importance of investing their time and effort into training, there are different areas to be addressed. Social needs should be addressed. Encouraging athletes to recover from training and invest time in eating right and sleeping is important (Brooks, 2003). Educating student athletes on how to get the most out of their time in strength and conditioning training to feel strong and prepared is essential.

Finally, creating an environment where the athlete needs to be focused and mentally present during the training is important. Ensuring that the student athlete is focused on training and has a task to complete is important. Having a task to complete is especially important when that student athlete is injured. It is important that the injured student athletes' needs are taken care of as well. During the qualitative interview process it was expressed that Participant 4 felt there was nothing for her to do in strength and conditioning training when she was injured. This impacted her belief about the importance of strength and conditioning training because she felt she was not using her time efficiently. In looking back to Table 11, this participant does not feel weight training is beneficial to her in improving gymnastics performance or limiting injuries; she also does not enjoy weight training. However, in speaking with Participant 1, she felt there were always alternate exercises given to her in strength and conditioning training when injured. She believes that by staying strong in strength and conditioning training when injured, she was able to return to her sport faster and more easily than if she had not been in a strength and conditioning program. Therefore, practitioners must take into account the needs of injured student athletes. Helping and encouraging these student athletes to stay physically strong throughout an injury can help create buy in.

Overall, there are many aspects practitioners must account for when working with student athletes. The process of creating buy-in with a team of student athletes takes time and, over time, student athletes have the potential to become more motivated to participate in strength and conditioning training. There are ways to distribute the research and information found within this study to benefit practitioners. There are conferences and clinics for strength and conditioning professionals held throughout the year. A presentation at one of these conferences is a way to communicate with other practitioners. Additionally, an article in one of the publications for strength and conditioning professionals, or on a website for strength and conditioning professionals, is an option. The researcher could partner with a more experienced and well-known professional in an effort to disseminate the knowledge.

CHAPTER 5: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FUTURE RESEARCH

This is the known first study completed on NCAA gymnastics motivations to participate in strength and conditioning training. The study was open to all NCAA women's artistic gymnastics participants. Research included the completion of an online survey (n = 141) with the opportunity to volunteer for a follow up phone interview (n = 5). Three research questions were examined.

1. What are the motivations of student-athletes in NCAA Women's Artistic Gymnastics to participate in strength and conditioning training?

The average of all questions asked about motivation for the categories of intrinsic, extrinsic, and belief resulted in a neutral response. This means participants had neither significant motivation nor had significant negative attitudes towards strength and conditioning training. However, there were six questions that had an average of 4.0 or above. Suggesting that participants enjoy time spent on strength and conditioning training, they feel encouraged to participate by their coaches, and they find value in strength and conditioning training.

2. How does motivation to participate in strength and conditioning training influence the performance level of the student-athletes?

In comparing school ranking and the three categories of motivation, the correlation with intrinsic motivation is -.051. The correlation of extrinsic motivation and school ranking is -.086. The correlation of belief and ranking is -.077. No relationship between motivation to participate in strength and conditioning training and performance

level was found in this study. However, it was found that participants from Division I schools had higher levels of extrinsic motivation.

3. How does motivation to participate in strength and conditioning training influence the injury rate of the student-athletes?

In comparing injuries and the three categories of motivation, the correlation with intrinsic motivation is -.081. The correlation of extrinsic motivation and injury is .007. The correlation of belief and injury is -.059. No relationship between motivation to participate in strength and conditioning training and performance level was found in this study.

Overall, this study did not see significant findings in the relationship with motivation to participate in strength and conditioning training with level of performance or injury rates. Qualitative phone interviews provided additional insight on experiences and feeling toward strength and conditioning training, which can be utilized by both researchers and practitioners. In order to further explore the relationship between strength and conditioning and gymnastics performance more research needs to be completed.

The following conclusions were found in this research:

1. Extrinsic motivation, intrinsic motivation, and belief are in the neutral range, meaning that NCAA gymnastics are neither positively nor negatively motivated to participate in strength and conditioning training.

2. There is no relationship between motivation to participate in strength and conditioning training and performance level found in this research.

3. There is no relationship between motivation to participate in strength and conditioning training and injury found in this study.

The following recommendations are presented for future research:

1. Make modifications to the survey for clarity of responses, specifically questions on training hours and injuries.

2. Only allow sophomores – fifth year seniors to participate.

3. Begin contacting administration earlier to allow for more communication, especially with staff turnover and summer vacation time.

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APPENDIX A: STUDENT ATHLETE ONLINE SURVEY

Dear Student-Athlete,

The purpose of this survey is to explore the motivations of collegiate gymnasts to participate in strength and conditioning training. As a competitive gymnast for 14 years and currently a Strength and Conditioning coach (Jennifer Pfohl), I know firsthand the challenges of competing in gymnastics and participating in strength and conditioning programs. Information obtained from this survey will enhance coaches' knowledge about gymnasts' current experiences and motivations for taking part in strength and conditioning training.

You must be a current NCAA (Division I, II, or III) gymnast to participate in this survey. If you choose to participate you will be asked to complete a brief questionnaire conducted through Qualtrics that will take about 10-15 minutes to complete.

Your participation in this study is on a voluntary basis and you may refuse to participate at any time without consequence. There are no foreseen risks, discomforts, or inconveniences to be expected from participation in this study.

There is no compensation for participation in this study, but the possible benefit to you is to know that you are contributing to the continued development of gymnastics training and the continued communication between gymnasts and strength and conditioning coaches. This continued development and communication will help future gymnasts train in a safe and effective manner to help the sport continue to grow and evolve.

Although the study team has placed safeguards to maintain the confidentiality of your personal information, there is always a potential risk of an unpermitted disclosure. To that degree, all documents and information pertaining to this research study will be kept confidential, unless required by applicable federal, state, and local laws and regulations to be disclosed. Understand the records and data generated by the study may be reviewed by Temple University and its agents, the study sponsor or the sponsor's agents (if applicable), and/or governmental agencies to assure proper conduct of the study and compliance with regulations. The results of this study may be published. If any data are published, participants will not be identified by name.

If you have any questions concerning your rights as a research participant, you may contact the Institutional Review Board Coordinator at IRB@temple.edu or at

Institutional Review Board Coordinator
Temple University Research Administration
Student Faculty Conference Center
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Thank you in advance for your time and consideration in completing this survey. If you have any questions about this research study please contact Dr. Michael Sachs at msachs@temple.edu or (215) 204-8718 or Jennifer Pfohl at jennifer.pfohl@temple.edu or (630)802-7649.

I agree
- ❍ Yes
- ❍ No

Q1. Year in school
- ❍ Freshman
- ❍ Sophomore
- ❍ Junior
- ❍ Senior
- ❍ 5th Year Senior

Q2. Are you currently participating in a strength and conditioning program?
- ❍ Yes
- ❍ No

Q3A.
You answered that you are not currently participating in a strength and conditioning program. Would you like to?
- ❍ Yes
- ❍ No

Q3B.

You answered that you are participating in a strength and conditioning program. Who is it designed and implemented by?

- ❍ Strength and Conditioning Staff
- ❍ Gymnastics Coaching Staff
- ❍ Both Strength and Conditioning Staff and Gymnastics Coaching Staff
- ❍ Not Sure
- ❍ Other (please specify): _____

Q3C.

You answered that the gymnastics coaching staff implements a strength and conditioning program. Does your university have strength and conditioning staff OR a sports performance staff?

- ❍ Yes
- ❍ No

Q4. How many years, in college, have you participated in a strength and conditioning program?

- ❍ 0
- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5

Q5. In the past year, approximately how many hours per week have you participated in the strength and conditioning program in season?

Q6. In the past year, approximately how many hours per week have you participated in the strength and conditioning program out of season?

Q7. How many serious injuries have you experienced during collegiate gymnastics? An injury is considered serious if multiple meets were missed due to one injury, surgery was required to repair it, it ended your competitive career, etc.

- ❍ 0
- ❍ 1-2
- ❍ 3-4
- ❍ 5+

Q8. Please check all that apply. How many of these exercises (or variation of these exercises) do you complete using free weights (barbell, dumbbell, kettlebell)?

- ❑ Squat
- ❑ Deadlift / RDL
- ❑ Hang/Power/Full Clean
- ❑ Hang/Power/Full Snatch
- ❑ Push/Split Jerk
- ❑ None of the above

Please answer the following questions about your experiences with weight training using the scale below

Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I enjoy participating in weight training during my time as a student athlete (1)					
I do not think weight training is needed for my sport (2)					
I find value in weight training (3)					
I enjoy discovering new training methods (4)					
I fear weight training will cause weight gain (5)					
I would rather practice my sport than participate in weight training (6)					
I feel 1 hour of weight training takes more of a toll on my body than 1 hour of gymnastics practice (7)					
I feel weight training improves gymnastics performance (8)					
I feel weight training reduces the risk of injury that may occur while doing gymnastics (9)					
I enjoy weight training (10)					
My teammates value weight training (11)					
My coaches encourage participation in weight training (12)					

I feel personal satisfaction when participating in weight training (13)					
I set my own goals in terms of weight training (14)					
I am concerned weight training will cause an injury (15)					
There are negative consequences for missing a strength training session (16)					
I am motivated by others to participate in weight training					
I enjoy weight training					
I feel personal satisfaction when participating in weight training					
I find value in weight training					
I enjoy working with the strength and conditioning staff					
I enjoy participating in weight training during my time as a student athlete					
I enjoy discovering new training methods					
My coaches encourage participation in weight training					

Thank you for completing the survey! Your opinions are valuable. A lucky select few participants will be randomly selected for an additional, and brief, interview. Would you like to be considered for this opportunity? This possible interview requires the input of first name and email address. This information will not be disclosed nor used to identify participants.

- ❍ Yes
- ❍ No

Please enter your contact information. This information will not be reported nor disclosed. In the case these data are published, names and contact information will not be used. Responses to prior questions and future questions will not be identified with this information.

First Name:

Email:

APPENDIX B: FOLLOWUP PHONE INTERVIEW QUESTIONS

1. How do you define strength training?

2. How do you define conditioning?

3. Do you participate in strength training yourself?

    a. If so, What do you do?

    b. Who helps you?

    c. Have they given you reasons for these exercises?

4. Do you believe weight training is beneficial to gymnastics performance and why?

5. What has been your experience with the strength and conditioning staff during your year(s) as a student athlete?

6. What is your general off season strength training plan? (Training that is not gymnastics specific)
    a. Days/wk
    b. Hours/session
    c. Methods Used (weights, body weight exercises, running, swimming, etc)
    d. Leader

7. What is your general In season strength training plan?
    a. Days/wk
    b. Hours/session
    c. Methods Used (weights, body weight exercises, running, swimming, etc)
    d. Leader
8. If you participate in a strength training program, do you feel your performance in collegiate gymnastics has been influenced by participating in a strength training program? Why or why not?

9. Do you have any other thoughts about strength training and conditioning that you would like to share?

APPENDIX C: EMAILTO SENIOR WOMAN ADMINISTRATOR

Dear **SWA**,

My name is Jennifer Pfohl. I am a graduate student at Temple University in the Psychology of Human Movement program in the Department of Kinesiology. I am a former competitive gymnast and a graduate of Colorado State University. In order to complete my master's program I am conducting a research project entitled, Exploring the Motivations of NCAA Women's Artistic Gymnasts to Participate in Strength and Conditioning Training. In order to conduct this research I have created a brief survey (10-15 minutes to complete) for student athletes to complete. The Institutional Review Board of Temple University approved this research on **DATE**. I would greatly appreciate your approval to contact your Head Women's Gymnastics Coach to request the potential participation of the Women's Gymnastics team at your University. I have attached a copy of the survey to the email as well so that you may review the survey if you would like. Please feel free to contact me at jennifer.pfohl@temple.edu or (630) 802-7649 or my adviser, Dr. Michael Sachs at msachs@temple.edu or (215) 204-8718, with any additional questions you may have. I look forward to your response and continuing this research.

Sincerely,

Jennifer Pfohl

APPENDIX D: EMAIL TO COACH

Dear **COACH,**

My name is Jennifer Pfohl. I am a graduate student at Temple University in the Psychology of Human Movement program in the Department of Kinesiology. I am a former Region 5 competitive gymnast and a graduate of Colorado State University. In order to complete my master's program I am conducting a research project entitled, Exploring the Motivations of NCAA Women's Artistic Gymnasts to Participate in Strength and Conditioning Training. In order to conduct this research I have created a brief survey (10-15 minutes to complete) for student athletes to complete. The Institutional Review Board of Temple University approved this research on **DATE.** I contacted **SWA** and received her approval to contact you in order to continue the research process. I would greatly appreciate the potential participation of your Women's Gymnastics team (team members may choose to participate or not, as they wish). I understand you may wish to review the survey prior to sending it to your student-athletes. I have attached a copy of the survey to the email so that you may review the survey. The link to my survey is: **www**. I ask that you please pass the link along to your student-athletes. Please feel free to contact me at jennifer.pfohl@temple.edu or (630) 802-7649 or my adviser, Dr. Michael Sachs at msachs@temple.edu or (215) 204-8718, with any questions you may have. I look forward to your response and continuing this research.

Sincerely,

Jennifer Pfohl

APPENDIX E: FREQUENCY OF RESPONSES TO ALL LIKERT SCALE QUESTIONS

I enjoy participating in weight training during my time as a student athlete

	Frequency	Percent
Strongly Disagree	3	2.8
Disagree	3	2.8
Neutral	13	11.9
Agree	47	43.1
Strongly Agree	41	37.6
Not Applicable	2	1.8

I do not think weight training is needed for my sport

	Frequency	Percent
Strongly Disagree	1	.9
Disagree	10	9.2
Neutral	21	19.3
Agree	51	46.8
Strongly Agree	26	23.9

I find value in weight training

	Frequency	Percent
Strongly Disagree	2	1.8
Disagree	7	6.4
Neutral	9	8.3
Agree	54	49.5
Strongly Agree	37	33.9

I enjoy discovering new training methods

	Frequency	Percent
Disagree	1	.9
Neutral	13	11.9
Agree	54	49.5
Strongly Agree	39	35.8
Not Applicable	2	1.8

I fear weight training will cause weight gain

	Frequency	Percent
Strongly Disagree	4	3.7
Disagree	18	16.5
Neutral	26	23.9
Agree	42	38.5
Strongly Agree	18	16.5
Not Applicable	1	.9

I would rather practice my sport than participate in weight training

	Frequency	Percent
Strongly Disagree	8	7.3
Disagree	32	29.4
Neutral	45	41.3
Agree	20	18.3
Strongly Agree	4	3.7

I feel 1 hour of weight training takes more of a toll on my body than 1 hour of gymnastics practice

	Frequency	Percent
Strongly Disagree	3	2.8
Disagree	23	21.1
Neutral	23	21.1
Agree	47	43.1
Strongly Agree	11	10.1
Not Applicable	2	1.8

I feel weight training improves gymnastics performance

	Frequency	Percent
Strongly Disagree	1	.9
Disagree	6	5.5
Neutral	27	24.8
Agree	53	48.6
Strongly Agree	22	20.2

I feel weight training reduces the risk of injury that may occur while doing gymnastics

	Frequency	Percent
Strongly Disagree	1	.9
Disagree	7	6.4
Neutral	35	32.1
Agree	50	45.9
Strongly Agree	15	13.8
Not Applicable	1	.9

I enjoy weight training

	Frequency	Percent
Strongly Disagree	1	.9
Disagree	10	9.2
Neutral	15	13.8
Agree	55	50.5
Strongly Agree	27	24.8
Not Applicable	1	.9

My teammates value weight training

	Frequency	Percent
Disagree	10	9.2
Neutral	24	22.0
Agree	62	56.9
Strongly Agree	10	9.2
Not Applicable	3	2.8

My coaches encourage participation in weight training

	Frequency	Percent
Strongly Disagree	1	.9
Disagree	5	4.6
Neutral	5	4.6
Agree	54	49.5
Strongly Agree	42	38.5
Not Applicable	2	1.8

I feel personal satisfaction when participating in weight training

	Frequency	Percent
Strongly Disagree	1	.9
Disagree	5	4.6
Neutral	14	12.8
Agree	56	51.4
Strongly Agree	32	29.4
Not Applicable	1	.9

I set my own goals in terms of weight training

	Frequency	Percent
Strongly Disagree	2	1.8
Disagree	15	13.8
Neutral	24	22.0
Agree	53	48.6
Strongly Agree	13	11.9
Not Applicable	2	1.8

I am concerned weight training will cause an injury

	Frequency	Percent
Strongly Disagree	1	.9
Disagree	16	14.7
Neutral	24	22.0
Agree	52	47.7
Strongly Agree	15	13.8
Not Applicable	1	.9

There are negative consequences for missing a strength training session

	Frequency	Percent
Strongly Disagree	1	.9
Disagree	23	21.1
Neutral	20	18.3
Agree	39	35.8
Strongly Agree	21	19.3
Not Applicable	5	4.6

Weight training is necessary to perform at my maximal potential

	Frequency	Percent
Strongly Disagree	3	2.8
Disagree	21	19.3
Neutral	35	32.1
Agree	36	33.0
Strongly Agree	9	8.3
Not Applicable	4	3.7

I believe I am capable of lifting more weight than I am currently

	Frequency	Percent
Strongly Disagree	2	1.8
Disagree	17	15.6
Neutral	34	31.2
Agree	38	34.9
Strongly Agree	14	12.8
Not Applicable	4	3.7

I look forward to weight training sessions

	Frequency	Percent
Strongly Disagree	3	2.8
Disagree	17	15.6
Neutral	30	27.5
Agree	39	35.8
Strongly Agree	16	14.7
Not Applicable	4	3.7

I enjoy working with the strength and conditioning staff

	Frequency	Percent
Disagree	1	.9
Neutral	16	14.7
Agree	56	51.4
Strongly Agree	29	26.6
Not Applicable	7	6.4

I am self-motivated to participate in weight training

	Frequency	Percent
Strongly Disagree	1	.9
Disagree	8	7.3
Neutral	16	14.7
Agree	61	56.0
Strongly Agree	21	19.3
Not Applicable	2	1.8

I am motivated by others to participate in weight training

	Frequency	Percent
Disagree	4	3.7
Neutral	21	19.3
Agree	66	60.6
Strongly Agree	16	14.7
Not Applicable	2	1.8

I receive rewards for participating in weight training

	Frequency	Percent
Strongly Disagree	13	11.9
Disagree	45	41.3
Neutral	26	23.9
Agree	11	10.1
Strongly Agree	4	3.7
Not Applicable	10	9.2

I will continue (or begin) weight training after retiring from gymnastics

	Frequency	Percent
Strongly Disagree	4	3.7
Disagree	10	9.2
Neutral	16	14.7
Agree	44	40.4
Strongly Agree	33	30.3
Not Applicable	2	1.8

Average of Intrinsic Questions

		Frequency	Percent
Valid	1.57	1	.9
	1.71	2	1.8
	2.43	2	1.8
	2.57	2	1.8
	2.71	4	3.7
	2.86	3	2.8
	3.00	1	.9
	3.14	1	.9
	3.29	1	.9
	3.43	9	8.3
	3.57	8	7.3
	3.71	7	6.4
	3.86	12	11.0
	4.00	12	11.0
	4.14	8	7.3
	4.29	6	5.5
	4.43	6	5.5
	4.57	3	2.8
	4.71	4	3.7
	4.86	4	3.7
	5.00	7	6.4

Average of Extrinsic Questions

	Frequency	Percent
2.67	1	.9
2.83	1	.9
3.00	4	3.7
3.17	13	11.9
3.33	8	7.3
3.50	15	13.8
3.67	13	11.9
3.83	15	13.8
4.00	9	8.3
4.17	6	5.5
4.33	7	6.4
4.50	2	1.8
5.00	1	.9

Average of Belief Questions

	Frequency	Percent
2.09	1	.9
2.36	1	.9
2.45	1	.9
2.55	1	.9
2.73	2	1.8
2.82	1	.9
2.91	4	3.7
3.00	3	2.8
3.09	8	7.3
3.18	3	2.8
3.27	6	5.5
3.36	9	8.3
3.45	1	.9
3.55	7	6.4
3.64	4	3.7
3.73	8	7.3
3.82	4	3.7
3.91	9	8.3
4.00	3	2.8
4.09	3	2.8
4.18	7	6.4
4.27	3	2.8
4.36	2	1.8
4.45	2	1.8
4.55	2	1.8
4.64	2	1.8
4.73	1	.9
4.82	1	.9