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Effect of practice court surface on NCAA Division One volleyball players

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EFFECT OF PRACTICE COURT SURFACE ON NCAA DIVISION ONE VOLLEYBALL PLAYERS

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ABSTRACT

EFFECT OF PRACTICE COURT SURFACE ON
NCAA DIVISION ONE VOLLEYBALL PLAYERS

by Traci L. Bluestein, ATC

The purpose of this research was to analyze the frequency and severity of lower extremity injuries, among collegiate women volleyball players, by the type of practice surface between 2001-2003. Participants included NCAA Division I women's volleyball athletic trainers whom worked with a team that predominantly practiced on either a Sport Court® surface or a spring-loaded wood court surface. A cover letter, volleyball injury survey, and a self-addressed stamped envelope were mailed to each participant. Eight usable surveys were mailed or e-mailed back to the investigator.

Results indicated that for this particular sample population, there were no significant differences between injuries sustained during volleyball practice on a Sport Court® surface compared to a spring-loaded wood court. Sixty-two lower extremity injuries occurred during practice on the Sport Court® surface and 73 lower extremity injuries occurred on the spring-loaded wood court.

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CHAPTER 1

Introduction

Volleyball is one of the world's most popular participation sports with over 800 million people in about 130 countries playing volleyball (Briner & Benjamin, 1999). Volleyball is a popular sport because it can be played by girls and boys and men and women on levels commensurate with their age, skills, physical condition, and interest (Rosenthal, 1983). The National High School Coaches Association (2004) reports that there are 14,490 girls varsity volleyball programs and 198 boys varsity volleyball programs.

In the National Collegiate Athletic Association (NCAA), there are three divisions of volleyball including Division I, II, and III. There are 973 collegiate women's volleyball teams in the NCAA with a total of 13,282 players (NCAA, 2003). In NCAA Division I women's volleyball, which was the focus of the present study, there are 312 teams with a total of 4,334 players (NCAA, 2003). The NCAA (2003) reports that there are 84 collegiate men's volleyball teams in the NCAA with 1,165 men volleyball players (23 schools in NCAA Division I with 409 players).

Volleyball is recognized as a competitive sport requiring agility, quick movement, coordination, physical conditioning, and determination (Rosenthal, 1983). Volleyball players have to be physically prepared for the fast, demanding, coordinated, and relatively uninterrupted pace of the game (Rosenthal, 1983). The training and conditioning needed to play volleyball can lead to overall endurance, strength, and physical well-being

(Rosenthal, 1983). Watkins and Green (1992) state that volleyball is a dynamic sport involving rapid and forceful movements of the whole body, both horizontally and vertically. Because of the large forces involved in such movements, injuries occur (Watkins & Green, 1992). Similarly, Briner and Benjamin (1999) state that volleyball players perform a variety of maneuvers that are unique to the sport, and each poses a risk of injury. Numerous variables contribute to injury in volleyball including jumping, landing, twisting, contact with the floor or another player and many more (Schafle, Requa, Patton, & Garrick, 1990). With millions of people playing volleyball at all different levels, from recreational to competitive, athletic injuries are likely to occur. Further knowledge of the causes of athletic injuries can help prevent the occurrence of athletic injuries.

Sports injuries occur as the result of a summation of various factors, such as extrinsic and intrinsic risk factors, at a given time (Lysens, de Weerdt, & Nieuwboer, 1991). These extrinsic risk factors include the type of sport the athlete is engaged in, the level of competition, equipment used, experience, and the type and condition of playing surface (Lysens, de Weerdt, & Nieuwboer, 1991). Intrinsic risk factors include individual physical characteristics and psychological traits of the athlete (Lysens, de Weerdt, & Nieuwboer, 1991). The type of playing surface, an extrinsic risk factor of sports injuries, is the injury cause factor that is of particular interest in this study.

The National Electronic Injury Surveillance System (NEISS) investigates injured people that are seen at hospitals across the United States. This surveillance system

includes only a sample of hospitals. The NEISS (2003) reports there was a total of 934 cases of females that became injured playing volleyball. Therefore, the NEISS (2003) estimates that 36,283 females may have been injured while playing volleyball in the United States.

The NCAA conducts an annual Injury Surveillance System (ISS) investigating injury incidence at the collegiate level. NCAA ISS participants are randomly selected from the population of schools sponsoring a given sport, within the constraints of having a minimum of 10% representation from NCAA Division I, II, and III (NCAA, 2004). Injury and exposure data, such as type of injury, body part injured, severity of injury, field condition, and special equipment worn by athlete, are recorded by certified and student athletic trainers from participating institutions (NCAA, 2004). For NCAA Division I women's volleyball teams in 2003, 39 schools participated in the ISS (NCAA, 2004).

NCAA (2004) reports that there was a 4.6 injury rate per 1,000 athlete exposures among NCAA Division I women's volleyball, 4.3 among Division II, and 4.1 among Division III. For example, the NCAA Division I women's volleyball number means that one would anticipate 4.6 injuries if one athlete participated in 1,000 practices/games, if 50 athletes participated in 20 practices/games, or if 100 athletes participated in 10 practices/games (NCAA, 2004). According to the NCAA (2004), there were more women's volleyball injuries during practice (65.6% of total injuries) than games (34.4%). The top three injuries that occurred during practices of NCAA women's volleyball were strains, sprains, and tendinitis (NCAA, 2004). The top three body parts that were injured

during practices of NCAA women's volleyball were ankle, knee, and upper leg (NCAA, 2004). NCAA women's volleyball (all divisions) has a total of 3.8 practice injury rate per 1,000 athlete exposures, where as football has a total of 3.9 practice injury rate per 1,000 athlete exposures (NCAA, 2004). According to the NCAA (2004), spring football (8.2) and wrestling (5.7) were found to have the highest practice injury rates per 1,000 athlete exposures.

The National Athletic Trainers' Association (NATA) conducted a 3 year injury surveillance study in 1995 to determine the trends of high school injuries in 10 sports, including women's volleyball. The two most common injuries in high school volleyball, according to the NATA (1995), include sprains (48.6% of total injuries) and strains (25.5% of total injuries). The NATA (1995) reports that most high school women's volleyball injuries occur at the ankle/foot (35.6% of total injuries) or hip/thigh/leg (16.2% of total injuries. NATA (1995) reports that injuries are more likely to occur to women's volleyball players during practices (79.6% of total injuries) than games (20.4% of total injuries).

In volleyball, lower extremity injuries are most common (Gerberich, Luhmann, Finke, Priest, & Beard, 1987; NATA, 1995; NCAA, 2004; Schafle, Requa, Patton, & Garrick, 1990). Current literature suggests a need for further investigation into the surfaces on which volleyball is played. This includes attention to types of surfaces and possible irregularities of the surfaces, which may contribute to injuries (Gerberich et. al, 1987). Ferretti, Puddu, Mariani, and Neri (1984) state that during the last few years,

many synthetic materials have been used as volleyball floor surfaces in gymnasiums and at international competitions. Ferretti et. al (1984) suggest that research on new materials for playing surfaces emphasize the production of materials with elastic properties, such as wood.

Even though significant relationships between playing surfaces and injuries have been identified, much of the previous research has focused on sports and activities, such as football, soccer, and tennis (Dufek & Bates, 1991; Ekstrand & Nigg, 1989; Heidt Jr., Dormer, Cawley, Scranton Jr., Losse, & Howard, 1996; Nigg, 1985; Nigg & Segesser, 1988). The impact of playing sports on astroturf or real grass is of interest for the sport of football and soccer (Heidt Jr., Dormer, Cawley, Scranton Jr., Losse, & Howard, 1996). In tennis, the choice of surface completely changes the injuries endured by tennis players (Nigg & Segesser, 1988).

In the sport of volleyball, there are various playing surfaces. For indoor volleyball, the most popular playing surfaces include tartan, wood, cement, or synthetic surfaces, such as Sport Court ®. For outdoor volleyball, the most common playing surface is sand. Research has identified a relationship between volleyball injuries and playing surfaces, such as wood, cement, and linoleum (Ferretti, Puddu, Mariani, & Neri, 1984). Patellar tendinitis is an overuse syndrome frequently found in athletes who engage in repetitive sports activities, such as volleyball (Ferretti, et. al, 1984). This study included a personal interview or questionnaire of 407 volleyball players from the Italian Volleyball Federation to identify the factors involved with patellar tendinitis (Ferretti, et.

al, 1984). Ferretti et. al (1984) concluded that 93 athletes had patellar tendinitis or currently had it. Ferretti et. al (1984) also concluded that the surface of the playing floor is another significant factor in the onset of patellar tendinitis because only 3 out of 64 athletes who play on a wooden floor (parquet) were affected with patellar tendinitis. Volleyball players that played on linoleum were more affected with patellar tendinitis than athletes participating on cement, parquet wood, or others (Ferretti, 1984).

Even though the Sport Court® volleyball surface has been the flooring for the NCAA Volleyball Championships for the past 10 years (Sport Court Incorporated, 2002), no research exists regarding the Sport Court® volleyball surface and the relationship to injuries. The purpose of this study was to extend previous playing surface research by assessing the relationship between volleyball injuries and the type of practice court surface (Sport Court® volleyball surface or spring-loaded wood surfaces), among the NCAA Division I women's collegiate level. This research will be significant because injuries not only affect the physical aspect of athletes, injuries also affect the athletes psychologically. Injured athletes may experience fear, anxiety, and may worry about whether they will recover and if re-injury will occur (Ball, 2002). Lack of self-confidence becomes an issue as injured athletes lose physical conditioning, and lowered confidence can result in decreased motivation, substandard performance or additional injury (Ball, 2002). If athletes do not return to play as quickly as they wanted to, they may push too hard, thus causing a chronic or recurring injury (Ball, 2002). Injury prevention is one factor that can eliminate injury. Therefore, if injuries can be prevented by using a certain

court surface in volleyball, then volleyball players and coaches need to know this information.

Statement of the Purpose

The purpose of the study was to investigate the frequency and severity of lower extremity injuries from 2001-2003 of women NCAA Division I volleyball players participating on a Sport Court® or spring-loaded wood court volleyball surfaces as reported to the athletic trainer.

Hypothesis

The following null hypothesis was constructed for the purpose of this study:

1. There will be no significant differences between the frequency and severity of injuries on spring-loaded wood and Sport Court® practice court surfaces.

Delimitations

1) The study was delimited to athletic trainers who:

   a. Worked with a NCAA Division I women collegiate volleyball team that play a majority of their practice time on a Sport Court® volleyball surface or spring-loaded wood court surface.

   b. Were over the age of 18 with no upper limit for age.

Limitations

The limitations of this study were:

1) Injured volleyball players may have sought medical attention outside the athletic training room and therefore may not have reported to the athletic trainer.

2) Some players may have thought that their particular injury would heal without medical intervention and may not have sought medical attention for their injury.

3) Accuracy of the medical records, such as the recording of injuries and the storage of injury reports, may have made it difficult to accurately obtain 3 years of volleyball injury records.

4) The days an athlete did not participate (time loss) due to injury may have been affected by the athlete's desire to return to play, the motivation of the injured athlete, or the athlete's level of importance for any upcoming competition

5) Movement conditions or intrinsic factors, may also limit the ability to infer that an injury occurred from the court surface alone.

6) Ankle taping and braces, which help prevent ankle injuries, worn for practice may have created an inaccurate evaluation of data.

7) Shock absorbing shoes may have created an inaccurate evaluation of data due to their possible prevention of injuries.

8) There are a limited amount of Sport Court® surfaces across the country which may have made it difficult to obtain a large sample size.

8) A lack of responses may not provide enough information to form conclusions.

Assumptions

For the current research study, the following assumptions were made:

1) The participants responded to all questions fully, truthfully, and to the best of their ability.

2) All injuries were promptly reported to the medical staff.

3) Injuries were accurately recorded and stored in the athlete's medical record file with no data loss in the transfer of information to medical records.

4) The data used from questionnaires were reliable and valid.

5) Correct evaluations were made by certified athletic trainers and doctors.

6) There will be enough survey responses to draw conclusions from.

Definition of Terms

Certified Athletic Trainer. A highly qualified paramedical professional educated and experienced in dealing with injuries that occur with participation in sports (Arnheim & Prentice, 1997).

College Athlete/Volleyball Player. For the purpose of this study, a collegiate volleyball player was a female who had a minimum age of 18, played volleyball for a NCAA Division I college team, and was also enrolled in classes at that same college.

Frequency. For the purpose of this study, frequency included the number of injuries sustained while practicing volleyball during the regular season of collegiate women's volleyball (August- December).

Injury. Physical damage caused by a sports related incident whether or not it results in a loss of time for the athlete (Watson, 1993).

Lower Extremity. For the purpose of this study, the lower extremity included the inferior portion of the body starting at the low back and hip and also including the legs, knees, ankles, and feet.

Major Injury. A major injury is defined as an injury to the lower extremity that

forces the athlete to miss more than 21 days of practice (NATA, 1995).

Minor Injury. A minor injury is defined as an injury to the lower extremity that allows the athlete to return to practice within seven days (NATA, 1995).

Moderate Injury. A moderate injury is defined as an injury to the lower extremity that forces the athlete to miss between 8 and 21 days of practice (NATA, 1995).

Severity. The level of physical damage caused during an injury and is measured by time loss for an injury, such as a minor, a major, or a moderate injury (Lysens, de Weerdt, & Nieuwboer, 1991).

Sport Court® Volleyball Surface. Sport Court® surfaces are formed by numerous tiles which are made of high impact Polypropylene Copolymer with 676 solid reinforced support legs with a proprietary positive locking system. Each tile contains a hexagonal support structure distributing force equally through the tile (Sport Court Incorporated, 2004).

Sprain. A sprain, one of the most common and disabling injuries seen in sports, is defined as a traumatic joint twist that results in stretching or total tearing of the stabilizing connective tissues, such as ligaments (Arnheim & Prentice, 1997). For the purpose of this study, sprains included injuries only to the lower extremities.

Strain. A strain is defined as a stretch, tear, or rip in the muscle or adjacent tissue, such as the fascia or muscle tendons (Arnheim & Prentice, 1997). For the purpose of this study, strains included injuries only to the lower extremities.

Project Completion

Data from this study were compiled into a journal article for the *International Journal of Sports Medicine* (see Appendix A), according to the *Author's Notes* (see Appendix B).

Summary

Volleyball is a popular sport played by numerous persons in many different countries. With many people playing volleyball at all different levels, from recreational to competitive, athletic injuries are likely to occur. Further knowledge of the causes of athletic injuries can help prevent the occurrence. One of the plausible causes of volleyball injuries may be court surface. Limited research is available concerning the relationship between volleyball injuries and court surfaces. Specifically, research is lacking regarding new synthetic volleyball court surfaces, such as the Sport Court® volleyball surface. The present study focuses on the role of volleyball practice court surfaces, the Sport Court® volleyball surface and spring-loaded wood surface, as related to the frequency and severity of injuries for women volleyball players competing at the NCAA Division I level.

CHAPTER 2

Review of Literature

The purpose of this study was to investigate the relationship between collegiate women's athletic injuries and volleyball practice court surfaces, a Sport Court® volleyball surface and a spring-loaded wood playing surface. This chapter will present literature focusing on injury causes (extrinsic and intrinsic factors), incidence of lower extremity injuries in athletics, injuries in volleyball, and the relationship between volleyball surfaces and injuries.

Injury Causes

Lysens, de Weerdt, and Nieuwboer (1991) state that the rise in sport activity has compensated for physical immobility, mental stress and other harmful aspects of 'modern' life. However, the negative side of this new trend has been a corresponding increase in sports injuries (Lysens, de Weerdt, and Nieuwboer). Injuries in sports can occur due to many factors. Past research has focused on determining which factors cause athletic injuries (Gerberich, Luhmann, Finke, Priest, and Beard, 1987; Lysens, de Weerdt, and Nieuwboer, 1991; Nigg, 1985; Schafle, Requa, Patton, & Garrick, 1990; Watkins & Green, 1992). General agreement among researchers exist on the classification of injury risk factors into two categories: 1) extrinsic risk factors and 2) intrinsic risk factors.

Extrinsic Factors of Injury

Some extrinsic risk factors of injuries are related to the type of sports activity, the

level of competition, the exposure to the sport, experience, the amount of playing time, and the position on the team Lysens, de Weerdt, and Nieuwboer, 1991). Some other extrinsic risk factors include the type and condition of the playing surface, weather conditions, time of the day, time of the season, protective equipment used, and footwear (Lysens, de Weerdt, and Nieuwboer, 1991). Similarly, Nigg (1985) also reported that the forces acting on various elements of the human body depend mainly on two factors, movement and boundary conditions. Boundary conditions, similar to extrinsic factors, include shoe, surface (grass, asphalt, etc.), weather, anthropometric factors (e.g. varus-valgus), and fitness level. Nigg (1985) also states that each change of a boundary condition may have an effect on the load and stress in the locomotor system. The change of the boundary condition, surface, influences load and stress in the musculoskeletal system, thus influencing the frequency of pain and injuries.

Intrinsic Factors of Injury

Intrinsic risk factors of injuries relate more to individual physical characteristics and psychological traits. Some intrinsic risk factors include age, gender, physical fitness, joint mobility, muscle tightness. Even though Nigg (1985) categorized fitness level as a boundary condition (similar to extrinsic risk factor), Lysens, de Weerdt, and Nieuwboer, 1991 categorized physical fitness as an intrinsic risk factor of injury.

Nigg (1985) reported that movement conditions, similar to intrinsic factors, can be subdivided into the general type of movement (running, jumping, walking, etc.), the velocity of the center of mass, the local velocity of each limb (e.g. the velocity of the heel

in running), the number of repetitions (e.g. mileage in running), and the muscular activity. Nigg (1985) states that changing one factor, for instance changing from walking to running or changing from slow heel-toe running to sprinting, changes the kinematics and kinetics of the movement and thus probably also the load/stress. Injuries are less likely to occur by decreasing the load and stress on the body.

Witvrouw, Bellemans, Lysens, Danneels, and Cambier (2001) conducted a study about intrinsic risk factors for the development of patellar tendonitis on 138 physical education students. During the 2-year period of the study, patellar tendonitis was diagnosed in 19 (13.8%) of the 138 students. No significant difference was found between the students who developed patellar tendonitis during the 2-year period and the students who did not in terms of context, the type, and the amount of their external sports activities. This finding indicates that both groups were comparable in external load and suggests that the incidence of patellar tendonitis in the students in this study was mainly a result of intrinsic risk factors.

Incidence of Lower Extremity Injuries in Athletics

According to the Injury Surveillance Systems conducted by the National Athletic Trainers' Association (NATA) in 1995 and the National Collegiate Athletic Association (NCAA) in 2004, injuries to the lower extremity are the most common in sports. NATA (1995) reports that the lower extremities were the most common injured body part among high school basketball, football, soccer, and volleyball players. The NCAA (2004) also reports that the most common body parts injured in collegiate sports, such as basketball,

football, soccer, and volleyball, are the lower extremities. The most injuries occurred at the ankle and/or foot in high school basketball, soccer, and volleyball (NATA, 1995). The knee, ankle, and upper leg were the top three body parts injured during practice in collegiate men's soccer, football, and women's volleyball (NCAA, 2004).

Nigg and Segesser (1988) conducted a study on tennis playing surfaces and their relationship to injuries. A retrospective study was conducted on 1003 tennis players over the course of three seasons (six month periods). Surveys were sent to various tennis players in Switzerland which asked for information related to personal data, racket, surface, sports activities, level of expertise, and injuries or pain. Different surfaces were associated with different numbers of injury occurrences in the lower extremities. The surface types were: clay; synthetic sand; a synthetic surface about 5 to 15mm thick with loose synthetic granular topping; synthetic surface about 5 to 15mm thick, solid with no loose granular topping; asphalt/concrete; felt carpet, mounted on concrete or asphalt; and synthetic grill, a grid-shaped structure surface used to cover ice hockey rinks during the summer. The results of this study indicate that 60% of all reported injuries were in the lower extremities, the pelvis, or back. A total of 990 injuries for the lower extremities and the lower back were examined. The back, the knee, and ankle joints were the locations most frequently injured and this is possibly related to the playing surface. These findings indicate that the construction of tennis surfaces influences the injury frequency in tennis. The injury frequency on clay and synthetic sand was significantly lower than on synthetic surface, asphalt/concrete, felt carpet, and synthetic grill. However, the data

suggested that the difference in the frictional properties of the surfaces may have been the main reason for the differences in pain and injury frequency. The affect of playing surface among volleyball players needs to be examined in a similar manner.

Injuries in Volleyball

Volleyball players perform a variety of maneuvers that are unique to the sport, and each poses a risk of injury (Briner & Benjamin, 1999). The highest rate of volleyball injury is associated with blocking (Schafle, Requa, Patton, & Garrick, 1990; Watkins & Green, 1992). The second highest rate of volleyball injury is associated with spiking (Schafle, Requa, Patton, & Garrick, 1990; Watkins & Green, 1992). Both of these volleyball skills, blocking and spiking, require a jump and a landing, thus increasing the risk of injury. Jumping, landing, and twisting upon impact with the floor surface accounted for 63% of total injuries in a study of 106 volleyball players conducted by Gerberich, Luhmann, Finke, Priest, and Beard (1987). In general, each player uses all of these maneuvers during a game, so all players are exposed equally to the risk of injury (Briner & Benjamin, 1999).

The NCAA's (2004) Injury Surveillance System reports that the three most commonly injured body parts during collegiate women's volleyball practices are the ankle, knee, and upper leg. The three most commonly injured body parts during collegiate women's volleyball games are the ankle, knee, and shoulder (NCAA, 2004). The top three types of injuries that occur during collegiate women's volleyball practices are strains, sprains, and tendinitis (NCAA, 2004). The top three types of injuries that

occur during collegiate women's volleyball games are sprains, strains, and fractures (NCAA, 2004).

Fukoda (1988) reported joint kinetic and energetic values for 4 men who landed barefoot from a height of 20cm onto both a soft and hard surface. Results identified that the knee muscles absorbed more energy than the ankle extensors, and the contribution of these extensor muscles to the energy absorbed at both joints increased as surface hardness increased. These results suggest that the increased load on knee muscles is one of the possible causes of injuries while running or jumping on harder surfaces. Due to the amount of energy absorbed by the knee, these results may indicate the reason that the knee is one of the most injured body parts in volleyball. However, Fukoda's (1988) study only consisted of 4 participants and all of them were male.

In a study conducted by Watkins and Green (1992) on volleyball injuries, forty-six injuries were reported among 86 male volleyball players in the Scottish National League. Results indicated that injuries occurred mostly from blocking (41% of total injuries). Spiking represented 30% of total injuries, and landing represented 15% of total injuries. Jumping is also a major risk factor in injuries.

Ferretti, Papandrea, Conteduca, and Mariani (1992) conducted a study of knee ligament injuries in 52 volleyball players. This study consisted of a questionnaire that included the mechanism of injury, the athlete's position on team, and the type of activity (practice or game). The findings of the study suggest that more women volleyball players were affected by ligament injuries than males. Another significant finding in this study

was that more injuries occurred during competitions than practices. However, according to the NCAA (2004) and NATA (1995) Injury Surveillance Systems, more injuries occur to women volleyball players during practice, rather than competitions.

The NCAA (2004) reports that 65.6% of all collegiate women's volleyball injuries reported for the Injury Surveillance Study, occurred during practice. Only 34.4% of all reported volleyball injuries occurred during games. According to the NATA's (1995) Injury Surveillance System, 79.6% of total injuries among high school girls' volleyball injuries occurred during practice. Only 20.4% of all reported volleyball injuries occurred during games.

Relationship Between Volleyball Surfaces and Injuries

A number of injury risk factors have been identified, such as techniques (movement patterns) of jumping, landing and hitting, hardness of the playing surface, and level of physical conditioning (Watkins & Green, 1992). Watkins and Green (1992) conducted a study on 86 male volleyball players in the Scottish National League. The method of inquiry for the research was a questionnaire consisting of six sections: personal details, volleyball experience, home court (location and playing surface), shoes and socks, use of supportive equipment, and injuries. The results of this study suggest that there was a clear positive relationship between playing surface and incidence of injury. The harder the playing surface, the higher the incidence of injury.

The Injury Surveillance System conducted by the NCAA (2004) reports that 269 injuries of collegiate women volleyball players occurred on a wood surface, 38 injuries

occurred on a composite surface, and three injuries occurred on a surface labeled other. However, the type of wood surface, such as spring-loaded or non spring-loaded, that the athletes were injured on is unknown. Also, the type of composite surface and the "other" surface is also unknown because these type of surfaces were never explained.

Ferretti, Puddu, Mariani, and Neri (1984) conducted a research study which included interviews with 407 volleyball players to study the incidence and epidemiology of patellar tendinitis, also known as "jumper's knee". Out of the 407 athletes, 93 players (74 men and 19 women) experienced symptoms related to "jumper's knee" or were experiencing knee pain during the time of the study. Ferretti et. al concluded that the floor and playing surface is one of the most significant factors in producing symptoms of "jumper's knee." Altogether, 37.5% of athletes who trained regularly on cement had "jumper's knee." The corresponding numbers were 23.3% for linoleum, 26.2% for other surfaces, and 4.7% for a wooden surface. These results also suggest that the harder the playing surface, such as cement, the higher the incidence of injury.

Energy absorption through the floor surface may also be a factor in volleyball injuries due to intrinsic risk factors (jumping and landing). Velocity of the volleyball player must change dramatically over a short period of time when landing from a jump (Holthe, Baker, Hahn, Pinckney, Fox, Devries, Derrick, and McLean, 1998). Bone, muscle, ligaments, shoe midsole, and the playing surface all try to absorb energy by deforming during the landing impact (Holthe et. al).

Holthe, Baker, Hahn, Pinckney, Fox, Devries, Derrick, and McLean (1998)

studied the shock absorption potential of the surface and identified that more impact energy absorbed by the surface means less energy needs to be absorbed by biological tissues. Holthe et. al studied seven different playing surfaces or surface combinations to understand the energy absorption characteristics. Playing surfaces and surface combinations included wood flooring, tartan flooring, artificial turf, wood flooring with the Sport Court®, tartan flooring with the Sport Court®, artificial turf with the Sport Court®, and artificial turf with the Sport Court® without the underlying mat. Conclusions identified that astroturf acts as a better shock absorber by decreasing the impact that must be attenuated by the subject, as well as allowing the deceleration to occur over a longer period of time. The addition of the portable court decreases time to peak deceleration at impact, which is probably due to a decreased amount of material deformation as a result of distributing the forces over a greater area (Holthe et. al). Energy return results indicate that more energy is absorbed by the astroturf surface and less energy is being returned to the dropped missile (Holthe et. al). Although the astroturf surface may be preferable to reduce impact injuries, it may not be the ideal surface to enhance performance because absorbing energy that is not returned to the body, requires the body to expend more energy (Holthe et. al., 1998).

Impact absorption at landing may be performed in a variety of ways, depending on the circumstances of the landing (Lees, 1981). These circumstances relate to the expected force of impact and can be observed by viewing landings on both hard and soft surfaces (Lees). For example, when landing on a soft surface such as a trampoline or springboard,

the body is typically straight and there is little flexion in the major joints of the body during the impact (Lees). However, on a hard surface, there is a marked flexion of the joints and an appreciable amount of 'give' in the body (Lees). In these cases, the body is adapting itself to the harder surface to reduce the force of impact (Lees). Thus, different volleyball court surfaces, such as the Sport Court® or spring-loaded wood floor, may affect the impact absorption causing less injuries.

Summary

Injuries occur in sports because of intrinsic and extrinsic risk factors. Some intrinsic risk factors of injury include psychological traits, age, gender, physical fitness, joint mobility, and muscle tightness. Extrinsic risk factors of injuries include the type of sports activity, the level of competition, the exposure to the sport, experience, the amount of playing time, and the position on the team. Some other extrinsic risk factors of injury include the type and condition of the playing surface, weather conditions, time of the day, time of the season, protective equipment used, and footwear.

According to the NATA (1995) and NCAA (2004) Injury Surveillance Systems, the lower extremities are the most common body parts that are injured in sports, such as collegiate and high school basketball, football, soccer, and volleyball. The lower extremities, such as the ankle, knee, and upper leg are the three most commonly injured body part during practice in collegiate men's soccer, football, and women's volleyball (NCAA, 2004). The top three types of injuries that occur during collegiate women's volleyball practices are strains, sprains, and tendinitis (NCAA, 2004).

There are many forces that act upon a volleyball player while performing skills, such as blocking and spiking. When a volleyball player jumps and lands on the floor surface, their body and the floor surface will absorb the forces. However, different court surfaces can help to decrease the absorption of these forces to a volleyball player's body. The purpose of the current study is to investigate the relationship of two volleyball practice surfaces, the Sport Court® and spring-loaded wood, on athletic injuries.

CHAPTER 3

Research Design and Methodology

The purpose of this research study was to investigate the relationship between practice surfaces and athletic injuries in NCAA Division I women volleyball players. This chapter will discuss the participants, instrumentation, research design, and data analysis used to conduct this investigation.

Participants: Stage I

The research design of this study was conducted in two stages. Stage one consisted of gathering information to select participants. Stage two consisted of participant selection. The participants of this research study included athletic trainers working with a NCAA Division I women's volleyball team at eight universities across the United States during the 2003-2004 academic year. Almost all of the head coaches and/or assistant coaches of NCAA Division I women's volleyball teams (289 total coaches) were contacted via e-mail to gather information for participant selection. Coaches' e-mail addresses of each NCAA Division I women's volleyball team was gathered from the team's home page on the internet. Twenty-three coaches were not contacted because no contact information was available on the team's home page. Participation selection information gathered from the coaches included the type of surface their team predominantly practiced on, the age of the practice surface, and the name and e-mail address of their athletic trainer. Only 145 volleyball coaches responded to the e-mail.

Participants: Stage II

Out of the 145 e-mail responses, only 24 NCAA Division I women's volleyball teams fit the criteria for participant selection. The criteria for participant selection was that the NCAA Division I women's volleyball team had to spend a majority of their practice time on a spring-loaded wood surface or a Sport Court® surface that was less than 10 years old. The athletic trainers for this study were selected by the e-mail response from the coach. Participant involvement in this study was strictly voluntary.

The sport of volleyball was selected because of the lack of research regarding injuries related to volleyball court surfaces. Collegiate women's volleyball was chosen because more women participate in volleyball than men. NCAA Division I women's volleyball was selected because more injuries occur at this level than NCAA Division II or III. Practice volleyball surfaces were selected because more injuries occur during practice of collegiate women volleyball players (NCAA, 2004). The Sport Court® surface was selected because the NCAA volleyball championships have been played on this surface for the past 10 years (Sport Court Incorporated, 2002). The spring-loaded wood surface was selected because it is a common surface among NCAA Division I women's volleyball programs, according to the e-mail responses from coaches.

Instrumentation

An injury information survey was constructed by the researcher and was used to collect lower extremity injury data from participants (see Appendix C). "The Volleyball Injury Survey" contained 2 items: 1) the frequency of lower extremity injuries related to

court surface, and 2) the severity (time loss) of the corresponding injuries in question 1. A panel of experts in the field of athletic training reviewed the questionnaire for face validity. This panel included four certified athletic trainers that were working towards their Masters degree in the field of Sports Medicine or had already earned their Masters degree in the field of Sports Medicine. Each panel member was e-mailed the Volleyball Injury Survey along with information about the purpose of the study and instructions on the completion of the survey. Different wording of the survey was suggested by some of the members on the panel. The survey was modified accordingly.

Procedures

Informed consent was explained in the cover letter (see Appendix D) and implied by the completion and return of the survey. Prior to the collection of data, approval to use human participants was granted by the Institutional Review Board at San Jose State University (see Appendix E).

A packet was mailed during the middle of the spring season of volleyball, to the athletic trainer of each participating NCAA Division I women's volleyball team. This packet included a cover letter explaining the study (see Appendix D) and the Volleyball Injury Survey (see Appendix C). All participants were requested to return the Volleyball Injury Survey in the self-addressed and stamped envelope provided in the packet.

Each participant received specific instructions for recording the number of injuries and time loss due to injury on the Volleyball Injury Survey. The athletic trainer was asked to record every lower extremity injury that was related to court surface which

occurred within the past 3 years during practice only, not competitions. Any questions concerning the questionnaire or procedures for its completion could have been directed to the researcher by phone and/or mail.

About 8 days after the initial mailing, participants were sent an e-mail reminder about filling out and mailing back the Volleyball Injury Survey. Nine days after the initial e-mail reminder, a second reminder was e-mailed to the participants. Since the number of spring-loaded wood court participants were still low, a third reminder was e-mailed to these participants. Data collection was considered complete when the researcher received the minimum 30% response rate (Dillman, 1978). E-mail reminders were ceased when a 30% response rate was achieved.

Data Analysis

The frequency of injuries on a Sport Court® surface and a wood court surface were compiled into frequency tables for cross-tabulation. The severity of injuries were graded according to NATA (1995) where a minor injury is when an athlete is out 1-7 days, moderate injury is when an athlete does not participate between 8-21 days, and major injury is when an athlete misses more than 21 days of participation. The frequency and the severity of injuries (time loss) from NCAA Division I women's volleyball teams with a Sport Court® surface compared to a spring-loaded wood surface were analyzed using charts to examine differences in the frequency and severity of injuries with teams participating on a Sport Court® volleyball surface. When the research study was originally planned, a multi-variate analysis (MANOVA) was to be used for data analysis.

However, due to the small amount of participants, a MANOVA could not be used because the results would be insignificant.

Summary

Injury surveillance studies suggest that more injuries occur during volleyball practice than games (NATA, 1995; NCAA, 2004). However, previous research has not compared the practice surfaces of volleyball and injury rates. Therefore, the present study consisted of information gathered from eight NCAA Division I women's volleyball programs across the United States. The injury information gathered from each university was calculated to determine if there were differences in the total number of injuries and the severity of injuries (time loss) with teams that predominantly practiced on a Sport Court® volleyball surface or spring-loaded wood playing surface.

Project Completion

Data from this study were compiled into a journal article for the *International Journal of Sports Medicine* (see Appendix A), according to the *Author's Notes* (see Appendix B).

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APPENDICES

Appendix A

Journal Article for the International Journal of Sports Medicine

Introduction

Volleyball is one of the world's most popular participation sports with over 800 million people in approximately 130 countries playing volleyball[1], 14,490 girls varsity volleyball programs exist in United States high schools[8], and there are 970 women volleyball teams with a total of about 13,107 women volleyball players in National Collegiate Athletic Association (NCAA) competition.[7] With the volume of volleyball athletes at all different levels, from recreational to competitive, athletic injuries are likely to occur.[9] Knowledge regarding the causes of athletic injuries may aid preventing the occurrence of athletic injuries, specifically a potential impediment that can be preventative, such as court surface.

Injuries in women's volleyball occur across all age ranges and have been studied with respect to injury rate, mechanism, and anatomical area.[4569] In NCAA Division I women's volleyball, there was a 4.6 injury rate per 1,000 athlete exposures.[6] For example, 4.6 injury rate per 1,000 athlete exposures means that one would anticipate 4.6 injuries if one athlete participated in 1,000 practices/games, if 50 athletes participated in 20 practices/games, or if 100 athletes participated in 10 practices/games. More injuries occur during high school and college women's volleyball practice, than in competition.[56] Although a few studies have been conducted on volleyball injuries, research on the relationship between volleyball injuries and the type of practice surface has not been published.[4910] Thus the purpose of this study was to investigate the relationship between volleyball practice surfaces and the frequency and severity of lower extremity injuries.

Lower extremities are the most common sites of the occurrence of athletic injuries in volleyball players.[4569] A study was conducted on severe volleyball injuries among 106 volleyball players and the results indicated that nearly 90% of the injuries have been determined to occur in the lower extremities.[4] The most common injury sites in a study conducted at the 1987 National Amateur Volleyball Tournament have been identified as occurring at the ankle (accounted for 17.6% of total injuries), low back (14.2%), and the knee (11%).[9] In the 1987 tournament, females were identified with an injury rate of 2.3 compared to 1.7 for males.[9] However, whether injury rate, injury site, or time loss is associated with practice court surface is unknown.

The purpose of this study was to investigate the relationship between volleyball practice court surfaces and injury rate and time loss due to injury. In order to obtain information about practice injury rates in collegiate volleyball, this retrospective study was conducted with NCAA Division I women's volleyball teams regarding practice court surface and injury rates.

Methods

The methods section of this study was conducted in two stages. In stage one, an e-mail was sent to the head and/or assistant coaches of 289 NCAA Division I women's volleyball teams to obtain the types and ages of volleyball practice court surfaces. Twenty three coaches had no contact information on their team's website and therefore, were not contacted. NCAA Division I women volleyball teams were selected based on electronic accessibility and premium level volleyball. One hundred and forty five

coaches responded regarding the type and age of their team's volleyball practice court surface, and the name and e-mail address of the volleyball athletic trainer.

The volleyball practice surface had to be a Sport Court® surface or a spring-loaded wood surface for study participation. The practice surface also had to have been purchased in the last 10 years and used from 2001-2003 in order to have similar surfaces for comparison. After review of the 141 responses from coaches, only 24 NCAA Division I volleyball programs qualified for this study.

Eleven NCAA Division I women's volleyball teams used a spring-loaded wood court, including ash and maple wood. As reported to the researcher by NCAA Division I volleyball coaches, only 15 NCAA Division I women's volleyball programs own a Sport Court. However, two schools used the Sport Court® surface only for competitions. Therefore, only 13 NCAA Division I women's volleyball programs use a Sport Court® surface for practice and were eligible for the study. There may be more Sport Court® surfaces used for practice for NCAA Division I women's volleyball but this information was not returned to the researcher.

An injury information survey was constructed by the researcher and was used to collect lower extremity injury data from participants. "The Volleyball Injury Survey" contains 2 items: 1) the frequency of lower extremity injuries related to court surface, and 2) the severity (time loss) of the corresponding injuries in question one (Fig. 1).

A 4-person panel of experts in the field of athletic training reviewed the questionnaire for face validity, reliability, and repeatability. Different vernacular of the

survey was suggested by some of the members on the panel, and the survey was modified accordingly.

Stage two consisted of data collection from the participants (athletic trainers). Prior to the collection of data, approval to use human participants was granted by the Institutional Review Board of Human Subjects at San Jose State University. The athletic trainers of the 24 volleyball teams that qualified for the study were mailed information packets. These packets contained a cover letter, the volleyball injury survey, and a self-addressed stamped envelope. Consent was detailed in the cover letter and implied by the completion and return of the survey. Data collection was completed when a 30% response rate was achieved because 30% is the average response rate for mailed surveys.[2]

A frequency chart was used to assess the relationship of the total amount of injuries on a Sport Court® surface and a spring-loaded wood court. A severity table was used to assess the relationship between practice court surface and the time loss of lower extremity injuries.

Results

A total of eight NCAA Division I women's volleyball athletic trainers (two males and six females) participated in the study. The average age of the participants was 24 years. Of these participants, three NCAA Division I women's volleyball teams practiced on a spring-loaded wood court surface, and 5 NCAA Division I women's volleyball teams practiced on a Sport Court® surface. Due to the limited number of the Sport Court® surfaces in NCAA Division I women's volleyball, a Sport Court® that was

assembled on top of any surface was included in this study. The included five Sport Court® surfaces were assembled on top of wood, rubber, tartan, or Mondo® surfaces. Both spring-loaded wood surfaces and Sport Court® surfaces were purchased in the past 10 years and used predominantly for practice from 2001-2003.

During the regular season of collegiate women's volleyball (August to December) for the years of 2001-2003, a total of 135 lower extremity injuries occurred among approximately 105 participants. Sixty-two lower extremity injuries occurred during practice on the Sport Court® surface and 73 lower extremity injuries on the spring-loaded wood court (Fig. 2). The knee was the most common lower extremity injury site, which accounted for 27% of the lower extremity injuries. The ankle (20%), lower leg (19%), and low back (12%) were also common lower extremity injury sites. No significant differences were identified between the frequency and severity of practice injuries on a Sport Court® surface and a spring-loaded wood surface (Fig. 2 & Table 1).

Slight differences were identified in the frequency of injuries which may provide some practical use for sports medicine personnel or future researchers. More knee (65%) and upper leg injuries (75%) occurred during practice on the spring-loaded wood surface than on the Sport Court® surface (32% and 25% respectively) and more ankle injuries occurred on the Sport Court® surface (56%) than on the spring-loaded wood surface (44%).

The severity of lower extremity injuries was graded on the scale from the NATA's Injury Surveillance Study.[5] A minor injury was defined as an injury to the lower

extremity that allows the athlete to return to practice within 7 days, a moderate injury was defined as an injury to the lower extremity that forces the athlete to miss between 8 and 21 days of practice, and a major injury was defined as an injury to the lower extremity that forces the athlete to miss more than 21 days of practice.[5] Data indicates that there were no moderate or major injuries reported on either practice surface for the toes, hip, or sacroiliac joint (Table 1). For minor and major injuries to the knee, the spring-loaded wood court had 53% more injuries than the Sport Court® surface. More minor toe injuries occurred on the Sport Court® surface than the spring-loaded wood surface. Major lower leg injuries occurred more often on the spring-loaded wood court than on the Sport Court® surface.

Discussion

Since the level of a NCAA Division I women's volleyball player differs from a recreational volleyball player, the data from this study may not be generalizable to volleyball populations outside the collegiate level or among male volleyball players, however it does offer insight into injuries that may be more prevalent based on court surface. Due to their skill level, collegiate women volleyball players may have fewer injuries than recreational volleyball players.[9]

Results from this study indicate that, within this sample population, a considerable number of collegiate women volleyball players have sustained lower extremity injuries related to the practice court surface (Fig. 2). The majority of volleyball injuries among collegiate women occurred to the knee, ankle, lower leg, and low back. These data are

similar to the findings of other volleyball injury research studies.[4569] One of the possible reasons that the knee was the most commonly injured site in this study may be due to the inflexibility of the practice court surface, but cannot be differentiated in this study by other factors such as contact with other players, pre-disposition to injury, biomechanical factors, or other unidentified factors. A study conducted on joint kinetic and energetic values was conducted on 4 men that landed barefoot from a height of 20cm onto both a soft and hard surface.[3] Research on joint kinetic and energetic values on men who landed barefoot from a height indicated that the knee muscles absorbed more energy than the ankle extensor muscles, and the contribution of these extensor muscles to the energy absorbed at both joints increased as surface hardness increased.[3] These results suggest that the increased load on knee muscles is one of the possible causes of injuries while running or jumping on harder surfaces. Thus floor absorption may play a role in knee injuries and contribute to the amount of energy absorbed by the knee. Therefore, these results may indicate the reasons why the knee is one of the most injured body parts during practice in volleyball.[3]

Of all the NCAA Division I women's volleyball coaches that responded with the type and age of the practice surface, only 13 used the Sport Court® surface for practice. Therefore, a small sample size may have made it difficult to analyze significant differences. A bigger sample size may produce more significant findings. Since the Sport Court® surface is not common among NCAA Division I women's volleyball programs, further studies would be required to examine all NCAA divisions of women.

Further studies also need to be conducted on the causes of high incidences of lower extremity rates for example, different shoes, such as shock absorbing shoes, should be studied and other biomechanical factors that may contribute to this phenomenon.

The Sport Court® surface showed less knee injuries than the spring-loaded wood surface. There were 45% more knee injuries on the spring-loaded wood court than the Sport Court® and the injuries were more severe on the spring-loaded wood court. Not only did players participating on the Sport Court® surface have less knee injuries, they also spent more time in practice and competitions compared to players that participated on a spring-loaded wood surface.

Conclusion

This study suggests that lower extremity injuries that are related to court surface may be present at the NCAA Division I level. The knee was the most common site of injury, followed by the ankle, lower leg, and low back. The NCAA Division I women's volleyball teams encountered more knee and upper leg injuries during practice on the spring-loaded wood surface (68% and 75% respectively) than on the Sport Court® surface (32% and 25% respectively). The NCAA Division I women's volleyball teams suffered from more ankle injuries on the Sport Court® surface (56%) than on the spring-loaded wood surface (44%).

For minor and major injuries to the knee, the spring-loaded wood court had 53% more injuries than the Sport Court® surface. More minor toe injuries occurred on the Sport Court® surface than the spring-loaded wood surface. There were more major lower

leg injuries on the spring-loaded wood court than on the Sport Court® surface.

More investigation is warranted because this study concluded that many injuries occurred on a Sport Court® surface and a spring-loaded wood surface. Even though this study found no significant differences between the frequency and severity of lower extremity injuries on a Sport Court® surface and spring-loaded wood surface, there may be other volleyball practice surfaces that may cause or inhibit more injuries. Further studies should be conducted comparing other practice surfaces, such as spring-loaded wood surfaces compared to non spring-loaded wood surfaces or Sport Court® surface compared to non spring-loaded wood surfaces.

There was a small number of participants in this study. Therefore, more investigation is warranted to include many more participants. More participants may produce significant results.

Recommendations

Since more time is spent on volleyball surfaces during practice rather than competitions, more research needs to be conducted on volleyball practice surfaces. Research studies have concluded that more injuries among volleyball players occur during practice. Therefore, more research needs to be conducted on practice surfaces to decrease injuries among volleyball players. The information gathered about volleyball practice surfaces and injury rates is important because future purchases of volleyball practice surfaces may affect the frequency and severity of injuries endured by volleyball players.

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Volleyball Injury Survey

Instructions: Please complete this survey as accurately as possible. When completed, please return this survey in the self-addressed stamped envelope provided. Thank you in advance for the completion of this survey.

1) What is the number of lower extremity injuries that have occurred among the volleyball players that are directly related to the court surface during practice (NOT competition) while in-season (August-December) for the past 3 years? For example, please include chronic injuries, such as stress fractures and tendonitis, and acute injuries, such as sprains, strains, and fractures. Please put the number of injuries that have occurred in the past 3 years on the space next to the body part in which the injury occurred. For example: Toes 5

Toes	___	Knee	___
Forefoot	___	Upper Leg	___
Midfoot	___	Hip	___
Ankle	___	Sacroiliac	___
Lower Leg	___	Low Back	___

2) For each injury, please mark down the amount of days that the athlete was unable to practice due to injury. For example: Toes 2 5 7 3 6.

Toes	_ _
Forefoot	_ _
Midfoot	_ _
Ankle	_ _
Lower Leg	_ _
Knee	_ _
Upper Leg	_ _
Hip	_ _
Sacroiliac	_ _
Low Back	_ _

Figure 1. The Volleyball Injury Survey.

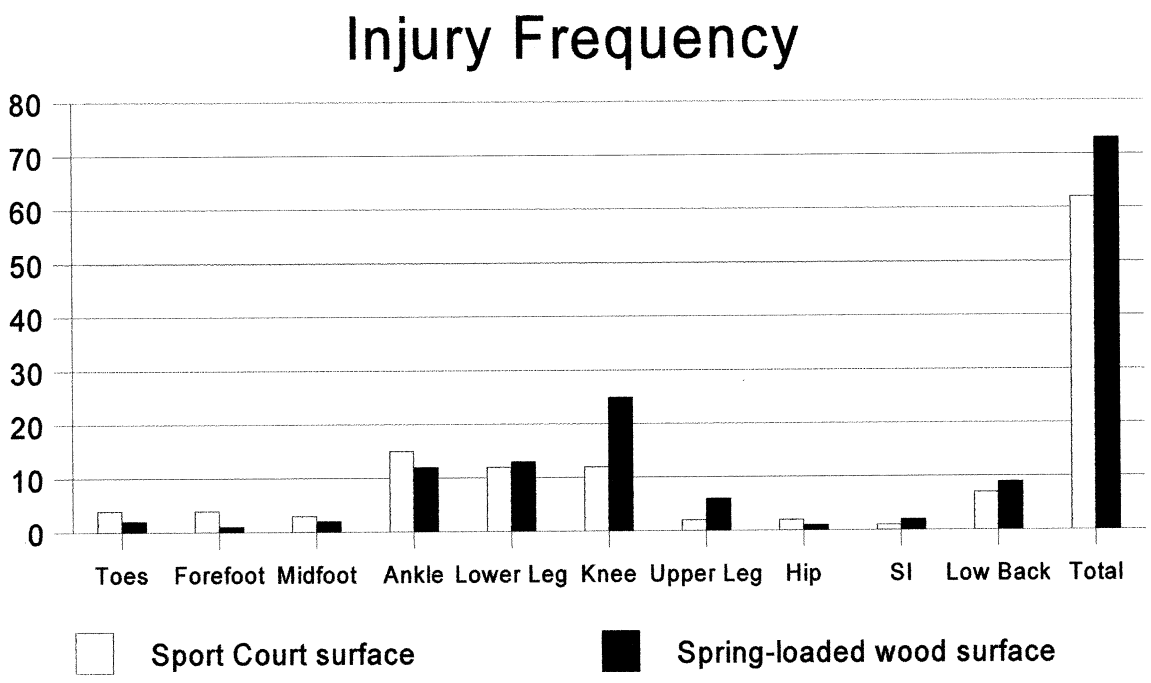

Figure 2. Frequency of Injuries among NCAA Division I women's volleyball players during practice on a Sport Court® surface or a spring-loaded wood surface.

Injury Severity

	Minor		Moderate		Major		
	Sport Court	Wood	Sport Court	Wood	Sport Court	Wood	Total
Toes	4	2	0	0	0	0	6
Forefoot	1	1	3	0	0	0	5
Midfoot	1	1	1	0	1	1	5
Ankle	7	9	7	3	1	0	27
Lower leg	11	9	1	1	0	3	22
Knee	8	15	0	5	4	5	37
Upper Leg	1	4	1	2	0	0	8
Hip	2	1	0	0	0	0	3
Sacroiliac	1	2	0	0	0	0	3
Low Back	7	8	0	0	0	1	16
Total	43	52	13	11	6	10	135

Table 1. Severity of Injuries among NCAA Division I women's volleyball players during practice on a Sport Court® surface or a spring-loaded wood surface.

Appendix B

Authors' Instructions for the International Journal of Sports Medicine

International Journal of Sports Medicine-Author Instructions

Scope of the Journal

The International Journal of Sports Medicine (IJSM) provides a forum for the publication of papers dealing with basic or applied information that will advance the field of sports medicine and exercise science. The following sections define the scope of the journal: training & testing; orthopedics & biomechanics; clinical sciences; nutrition; behavioral sciences; physiology & biochemistry; immunology.

General Policy

The journal publishes original papers, reviews, short communications and letters to the Editors. Manuscripts submitted to the journal must contain novel data on theoretical or experimental research or on practical applications in the field of sports medicine and exercise science. No substantial part of the submission should have been published elsewhere. If a part of the submission has been published or presented on a congress, symposium, or national meeting proceeding, the reference for that publication and/or presentation should be given in the manuscript acknowledgement section. Submitted papers undergo peer reviewing by two independent referees. Authors may suggest names and full addresses including telephone and FAX numbers of two referees but not from their own institution.

Categories of articles accepted for review

Original articles: Theoretical or experimental (basic or applied) research or practical applications. Either original work or the replication of work that better establishes basic principles will be considered. Original articles should not exceed a total of 15,000 characters, including references.

Review articles: Review articles on topics of broad interest are desirable. Authors who wish to submit an unsolicited review article should correspond with the Editors-in-Chief to determine the timeliness of the proposed review article. The correspondence should include an abstract and a complete outline of the proposed review article, including figures and tables (if possible). Review articles should not exceed 30,000 characters, including references. Review articles are considered by the Editors and expert referees before a final decision regarding publication is made.

Rapid communications: Short manuscripts containing results of unusual scientific interest and importance, requiring rapid publication. Papers submitted for this accelerated process must require little or no revision. Accompanying the submission should be a letter from the authors stating why they feel the paper should be published as a rapid communication. The manuscripts must not exceed four journal pages (2500 words including figures,

tables and references). The format is the same as for full papers. For articles submitted as Rapid Communications every effort will be made to make a decision within three weeks and publish it within two or three months. Manuscripts rejected as Rapid Communications are eligible for resubmission as regular articles.

Letters to the Editor are welcome and will be published if appropriate. Letters (maximum length 700 words) relating to material previously published in IJSM should be submitted within 6 months after publication of the material the letter is referring to. Such letters will be sent to the corresponding author for comment within six weeks. The original letter and any reply will be published concurrently.

Preparation of the submission

General: Each submission must come with a cover letter containing the following information:

- title of the article and authors' names;
- statement that the manuscript is not under consideration for publication by any other journal;
- statement indicating that each author has contributed substantially to the submitted work and has reviewed and agrees with the submission of the manuscript for review (please note: authorship may not change during review process);
- statement indicating that the corresponding author will cover the page charge starting from the fourth printed page;
- a signature by each author, or at minimum the senior author with the authority from the coauthors.
- If the reader is referred to previous work by the same authors, particularly in relation to methodology but also if a previous concurrent article is unpublished, copies or reprints of the other publications should be sent with the original submission.

Electronic submissions

Send a disk to the Editorial Office, or send an e-mail with the manuscript attached. Tables and figures must be included, though print quality/high-resolution (color/grayscale 300 dpi, graphics/line drawings 800 dpi) will only be required for accepted manuscripts. We encourage all electronic submissions in PDF format; MSWord files will also be accepted. Please indicate the file type (and version) in

the text of the e-mail. Maximum acceptable file size is 2 MB.

Paper submissions

Format: Manuscripts must be typed legibly on standard paper no larger than 21x29.7 cm (DIN A4) with a 3 cm margin on the left, font 12 point, double spaced. The pages must be numbered in sequence beginning with the title page as page number one. The lines of each page must be numbered consecutively beginning with the title page.

Four copies of the manuscript are required, one original (with illustrations suitable for reproduction) and three complete copies including copies of illustrations and tables.

Style: Manuscripts may be rejected without review on the basis of poor English or lack of conformity to stated standards of style.

Title page: The title page of the manuscript should contain the following information:

- specification of the most appropriate section of the journal (as list„ed above under Scope of the Journal);
- concise but informative title;
- authors' names with first and middle initials (do not include degrees);
- short concise running title (not exceeding 45 characters including spaces) for presentation on the journal cover;
- name and location of the institution(s) where the work was undertaken;
- name and address of the corresponding author and author to whom official correspondence and reprint requests should be addressed that must include telephone and fax numbers and an e-mail address.

Abstract page: The abstract should be informative. It should be self-explanatory without reference to the text of the manuscript. It should include essential significant results that support the conclusion of the work. Three to six key words not used in the title should also be provided. Abbreviations should not be used in the abstract.

Introduction: Should be comprehensible to the general reader. Give a clear statement of the purpose of the paper and provide relevant context to support the basis for the paper

and the significance of the work. Do not exhaustively review the literature.

Materials & Methods: Provide sufficient information in the text or by reference to other work to permit the submitted work to be repeated without the need to communicate with the authors. Relevant validity and reliability data should be provided for critical methods.

State the type of statistical tests used. Include the number of observations and the statistical findings when appropriate. Parametric and non-parametric statistics must be used as appropriate.

Results: Should be presented precisely and should not contain material that is appropriate in the discussion. Units, quantities, and formulas should be expressed according to the Syste|`me Internationale (SI units). All measurements should be given in metric units.

Discussion: Emphasize the new and important aspects of the study and conclusions derived from the study.

Acknowledgements: Reference to prior publication of the results in abstract form or in proceedings should be provided. Addresses of authors other than the laboratory acknowledged for the work should be provided. Financial support should be stated.

References: References should be cited in the text by number and compiled alphabetically at the end of the article and numbered accordingly. Titles of journals should be abbreviated according to the latest edition of Index Medicus. All authors should be named (do not use "et al."). Authors bear complete responsibility for the accuracy of the references.

Only published or "in press" papers or books may be cited in the reference list. Information from manuscripts submitted but not yet accepted should be cited in the text as "unpublished observations" in parentheses. Personal communications should be listed in the text in pa„rentheses. Published abstracts must not be used as references. Use of a large number of abstracts or non peer-reviewed articles in the reference section will be grounds for rejection of the submission without review.

Examples of references

Journal article:

[1] Palmer GS, Dennis SC, Noakes TD, Hawley JA. Assessment of the reproducibility of performance testing on an air-braked cycle ergometer. Int J Sports Med 1996; 17: 293-298

Complete book:

[1] Dingle JT (ed). Lysosomes. New York: American Elsevier, 1972: 65

Chapter of a book:

[1] Zancetti A, Baccelli G, Guazzi M, Mancia G. The effect of sleep on experimental hypertension. In: Onesti G, Kim KE, Moyer JH (eds). Hypertension: Mechanisms and Management. New York: Grune & Stratton, 1973: 133-140

Figures: Figures, illustrations, or half-tones should be used when findings are best visually communicated. Figures should be numbered in Arabic numerals in the sequence as they appear in the text. Each figure should be accompanied on a separate sheet by a suitable short and concise legend. Abbreviations used in the figure must be explained in the legend. Figures should be labeled with the name of the first author and the figure number on the top left-had corner of the reverse side of the figure with a soft pencil. Reference to the figure should be made in the text.

Figures, illustrations or half-tones must be submitted that are clear, black and white, on glossy paper and must be sharp, high-contrast and suitable for reproduction also after reduction in size. Uniform typographical setup (font style & size, line thickness) of all figures in a paper is highly desirable.

Color figures, illustrations or half-tones will not be published unless the author requires color in the publication. In this case the author will be charged with the additional cost of printing. The use of photographs or equipment and experimental subjects should be avoided. Good line drawings are more informative.

Tables: Tables should be used to communicate information that is hard to present visually. Results whose interpretation is more easily comprehended by knowing the means and SEM (or SD) may be presented in a table(s). Tables should be self-explanatory and bear a short title. Table legends should be typed on the same sheet as the table as a header. A footnote to the table should explain all abbreviations used in the table.

Submitting the manuscript

- All manuscripts from the Western hemisphere (United States, Canada, South America) and from Pacific Ocean countries (Australia, Japan, New Zealand and Taiwan) should be addressed to: W. M. Sherman, PhD, HPER/Larkins Hall, The Ohio State University, 337 W 17th Avenue, Columbus, OH, 43210-1284, USA.

- Manuscripts from all other countries should be submitted to the Eu„ropean office journal secretary: Mrs. Louise Lehnen, An der Eiche 29, D-53937 Schleiden,

Germany. Do not send submissions via express mail to this German address.

Electronic manuscripts

Whenever possible, accepted manuscripts should be made available electronically. Please send diskettes to the publisher's address which is provided in the letter of acceptance. Widespread text processors should be used and the operating system, programme and version numbers should be indicated on the diskette. Please save your file in the standard format of your text processor and in one or several exchange format/s (for example, *.txt, *.rtf). If possible, the "endnote" function of the text processor should be used for the management of references. Figure legends and tables should be listed at the end of the document.

Please save figures as separate files. They should not be integrated into the text document. The following graphic file formats are preferred:

- For coloured and black-and-white bitmaps: *.eps, *.tif, *.jpg, *.wmf (resolution: 300 dpi).
- For diagrams and line drawings: *.eps (resolution: 800 dpi).

In addition to the electronic files, four paper versions of both text and figures must be submitted. In case of doubt, the paper version is given the higher priority.

Please provide a signed declaration that the paper and electronic versions are identical.

Galley proofs and proof-reading

Galley proofs will be sent to the corresponding author for proof reading. Proof reading is for typesetting errors only. At this stage the manuscript cannot be changed. The galley proofs should be returned to the appropriate address within 48 hours so the publication of the submission is not delayed.

Page charge

Together with the galley proofs, if the manuscript is more than three printed pages, the corresponding author will be asked by the publisher to submit a check or purchase order to pay the cost of publication. Up to three printed pages of publication are without charge to the corresponding author. Each printed page beginning with the fourth printed page will carry a page charge of € 160.-- (including 16% VAT).

Reprints

The authors will receive 25 reprints free of charge. An order form for reprints will be sent to the authors enabling further reprints to be ordered at prices indicated on materials contained with the galley proofs.

Appendix C

The Volleyball Injury Survey

The Volleyball Injury Survey

Instructions: Please complete this survey as accurately as possible. When completed, please return this survey in the self-addressed stamped envelope provided. Thank you in advance for your help!

1) What is the number of lower extremity injuries that have occurred among the volleyball players that are directly related to the court surface during practice (NOT competition) while in-season (August-December) for the past 3 years? For example, please include chronic injuries, such as stress fractures and tendonitis, and acute injuries, such as sprains, strains, and fractures. Please put the number of injuries that have occurred in the past 3 years on the space next to the body part in which the injury occurred. For example: Toes 5

Toes	___	Knee	___
Forefoot	___	Upper Leg	___
Midfoot	___	Hip	___
Ankle	___	Sacroiliac	___
Lower Leg	___	Low Back	___

2) For each injury, please mark down the amount of days that the athlete was unable to practice due to injury. For example: Toes 2 5 7 3 6. If you need more spaces please use the back.

Toes _

Forefoot _

Midfoot _

Ankle _

Lower Leg _

Knee _

Upper Leg _

Hip _

Sacroiliac _

Low Back _

Appendix D

Letter of Consent

San José State
UNIVERSITY

College of Applied Sciences and Arts
Department of Human Performance
One Washington Square
San José, CA 95192-0054
Voice: 408-924-3010
Fax: 408-924-3053

April 1, 2004

Dear Certified Athletic Trainer:

To date there is a lack of research on volleyball court surfaces and their relationship to the frequency and severity of injuries. Thus, I am conducting a study on volleyball court surfaces and their relationship to the frequency and severity of injuries across the United States in order to gain valuable information. This information could someday directly affect volleyball players and indirectly affect you and your peers. There are no direct benefits to you (the subject) for participating. However, data gathered may be used in the purchasing decisions for volleyball programs.

As a certified athletic trainer, I realize how important your time is. However, completion of this survey could aid in the recognition and prevention of injuries among volleyball players.

You should understand that your participation is voluntary and that choosing not to participate in this study, or in any part of this study, will not affect your relations with San Jose State University. No risks have been anticipated as a result of your participation in this study. The results of this study may be published, but any information that could result in your identification will remain anonymous. Completion and return of the following survey implies consent to utilize the anonymous information you provide. Please take your time to complete the enclosed survey and return it within one week of its arrival in the enclosed self-addressed stamped envelope.

If you have any questions or concerns about this study, please feel free to contact me at (408) 482-5965, or Dr. Leamor Kahonov, Thesis Chair, at (408) 924-3040. Complaints about the research may be directed to Dr. Greg Payne, Department Chair, Department of Human Performance, at (408) 924-3010. Questions or complaints about the research, participants rights, or research related information may be presented to Pam Stacks, PhD., Associate Academic Vice President for Graduate Studies and Research, at (408) 924-2480.

Sincerely,

Traci L. Bluestein, ATC
San Jose State University

Appendix E

Institutional Review Board Approval Letter

San José State
UNIVERSITY

Office of the Academic Vice President
Academic Vice President Graduate Studies and Research
One Washington Square
San José, CA 95192-0025
Voice: 408-283-7500
Fax: 408-924-2477
E-mail: gradstudies@sjsu.edu
http://www.sjsu.edu

To: Traci Bluestein
2118 Canoas Garden Ave., #82
San Jose, CA 95125

From: Pam Stacks,
Interim AVP, Graduate Studies & Research

Date: March 11, 2004

The Human Subjects-Institutional Review Board has approved your request to use human subjects in the study entitled:

"Volleyball Injuries among Collegiate Women by Court Surface."

This approval is contingent upon the subjects participating in your research project being appropriately protected from risk. This includes the protection of the anonymity of the subjects' identity when they participate in your research project, and with regard to all data that may be collected from the subjects. The approval includes continued monitoring of your research by the Board to assure that the subjects are being adequately and properly protected from such risks. If at any time a subject becomes injured or complains of injury, you must notify Pam Stacks, Ph.D. immediately. Injury includes but is not limited to bodily harm, psychological trauma, and release of potentially damaging personal information. This approval for the human subjects portion of your project is in effect for one year, and data collection beyond March 11, 2005 requires an extension request.

Please also be advised that all subjects need to be fully informed and aware that their participation in your research project is voluntary, and that he or she may withdraw from the project at any time. Further, a subject's participation, refusal to participate, or withdrawal will not affect any services that the subject is receiving or will receive at the institution in which the research is being conducted.

If you have any questions, please contact me at (408) 924-2480.

cc: Dr. Leamor Kahanov