THE INCIDENCE OF ATHLETIC INJURIES AMONG FEMALE INTERCOLLEGIATE ATHLETES

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DEDICATION

I dedicate this work
and all the thought that went into it
to all those Puertorican female athletes
who are still waiting for an answer
to their athletic health care.

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CHAPTER I

INTRODUCTION

As females become more involved in athletic competition and as the intensity of that participation increases, the need to define injury patterns increases too. Information regarding injuries to female athletes is scarce and, without concrete research data, it cannot be assumed that trends and injury rates are similar to men's sports. Although some information does exist comparing men and women, much less information exists related to female intercollegiate competition.

The growing concern about sports trauma in female athletes is leading to alterations in training programs and in sports medicine programs for women. Clarke and Miller (1977) have stated:

> A vast number of female students are now participating in a variety of interscholastic and collegiate sports to obtain the assorted benefits associated with participation and training for participation. In doing so, they are accepting a reasonable risk of injury and assuming that those who govern and assist sport programs are using professionally defensible methods for keeping the risk reasonable (p. 19).

Both researchers state that coaches, athletic directors, and rules committees are facing many decisions concerning sports safety problems with conflicting recommendations and without data to verify or refute respective contentions.

Sports injury data on females is incomplete, obsolete, or uninterpretable. Existing studies are confined to short-term research usually during one season, to a particular sport such as basketball, to a particular area which is usually no larger than one community, and/or to a particular injury as the knee. Clarke and Miller (1977) contended that this state of affairs exists because sports injuries and illnesses are not as readily adaptable to routine national reporting as other medical problems with a sound epidemiological design. Both investigators outlined six factors that make it difficult for decision-makers to be aware of normative data, prevailing factors, the influence of particular changes or trends, or the significance of a publicized occurrence or isolated study. These factors are:

1. Sports injuries stem from an environment in which injury is expected (p. 19).

2. The athlete challenges the injury and the persons who evaluate and treat it because of the profound motivation to perform (p. 19).

3. The 'health care system' for handling the athlete's injury is organized differently than for traffic, industrial or home injuries (p. 19).

4. The criteria for evaluating an athletic injury are related more to performance impairment (time loss from participation) than to type of medical care (e.g., hospitalization, surgery) (p. 19).

5. Formally trained medical records personnel are basic to hospitals and industry but not to sports (p. 19).

6. Organized sports programs for females have not yet stabilized in scope and intensity (p. 19).

An athletic medicine program for women should be established utilizing a team approach and stressing the importance of prevention of injuries as well as the care of the acutely injured athlete. Such a program could be expected to reduce disability, improve team and individual performance, and increase the total fund of knowledge relating to the active participation of women in athletics. Also, it has been suggested that an administrative position of team physician for women athletes be created within the University Health Service (Garner and Turner, 1973).

Therefore, a need exists to closely examine the incidence of athletic injuries among females in order to establish the patterns and trends which might exist.

The Problem

The purpose of the study was to examine sports injury patterns among intercollegiate female athletes representing three sports.

Importance of the Study

Physical education programs, athletics programs, athletic training, health sciences and the sports medicine areas can utilize information relevant to the incidence of injury among female athletes. People in these areas can make a serious contribution toward achieving a better understanding in the prevention and care of injuries for the athletic female.

Scope of the Study

Two intercollegiate school settings were involved in this research: Oklahoma State University at Stillwater and The University of Oklahoma at Norman. Three varsity intercollegiate competitive sports for women were considered in the study:

(a) Basketball;

(b) Track and Field; and

(c) Softball.

The injury patterns were compared and analyzed over three consecutive athletic-competitive years: 1979-1980, 1980-1981, 1981-1982.

Pertinent Questions

The following questions were assessed:

(1) Is there a substantial difference in the trends of sports injuries related to varsity female sports between Oklahoma State University and The University of Oklahoma?

(2) Is there a substantial difference in the trends of sports injuries related to the body part affected between Oklahoma State University and The University of Oklahoma?

(3) Is there a substantial difference in the trends of sports injuries related to joints, and miscellaneous sites affected between Oklahoma State University and The University of Oklahoma?

(4) Is there a substantial difference in the trends of sports injuries related to a three years span between Oklahoma State University and The University of Oklahoma?

Limitations

The research may have been limited by the following:

(1) There was no attempt to compare injuries related to game positions and/or individual roles of competition; practices and/or games; or nature of injury.

(2) Relevant information such as age, diet and sleeping habits, rest, daily and extracurricular activities, domestic and/or off-season injuries, was not present in the data.

Delimitations

The research was delimited to:

(1) Female varsity athletes.

(2) The following sports: Basketball, track and field, and softball.

(3) Three (3) competitive years: 1979-1980, 1980-1981, 1981-1982.

Assumptions

The following assumptions were made:

(1) Since the athletic training staff at both schools is certified professionally in the area of athletic injuries and sports trauma, the reported injuries were well managed and correctly presented in the training records.

(2) The information received as data for this study was reliable and valid and the help provided by the staff in charge was accurate and evident for the purposes of the investigation.

Glossary of Selected Terms

Androgen - Testosterone or androsterone, that stimulates the activity of the accessory sex organs of the male and encourages the development of the male sex characteristics (Stedman, 1976, p. 67).

Avulsion - A tearing away or forcible separation (Stedman, 1976, p. 146).

Contusion - A bruise; direct trauma causing tissue damage (AMA, 1876, p. 23).

Ecchymosis - General extravasation of blood in soft tissues from blow producing skin discoloration (AMA, 1976, p. 121).

Estrogen - The female sex hormones; more specifically the estrogenic hormones, estrodiol and estrone, produced by the ovary. Estrogens are responsible for the development of secondary characteristics (Taber, 1977, p. 504).

Etiology - Causation; the possible or actual causes of a disease or injury (AMA, 1976, p. xii).

Menisci - Internal semilunar fibrocartilages of the knee joint (Stedman, 1976, p. 849).

Myositis Ossificans - From a direct blow or contusion, hematoma involving muscle overlying bone; repeated irritation of injured area by unwise manipulation or too early activity, with possible limitation of motion (AMA, 1976, p. 73).

Neuropraxia - A state of a nerve in which conduction is blocked across a point but is present in the nerve above and below the lesion (Stedman, 1982, p. 949).

Osteomyelitis - Local inflammation of the bone marrow and adjacent bone infection with pain elicited on movement of limb (AMA, 1976).

Osteosarcoma - A tumor usually highly malignant arising from bone forming cells and affects chiefly the ends of long bones (Stedman, 1976, p. 1253).

Osteochondritis Dissecans - Local inflammation of a segment of articular surface on bone and or overlying articular cartilage with muscle atrophy and limited movement of limb (AMA, 1976, p. 75).

Propioceptive Feedback (mechanism) - The awareness of posture, movement and changes in equilibrium and the knowledge of positions, weight, and resistance of objects in relation to the body within the capability of receiving stimuli originating in muscles, tendons, and other internal tissues (Taber, 1977, p. 1168; Stedman, 1982, p. 518).

Rhabdomyosarcoma - A malignant new growth tissue derived from skeletal striated muscle (Stedman, 1976, p. 1229).

Serous Effusion - The escape of serum (fluid) from the blood vessels or lymphatics into the tissues or a cavity (Stedman, 1976, p. 444).

Shin Splints - Any pain in the athlete between the tibial tubercle and the ankle (Jackson, 1978, p. 52).

Sprain - An injury to a joint, with possible rupture of ligaments fibers. Classification consists of: 1st degree, 2nd degree, 3rd degree sprain (AMA, 1976, p. 99).

Strain - Trauma to portion of musculotendinous unit from excessive forcible overuse or stretch. Classification consists of: 1st degree, 2nd degree, 3rd degree pulled muscle (AMA, 1976, p. 101).

Synovitis - Painful inflammation of the inner lining of a joint secondary to injury, characterized by the development of fluid within the joint (synovial effusion), perhaps mixed with blood (AMA, 1976, p. 126).

Tendinitis - Inflammation between tendons and surrounding tissues with consequent loss of smooth gliding motion (AMA, 1976, p. 105).

VO_2 max - A measure of aerobic (oxygen-using) fitness; indicator of cardiovascular fitness measured through the maximum volume of oxygen that can be consumed per minute during strenuous exercise (Weltman and Stanford, 1982, p. 212).

CHAPTER II

REVIEW OF RELATED LITERATURE

The review of the literature in this chapter consists of the following topics: (a) Social Overview of Women's Sports, (b) Women vs. Men: Some Physiological Issues, (c) The Nature of Sports Injuries, with sub-topics related to: Injury Defined; Classification of Injury by Causal Factors; Types of Tissue Damage, (d) Etiological Features of Sports Injuries, with sub-topics pertinent to: Physical Contact Sports; Individual Performance Activities; Repetitive Training, (e) Training and Conditioning: A Matter of Injury Prevention, with sub-topics directed to: A Brief Outlook on Running Injuries; Flexibility and Strength Training: Measures of Injury Prevention, and (f) Research Efforts and Findings: Injuries Among Female Athletes.

A Social Overview of Women's Sports

In the past ten years most collegiate athletic programs have added additional women's sports to their programs. Introducing women's sports like basketball, track, tennis, golf and gymnastics presents not only administrative problems associated with any growing athletic program, but also problems unique to women's sports. These problems must be recognized and effectively dealt with by administrators. Four major factors that influence women's sports at the present time include: (1) The role of women as perceived by members of society;

(2) The physiological differences between men and women; (3) The resurgence of women's sports; and (4) the impact of Title IX on women's and men's sports (Broyles, 1979).

Title IX of the Education Amendments Act of 1972 puts the force of law behind the fact that women are entitled to a fair and equitable share of whatever opportunity a federally-assisted educational institution offers. Forbidden are sex discrimination in admissions, scholarships, employment, rules and regulations, and physical education (Hogan, 1976). Generally, women have more support in school sports now than they did before, but clearly college women athletes are not being treated as well as men (Hogan, 1976). Historically, the lack of opportunity for female athletes throughout this century has not been the fault of people in men's athletics, but rather the result of complex societal attitudes (Grant, 1979).

In the early 1970s the slogan for the female competition boom in sports was, "Athletics for women have arrived!" Now in the early 1980s it appears that more comprehensive competitive sports programs for women are here to stay. However, female athletes still struggle to develop and substantiate the concept that a female can be an athlete and retain her gender identity. In general, we know that women tend to live longer and to be healthier than the men; we also know that women differ from the men in strength and endurance, yet women can enjoy sports traditionally associated only with men (Malumphy, 1971).

The traditional message in American society was that the desirable qualities for males were aggressiveness, independence, and achievement striving, while desirable qualities for females were passivity, affiliation, nurturance and dependence. However, more recently sports participation and vigorous physical pursuits have been associated with the female role (Sage and Loudermilk, 1979). Harris (1971) states that one of the main criticisms and most persistent deterrents to female participation in athletic competition is that it tends to masculinize the behavior of girls and women. Bird and McCullough (1977) refer to femininity as a construct used to describe the constellation of social behaviors and attributes associated with the female sex role. Both researchers point out that the word femininity reflects a culture's concept of acceptable or correct role behavior for its female members. Hall (1977) states that some of the sociological literature on women in sports reveals a belief that women athletes experience a social conflict between the desire to fulfill appropriate feminine sex roles. There is also a prevailing social view that if a woman is a dedicated athlete, she is probably unfeminine. Across this situation, studies related to the psycho-social dimensions on the basis of masculinity and femininity have been done (Del Rey and Sheppard, 1981). Butt (1976) writes:

> When judged within a traditional framework of social values, the woman pursuing an athletic career is pursuing a male role. The role of athlete and the role of female are opposed (p. 68).

Fasting and Tangen (1980) add:

> The traditional male role and the sport role have consequently much more in common than the sport role and the traditional female role. Therefore, it is more natural for men than women to engage in sports (p. 42).

Zoble (1973) declares that the American culture values grace and femininity and bravery and strength for women and this is shown by the fact that some sports are generally accepted for women, while others are not. These which are acceptable involve projecting the body through space in aesthetically pleasing patterns, using force through a light implement, or overcoming the resistance of a light object with skill and manipulation. Unacceptable sports involve body contact, application of force to a heavy object, and projecting the body through space over distances.

A study was undertaken by Greendorfer (1977) to investigate the process of female socialization into sports. The research was designed to determine the factors that influence women to become actively involved in sports for eight intercollegiate sports. In one of her findings, gymnastics, an aesthetic sport (Elliot, 1974; Aspin, 1974), contained as many participants as did volleyball, a sport with application of force to an object and with projection of body movements through space and distance.

Women vs. Men: Some Physiological Issues

In 1960, men and women's roles were still steeped in traditional attitudes: The new feminist wave was not to break on Western culture for another decade. Any sport requiring physical strength and endurance was considered beyond a woman's normal qualifications. However, sex differences may not be as prevalent as they once were. The trends show that in many sports women's performances are consistently closing the gap with the men's. Most certainly beliefs about women and particularly women in sports have changed. Myths have been exploded, and are being exploded; such as myths about women's lack of stamina, inadequate physiological response to exercise, inefficient heat regulating system; and myths about the effects of exercise on fertility, menstruation, pregnancy and labor (Ferris, 1980). These myths and ill-founded arguments have been used to maintain sex differences in human performance. The absolute physical inferiority of girls and women relative to boys and men has been put forward by some to explain the restriction of female participation in sports.

Existing evidence indicate that female athletes in general become inferior to males after the age of 12 when performing certain physical tasks. Some researchers explain this inferiority by citing physiological differences between men and women such as smaller bone structure, increased percent of body fat, decreased absolute strength, lower VO_2 max, lower maximum endurance and some limited muscle enzyme activities. However, some running and swimming events seem to favor women. When races extend beyond 2 hours, women seem to excel as the time becomes longer. For instance, a woman, Natalie Cullimore, won the 1974 Amateur Athletic Union Super Marathon run of 100 miles and in 1976 two women broke the world record for swimming the English Channel (Poortmans, 1980).

In nearly all sports the absolute performance values of males are higher than those of females. However, in swimming the differences are less marked than in most other sports. Thus women can be said to perform relatively better than men in this area. A number of factors are in part responsible for the improved relative performance of women in the sport of swimming. In addition to the existence of slightly better capacity to float, the three major factors identified appear to be: Better joint flexibility, more appropriate stroke mechanics and greater technical proficiency (Vervaecke and Persyn, 1980).

Recently, much attention has been given to the intriguing problem of whether true biological performance differences exist between sexes.

It has been shown that well conditioned male and female bodies are much more similar in lean body mass and cardiovascular performance than previous researchers assumed (Cheska, 1980; Wells and Plowman, 1983).

There appears to be great variability in the degree of differences in strength between men and women. Because it has been suggested that trained women athletes may be as strong as untrained men and that sex differences in strength are primarily attributable to differences in body size, Morrow and Hosler (1981) conducted a study to compare trained intercollegiate women basketball and volleyball players with untrained college-age men for absolute and relative upper and lower body strength. In this study untrained men were stronger than trained women athletes. Studies show that women are typically lower than men when tested for absolute strength. This is particularly true of upper body strength, where the female is 43% to 63% lower in strength in contrast to lower body strength where the female is only 27% lower. Endurance tests in both sexes quantified in the research laboratory by the assessment of the subject's maximal oxygen uptake have shown male athletes to be superior to female athletes but the female athletes perform 25% above sedentary males of the same age (Wilmore, 1975). Attempts to equate a feasible and valid procedure for matching male and female subjects to assess the most accurate VO_2 max comparison have been carried out by Cureton (1981). Studies have shown that women respond to systematic exercise training in much the same manner as men (Drinkwater, 1973; Pollock, 1973). Costill et al. (1979) have shown that males and females who are equally trained for endurance have similar aerobic capacities and muscle fiber composition.

Studies that examine the physiological characteristics of men and women, including body composition and physique, muscle fiber characteristics, strength, and cardiovascular endurance have been published. Although substantial physiological differences have been found between the average male and female, the differences reduced considerably when highly trained male and female athletes competing in the same event are compared. The physiological characteristics of highly trained female athletes do not differ significantly from those of highly trained male athletes, indicating that it is physically possible for women to compete successfully against men in some sports (Wilmore, 1979).

The size and structural differences between and among males and females are only a matter of degree and are quite possibly produced by the variations of the ratio of androgens to estrogens in the body. This variation in size and structure produces marked differences in speed and strength and the ability to generate power. The higher the level of competition, the more selective the process is for those individuals who are stronger and faster. This is true whether the athletes are males or females. Therefore, the characteristics of the male are much more compatible to the physical demands of many sports. This is not to say that females cannot participate at a high level; however, it does suggest that for high level sports performance in some sports, males and females should compete on separate teams. Otherwise, very few females will have the opportunity for high level performance. It appears that 'biology is destiny' when developing strength and speed and power. This along with the fact that sport is selective of the stronger and faster athletes suggests that the male will have an inherent advantage in any sport that involves strength and speed. This advantage often allows him to beat another who may be more skilled but have less power (Harris, 1976). It appears that even if strength differences between the sexes are in part related to differences in body size, the cause of these strength differences must be attributed to further factors (Hoffman et al., 1979; Dyer, 1982).

For many years it has been thought that girls and women could not tolerate environmental heat stress. It is documented that although women have a larger number of sweat glands than do men, they have a lower total body sweat rate when working in a hot environment. The body temperatures of the female are usually two to three degrees higher than that of the male before the sweating mechanism is stimulated. Recent research indicates that although women do not sweat as much as men, they are able to regulate their internal body temperatures equally well (Wells, 1977). In an investigation recently conducted, 5 men and 6 women known to be physically active in an outdoor hot-dry environment were studied in a temperate environment and in an outdoor desert environment during rest and exercise at 50% VO_2 max. No differences between the groups occurred in either environment and no differences occurred in evaporative weight losses, sweating rates, or % body weight in the heat. It was concluded that women accustomed to exercise in a desert climate are able to substantially increase their sudorific response and that acclimatized male and female subjects of similar aerobic capacity have comparable responses to rest and exercise in desert environments (Wells, 1980). Dill et al. (1977) conducted a tolerance test for sustained activity in the desert at about $40^{\circ}C$ on high school students-athletes. The conclusions in this study suggested that superior capacity of males over females for sustained exercise in desert heat is related to their higher aerobic capacity and not to a difference in capacity for thermoregulation. However, a substantial improvement in heat tolerance can be derived from 8-11 weeks of training under temperate conditions, and thermal equilibrium can be maintained for at least 4 hours during mild work in dry or wet heat by endurance runners. These adjustments occur in both men and women and appear to be independent of aerobic capacity (Gisolfi and Cohen, 1979).

Given the dissimilarity of the sexes identified by the results of different research investigations, researchers are in support of the biologic heterogeneity of the sexes at different levels. Therefore, their interest in other aspects of physiological differentiation between males and females has been studied. For instance, the existence of any sex difference in pain tolerance is incertain. Several factors are associated with pain tolerance: Age, social class and early childhood experiences have been found to be related. Any differences between male and female pain responses could possibly be attributed to sociocultural factors (Walker, 1971). Hall and Stride (1954) considered sex and intelligence while comparing subjects on pain threshold. Both researchers found no relationship between intelligence and pain threshold, but did report that females had a lower threshold than males; yet other investigators (Clausen and King, 1950; Kennard, 1952; McKenna, 1958; Haslam, 1965; Voevodsky et al., 1967; Lukin and Ray, 1982) have found no differences.

To summarize, the following evidence exists: (1) In many sporting events, women have performed as well as and on occasions better than their male counterparts; (2) in running and swimming, female performances are improving at a faster rate than male performances, showing a trend in top world achievements towards equality between the sexes; and (3) physiological research reveals that highly trained female athletes are very similar in their capacities with respect to exercise to their highly trained male counterparts (Ferris, 1980).

The Nature of Sports Injuries

Injury Defined

Defining the term 'injury' is a task with indefinite limitations. The definitions are various and the meanings are relative to the circumstances and actions involved. Damron (1981) presents four categories in his definition of an injury as a concept. These are: Injury, reportable injury, disability injury and nondisabling injury. Stedman (1982) defines injury as trauma from accidental or inflicted wound. Taber (1977) defines the term as any damage to some part of the body depending on the nature, extent and severity. Both authors establish a group of categories to define the term around causative factors.

All injury is damage. Two types of injuries are defined in the safety field: Restricted-activity injuries, and disabling injuries confining the victim to bed. Half of an estimated 50 million sports injuries require only brief medical attention with no restriction of the person to bed. According to the National Health Survey, a 'bed disabling injury' is one that confines a person to bed for more than half of the daylight hours on the day of the accident or on a following day. The National Safety Council defines a disabling injury as an injury that prevents a person from performing his usual activities for a full day beyond the day of the injury (Dean and Hoerner, 1981).

The term 'sports injury' is something of a misnomer. It is formulated that injury is the result of the application to the body or part of the body of forces which exceed the body's ability to adjust to them. These forces may be applied instantaneously or over a considerable period. The exact nature of the injury, the tissues involved and the way in which the damage is sustained, depends upon the mechanism by which excess force is applied. The body is able to differentiate between different types of stress. For example, the tissue response to a direct blow is different from that to a sudden stretch, but the body is not able to differentiate between the different activities in which one particular mechanical type of violence is applied. Most injuries sustained in sport are essentially no different from those sustained in other activities, although the demands of the patient in terms of rehabilitation and return to activity may be significantly greater (Williams, 1980).

From a practical point of view studies of patients attending clinics for sports injuries show that a very substantial majority of problems could be well handled either by general practitioners, hospital accident and emergency departments, or hospital specialists in appropriate disciplines as part of their normal practice. The number of injuries and clinical problems which are peculiar to sports as such and which are in general unrelated to ordinary day to day activities is small, but they do require particular expertise and knowledge in their management (Williams, 1980).

Under this approach and in terms of quantification around sports related injuries, men often receive more attention than women because of their higher sport participation and higher injury rate. Calculations of the costs of sports injuries estimate higher indirect costs upon treatment and resource requirements for those sports primarily dominated by youth and men as opposed to those sports primarily engaged in by the older population and by women. In order to calculate the direct and indirect costs of injuries associated with a given sport incurred in a particular time period, the following information is required:

1. Incidence of injury by age and sex.
2. Type of injury incurred.
3. Severity of injury.
4. Resources required in the diagnosis and treatment, and per unit costs of such resources.
5. Morbidity and mortality estimates associated with each type of injury (Bentkover and Tolpin, 1981).

In a comprehensive and outstanding review Williams (1980) presents the nature and incidence of sports injuries under three main aspects. These aspects are: (1) Classification of injury by causal factors, (2) types of tissue damage, and (3) other conditions presented as sports injuries.

Classification of Injury by Causal Factors

The extent and severity of the injury is modified by a number of factors including the general physical and psychological fitness of the athlete, the athlete's constitutional suitability for the sport, environmental conditions at the time of the injury, age and sex and general level of nutrition. The victim's general level of skill and proficiency is also significant. Williams (1980) points out that it is interesting to note how in body contact sports most severe injuries occur in the first part of the game, whereas the last part of the game is marked by an excessive number of minor and relatively trivial injuries exacerbated by the player's fatigue.

Types of Tissue Damage

Tissue response to injury largely reflects the nature of the damaging mechanism. The general pattern of injury, however, remains reasonably constant throughout the body. Typical examples of pathological response to trauma in the tissues are repeatedly reproduced at different anatomical sites.

In a skin injury a variety of different types of trauma may be noted. A laceration is damage to the skin involving the full thickness and exposing the underlying subcutaneous tissue. Puncture wounds are lacerations where the depth of the wound is greater than its length or breadth. Burns involve damage to the skin as a result of heat. In friction burns invariably an abrasive component is present as well. Skin damage may show a mixture of injury, for example bruising and laceration together.

Types of damage to muscle injury and/or muscle tear occur as a result of either external forces (contusion, haematoma or laceration) or more commonly as the result of forces generated within the tissue, i.e. as an intrinsic injury. The injury is then called a strain or tear of which there are three basic types: Complete and partial, the latter being either interstitial or intramuscular.

In sports damage to tendons by direct violence is uncommon. Usually injuries are intrinsic and most are of the overuse type. They are readily classified by their local pathology which is associated with well defined clinical features. Otherwise, joint injuries are common in sports, particularly in body contact events. The range of damage varies from minor sprain to major fracture or dislocation. Most joints are synovial, being reinforced in certain sites by ligaments, and some fibro-cartilaginous menisci. Damage may occur to any or all of these structures.

The general effects of injury, disease, or aging may be postulated by using the normal function of a joint structure as a basis for analysis. The complex joints are more likely to be affected by injury, disease or aging, than the simple joints. The complex joints have more parts, and because their function is dependent upon a number of interrelated factors, they are subject to more wear and tear than a simple joint (Norkin and Levangie, 1983). Hettinga (1979; 1980) describes how normal joint structures react to injury. In a comprehensive review about what occurs when a joint is injured, Hettinga first outlines the reactions of joint structures and synovial membrane to injury. Secondly, a description of the reactions of synovial fluid, the joint capsule and other intra-articular structures to injury is presented. Finally, an analysis of the reactions of articular cartilage to injury is discussed.

Loose bodies are a common cause of joint problems in sports, usually because they interfere mechanically with the function of the joint. In some instances, as in osteochondritis dessicans, discomfort in the joint may be associated with the underlying condition. In the case of damage to ligaments minor tears or complete rupture may be present. Tearing, even if quite minor, may damage the proprioceptive feedback mechanism and lead to stable instability. A complete rupture leads to mechanical instability (Williams, 1980).

Vascular and nerve injuries usually complicate other injuries but are occasionally isolated. These conditions usually occur as a result of a direct blow or wound. Venous thrombosis is much more common in vascular injuries, often associated with an episode of overuse. The commonest type of nerve injury is neuropraxia (Williams, 1980).

Bone injuries are quite common in sports, usually as a result of direct violence. As in the case of subchondral fractures, there may be bony damage beneath the articular cartilage associated with ligament injury or with the presence of a loose body jamming between the joint surfaces. Stress fractures of the tibia, fibula and metatarsals are very common in sports as a result of excessive training on hard surfaces (Williams, 1980).

Other Conditions Presented as Sports Injuries

Infections and tumors may appear as sports injuries. In the former the person presents having first experienced pain in the affected tissue during sports activities. As examples of these are: Septic arthritis and acute osteomyelitis. Tumors are classified as benign tumors, borderline and malignant. Examples of tumors are: Rhabdomyosarcoma and osteosarcoma, these being malignant (Williams, 1980).

Etiological Features of Sports Injuries

A clear appreciation of the manner in which an injury condition develops is of great importance in its diagnosis and prospective treatment. In order to facilitate this understanding it is important to have an appreciation of the activities undertaken by individual athletes in their different fields. Markham (1981) differentiates three basic categories of sports activities, each of which has its own different and unique medical problems. These categories are: (1) Physical contact sports, (2) individual performance activities, and (3) repetitive training.

Physical Contact Sports

In general terms, athletes involved in physical contact sports tend to suffer fractures, acute ligament injuries and massive haemotoma in skeletal muscle, all of which are common sequelae of violent contact between competitors or result from subsequent falls. Sport medicine care requires an understanding of the various injuries which can be sustained by physical contact as well as a detailed awareness of the individual function of an athlete within a team. This is well illustrated in the game of soccer where defensive players 'attack the attacker' while attacking players 'attack the ball'. This may be partly responsible for the greater preponderance of injuries sustained by attacking and mid-field players noted in recent surveys of injuries sustained in this particular sport. Pardon (1977) reports that about 70% of all injuries in soccer occur in the lower extremities with strains, pulled muscles, contusions, and torn menisci being the most frequent.

Individual Performance Activities

Individual performers suffer from acute muscle strains and sprains caused by competitive performances which drive individual muscles or muscle groups beyond the point of physiological and mechanical fatigue. The point of fatigue is undoubtedly related to training schedules prior to competition. When the individual athlete demands a performance from the musculo-skeletal system beyond its biochemical limit, the athlete is likely to sustain an injury. Such an injury is related to those self-induced and excessive demands (Markham, 1981).

Repetitive Training

Injuries in training are common to all athletes and have the tendency to be chronic in nature. These injuries may be related to badly designed training schedules, unsatisfactory equipment used during training and pursuing long training schedules in an environment which is not conducive to such activity. Training injuries usually take the form of chronic tendinitis and are often precipitated by a change in training regime or may develop during the early training sessions at the beginning of a sport season where the schedules are too demanding for the individual's overall state of fitness at the time (Markham, 1981). According to Thomas (1981) the development of sport fitness in training must include injury preventive elements, since the occurrence of injuries is counter-productive in performance terms. The fitness status at which training is initiated may lie anywhere along the continuum of fitness, and is often temporarily depressed by injury.

The major parameters of fitness in a modern performance context are:

1. Strength - defined as the ability to exert force.
2. Speed - defined as the ability to react and/or move quickly.
3. Stamina - defined as the ability to maintain function over time.
4. Skill - defined as the ability to select and execute effective and efficient methods of achieving sporting objectives (Thomas, 1981).

Training and Conditioning: A Matter of Injury Prevention

The relatively recent emphasis on health promotion, disease, and injury prevention has its origins in the hypothesis that, in economic terms, 'an ounce of prevention may indeed be worth a pound of cure.' Prevention not only saves lives but improves the quality of life. Prevention may indeed by the cost-effective strategy of maintaining and improving health status (Tolpin, 1981). Thomas (1981) emphasizes that the prevention of sports injuries includes a large element of what is termed 'physical medicine.' The aims of physical medicine in this context may be in terms of strength, speed, stamina, skill and spirit. The physical medicine component of sports medicine is allied with the other dimensions of care including prophylactic, psychiatric, and pharmaceutical. As stated by Bucher (1979) conditioning in athletes helps prevent sports injuries. It requires pre-season training as well as proper maintenance during the season, careful selection and fitting of equipment, protective strapping, counseling about nutrition and rest, proper playing surfaces and facilities, and educators who know correct athletic training procedures and how to coach fundamentals.

Klafs and Arnheim (1981) point out that training must be considered principally in terms of prevention of injury. Muscular imbalance, improper timing because of poor neuromuscular coordination, lack of ligamentous or tendinous strength, lack of flexibility, and inadequate muscle bulk are among the causes of injury directly attributable to insufficient or improper physical conditioning. Inadequate nutrition and psychological readiness are also important factors. Both researchers add that there is a considerable difference between training to reach peak performance in a sport and training to reach a good level of fitness to reduce injury potential. According to Ryan and Allman (1974) the development of proficiency in any sports activity whether the individual is coached or self-taught, depends on the successful interaction of a number of basic abilities or capacities that may be naturally present or acquired by training. It becomes especially important to establish what part deficiency in these basic capacities may play in the production of acute and chronic injuries. Unitas and Dintiman (1979) in their analysis relating risk of injury in major sports to performance, cite that practically all studies indicate a higher rate of injury in late or practice competition when the muscles enter a state of general fatigue. This fatigue causes a reduced blood supply to muscles; fibers become devitalized and easily torn, leaving an individual susceptible to injury. Fatigue also reduces movement efficiency and performance because other muscles are activated in an attempt to rest fatigued muscles, and the result is loss of coordination. Unitas presents these basic principles to be applied to all preventive conditioning programs:

1. During the off-season, exercise should be used that strengthen injury-prone areas such as the ankle, knee, shoulder, and neck.
2. Weight training should be performed after practice to ensure full recovery prior to the practice session the following day. Training prior to practice may weaken muscular support through decreased strength and leave the individual more susceptible to injury.
3. Exercises should be used that are similar to those in the sport for which the individual is training.
4. Following, a substantial training period (preseason or postseason) on vigorous weight-training workout weekly should be used to maintain strength. If a maintenance in-season approach is used, the session should be held following the Wednesday or midweek practice session.
5. Train hard. A high level of cardiovascular conditioning should be maintained. High level conditioning and proper execution of skills are the best protection against injuries.

Ryan (1976) states:

> The prevention of sports injuries may be thought of in terms of the many different types of problems which are presented by the universality of sport; the role it plays and the form it takes in different cultures varies. The beginning of accident prevention is to acquire information about the occurrence of accidents in the activity in which the individual is interested

> and to try to identify the causes of these accidents (pp. 12-13).

For instance in the younger age group, classification by height and weight as well as by age must be stressed in injury prevention. Adrian (1976) suggests that sports programs for girls and women should be based upon lean body weight or physiological age among other factors. The introduction of better training practices based on physiological principles, the prescription of certain techniques of play and performance based on the occurrence of frequent and serious injury, and the introduction of new items of protective equipment must be the major considerations in injury control in sports. In summary, Ryan (1976) stresses that through rules changes, a greater emphasis on safety education, the accumulation of better and more complete information as to how, when, why and to whom sports injuries occur, and more efficient procedures for the screening and qualifications of athletes seem to be the major priorities toward a significant reduction in the numerous injuries in physical recreation and sports participation.

Other researchers present different theories for injury prevention. Maron (1981) advises counseling which includes the following factors: (1) Injury history, (2) joint mobility, (3) muscle power, (4) ligamentous stability, (5) developmental anomalies, (6) body type (mesomorphic; ectomorphic; endomorphic), and (7) motivation for participation. Godshall (1975) puts emphasis in physical examinations, previous competition, good preventive and rehabilitative measure to minimize recurrent injuries and selective training and conditioning programs for the previously injured athlete. O'Donoghue (1976) stresses the importance of conditioning and instruction programs. These should include: (1) Proper techniques for the particular sport, (2) protective equipment, (3) calisthenics, (4) endurance training, and (5) weight training. Also, he recommends that those vulnerable parts of the body should be protected with taping and orthotic supports.

A Brief Outlook on Running Injuries

Many investigators have described the uses of foot orthoses for overuse injuries associated with long distance running (Donovan et al., 1979; Vixie, 1980; Rodgers and LeVeau, 1982; Doxey, 1983; Subotnick, 1983). An orthotic is used to bring the foot into proper alignment when it strikes the ground. The use of orthotics has become popular as a means of preventing and curing the stress related injuries found especially in long distance runners whose malaligned problems become manifested as injuries because of the high forces generated in running (D'Ambrosia and Douglas, 1982). In a survey of 300 runners, Eggold (1981) analyzed the effectiveness of orthotics in controlling symptoms and recurrence of overuse and impact shock injuries. He found that orthotics can be of significant therapeutic value in treating abnormal function and preventing its recurrence.

In running, as in many other sports, attention to four general principles of injury prevention is essential as a first step in reducing the rate of severity of injury. These include: (1) matching of participant to sport, (2) specific training and conditioning, (3) modification of running terrain or surface, and (4) appropriate running equipment. Proper attention to slow progressive training and conditioning and supplemental muscle strengthening and flexibility are the best ways of preventing serious running injuries. Training errors and muscle tendon imbalance appear to be much more associated with overuse injuries (Micheli, 1981).

An overuse injury is a reaction of tissue to stress from excessive motion or impact shock. In a survey of high school and college runners Maron (1978) found the following injuries classified as 'overuse injuries' and their incidence: Knee pains - 60%; lower back aches - 58%; tendonitis of tendo-achilles - 42%; runner's cramps - 41%; shin splints - 40%; weak ankles (ankles sprains) - 30%; toe cramps - 26%; arch pains - 20%; heel pains - 16%; blisters - 25%; stress fractures (leg and/or foot) - 8%; blood blisters - 10%; loss of toenails - 7%; corn and/or callouses - 4%. In another survey of runner's injuries Krissoff and Ferris (1979) found that the knee was most commonly injured comprising 25% of the complaints, followed by the Achilles tendon, shin, ankle, arch, calf, hip, hamstrings and foot. The incidence of injury found in this study showed the following results: Knee - 25%; Achilles tendon - 18%; shin - 15%; ankle - 11%; heel - 10%; arch - 8%; calf - 7%; hip - 7%; hamstrings - 6%; and forefoot - 6%.

Flexibility and Strength Training: Measures of Injury Prevention

Flexibility like strength is quite specific to the joint and its surrounding complementary tissues. Tests and observations indicate that joint looseness is a trait. It varies in its natural degree among individuals (Marshall et al., 1980). Flexibility and strength are independent of each other since strength per se involves only muscle tissue, whereas stretch is concerned with the connective tissue (Klaf and Arnheim, 1981). Flexibility is the range of motion of a joint or how far a joint can flex (bend) and extend (straighten). Muscular strength is defined as one all-out effort against resistance; muscular endurance is the ability to repeat a movement against resistance several times (Shierman, 1980).

Good flexibility increases the athlete's ability to avoid injury. Since it permits a greater range of movement within the joint, the ligaments and other collagenous tissues are not easily strained or torn. Although stretching exercises can reduce muscle injuries and enhance athletic performance, overstretching can also cause injury. There has been some speculation that overflexibility in a joint may result in injury. Some authors feel that because of improper stretching techniques, muscles being stretched can be easily injured. However, views have not been supported by the research literature yet (Nicholas, 1970). Reilly (1981) points out two dimensions of flexibility: Extent or static, and dynamic flexibility. Extent flexibility refers to the range of movement possible at a particular joint or series of joints in functional combination. Dynamic flexibility describes the ability to move part of the body quickly or more rapid and repeated movements involving muscle flexibility.

There appears to be a definite relationship between injury and joint flexibility. The tight or inflexible athlete performs under a considerable handicap in terms of movement besides being much more injury prone. Tight-jointed athletes seem to be more susceptible to muscle strains and tears (Garfield, 1977). Johns and Wright (1962) add that repetitive stretching of the collagenous or fascial ligamentous tissues over a long period of time permits the athlete to obtain an increased range of motion. Liemohn (1978) presented evidence that inflexibility in the hip predisposes one towards hamstrings strains. Wiktorsson et al. (1983) measured the effects of general warming up, massage, and stretching on ranges of motion (ROM) and strength of quadriceps and hamstrings muscles in eight male volunteers with no history of musculoskeletal or neurologic problems. The results of the study showed that thigh muscle strength was not influenced by the experimental procedures. Nevertheless, stretching resulted in a significantly increased range of hip flexion/extension, hip abduction, knee flexion, and ankle dorsiflexion. Only ankle dorsiflexion was influenced by massage or warming-up, whereas stretching affected all muscle groups tested.

Flexibility exercises are used in warming up for training and competition and for more permanent effects as a component of the training program. Justification for this practice is based on a number of studies. Research studies have indicated that there are beneficial effects on performance as the result of warm-up; and that warm-up must be used as a preventive measure as the means of aiding the body to prepare physiologically and psychologically. It is believed that warm-up will not only aid in improving performance but will materially lessen the possibilities of injury (Asmussen and Boje, 1945; Masset et al., 1961; Jensen, 1977). The main purposes of warm-up are to raise both the general body and the deep muscle temperatures and to stretch the ligaments and other collagenous tissues in order to permit greater flexibility. For each degree of internal temperature rise there is a corresponding rise in the rate of metabolism of about 13%. There is a speed-up in the transmission of nerve impulses with the result of an increase in the athlete's physical working capacity (Martin et al., 1975).

There are four popular stretching techniques used by athletes in training programs. These are: Ballistic; passive; contract relax; and static. The static technique is highly used and recommended. Compared to the other techniques, static stretching produces the least amount of tension (Beaulieu, 1981). Many stretching techniques have been developed by athletes, dancers, and physical therapists, including ballistic or "bouncing" methods, slow movements such as those used in dance, static stretches, and proprioceptive neuromuscular facilitation (PNF) procedures. In a study conducted in 21 women aged 17-23 years, actively involved in gymnastics for an average of 6 years, Moore and Hutton (1980) determined the level of muscle relaxation achieved during static and modified PNF stretch procedures electromyographically (EMG). Subjects produced hamstring stretch by static, contract-relax (CR), and contract-relax with agonist contraction (CRAC) methods. In 12 subjects, the CRAC method elicited significantly greater hamstring EMG activity than the other methods. The static method produced a higher level of muscle activation in only 1 subject. The CRAC technique, while apparently contributing to increased muscle stiffness, produced the largest gains in hip flexion. The investigators concluded that the CRAC technique appears to be best for achieving maximum flexibility in experienced, well-motivated subjects when enough time is available to practice the procedure. If comfort and limited training time are major considerations, the static method appears to be more desirable. Continuing research in mechanical efficiency to compete successfully and attain excellence in athletic performance through effective flexibility procedures have been accomplished. Improvements and comparisons between techniques have been presented (Cornelius, 1981). Schultz (1979) states:

> For the athlete, static stretching does improve flexibility in relative safety, offers prevention and therapy for muscular distress, and may, though the proposition is hard to prove, reduce the risk of injury (p. 117).

One of the main objectives in an athlete's training program to have the assurance for a successful athletic performance and the guarantee for one without a serious muscle injury is introducing a strength building program in any phase of the training process. Strength reflects the ability to apply force and overcome resistance. It is a function of the neuromuscular-skeletal system and closely related to muscle cross-sectional area. Muscles act as agonists, antagonists and synergists to cause, permit and assist movement. Unwanted actions are prevented by muscles acting as stabilizers (Reilly, 1981).

Imperfect strength development in particular muscle groups may predispose one to local injury. This is because muscles secure the integrity of joints by crossing the joint or having their tendons inserted in the joint (Scriber, 1978). Smillie (1978) recommends that knee stability is considerably enhanced by strengthening the quadriceps which safeguards the joint in conjunction with the cruciate and collateral ligaments. Quadriceps exercises are especially effective in rehabilitation of knee injuries as the joint is further unstable if strength in the quadriceps muscles subsides

(Paulos et al., 1981). Cahill and Griffith (1978) showed that pre-season total body conditioning significantly reduces the frequency and severity of knee injuries in high school football players. A pre-season strength testing profiling is given to most varsity athletes at Eastern Illinois University as part of an injury prevention program to insure that individuals exercise specific vulnerable areas. The staff in charge administers tests for ankle strength, vastus medialis strength, hamstring strength, and hamstring flexibility (Aten, 1978).

Uneven distribution of strength likely predisposes one to injury. This manifestation exists because disproportionate development exists in one of the agonist/antagonist pairs. Burkett (1970; 1975) manifests that a greater susceptibility to hamstring strains is found when individuals have an inappropriate flexor-extensor strength ratio or when an extensive attachment of the biceps femoris to the femur exists, coupled with the strength imbalance. The hamstring strength ratio recommended by several investigators is 60% as strong as the quadriceps, but there are differences in opinion (Klein and Allman, 1969; Nosse, 1982; Parker et al., 1983). Uneven distribution is also evident in contra-lateral differences in strength acquisition. Imbalance has serious consequences in the lower extremities since it may prompt locomotion (Klein, 1978).

Though specific unilateral demands are imposed in certain athletic performances, conditioning must involve bilateral strength training to avoid uneven gains. Improving the strength of abdominal and back muscles prevents lumbar pain and serves as a remedy for low back pain conditions (Mirkin and Hoffman, 1978). Bodnar (1977) reported a relationship between the incidence of shoulder and neck injuries and weakness of the cervical muscles in college football players and recommended strength exercises for cervical and trunk muscles as protective measures.

Strength is exhibited in various ways, which must be reflected in the evaluative techniques. Wilmore (1977) stresses the importance in the understanding of the various ways of strength assessment. When talking about any strength-training program, the type of program and the type of equipment used arise different opinions and burning discussions. Theoretically, Nautilus equipment should provide an optimal training stimulus for developing muscle strength and endurance because of its mechanical design, with maximal resistance provided through the full range of motion. Sanders (1980) compared training using Nautilus and traditional barbell equipment in college-age men who trained 3 days a week for 5 weeks in 3 minute bouts of rhythmic isometric exercise involving the forearm extensors and shoulder flexors. The researcher found that the two types of training appeared to be equally effective in developing muscle strength and endurance. Smith and Melton (1981) studied the ability of isokinetic exercise at slow and fast speeds (accommodating resistance) and of isotonic variable-resistance training with Nautilus equipment to increase the strength of the quadriceps and hamstrings in 12 boys, aged 16 to 18 years, who were not conditioned athletes. Before and after the 6 week study, isometric strength of the knee extensors and flexors was tested in all boys. To test functional motor performance, each boy performed a standing broad jump, a standing vertical jump, and a 40 yard dash. The findings of this study established that variable-resistance isotonic exercise (Nautilus) is not an inferior method of training, but isokinetic exercises (Cybex II) at high speeds produce much better results. This conclusion is sustained by Pipes and Wilmore (1975). Isotonic exercise has been found preferable to isometric (Clarke, 1973); though both methods have shown equal effectiveness when equated for load and duration (Coleman, 1969).

Women appear to have the same biologic ability as men to develop strength in a high-intensity weight training program (O'Shea and Wegner, 1981). However, strength training does not result in substantial gains in muscle mass in women, and the problem of a reduction in capillary-to-fiber size ratio associated with hypertrophy would be relatively insignificant (Heyward, 1980). Borowicz (1978) gives a word of advice to coaches of female athletes concerning weight training. She points out that coaches should start using weights as part of their female athletes repertoire. Women benefit not only from an identifiable loss of adipose tissue, but also an improvement in strength, from which follows speed and endurance. Weight training in women develops muscles in need of growth, improve tonicity, and brings about coordinated movements.

Research Efforts and Findings: Injuries Among Female Athletes

With the new emphasis on women's sports, there has also been much speculation regarding female athletic injury potential. As recently as 10 years ago, very little was known about possible types of athletic injuries to women. There was a question as to whether they would be different from those sustained by men (Haycock, 1981).

Harris (1977) indicates that statistics tend to show that females are more vulnerable to injury than males. However, when the female athlete is adequately conditioned and trained, the injuries become sport-related rather than sex-related. Harris adds that two factors make the female better equipped to withstand contact: (1) Her sex organs are internally protected, and (2) her overlay of subcutaneous fat provides a padding for protection of bony joints and protrusions. Campbell (1980) points out that involvement in athletics does not bring greater risk of injury to women than men. Recent surveys of sports injuries conclude that in general female athletes sustain the same numbers as their male counterparts. Campbell states that the female athlete is certainly at no greater risk than the male and the many benefits accruing from participation outweigh the possible disadvantages.

The acceptance of risk in sports is a natural human characteristic. Risk taking is a very personal factor influenced largely by personal opportunities and responsibilities. In sports it is available at all levels from low risk activities to dangerous highly competitive events (Miles, 1981). Hayes (1974) defines a risk factor as the susceptibility of a participant to injury. The problem appears to be threefold: (1) Identification of the risks inherent in sports; (2) differentiation between acceptable risks and undue risk taking; and (3) the implementation of preventive measures to reduce the incidence and severity of injuries to the participants. An approach to this problem was taken by Clarke (1966) when he defined a 'calculated risk' as an assessment of the hazards in the sport being offered relative to the sports purported benefits. This definition implies that it is possible to assess the hazards in sports, and, secondly, that it is possible to ascertain the purported benefits of the sport. According to Haddon (1966):

> Exposure to risk, incidence and prevailing injuries and benefits and differences between injured and non-injured and participants and non-participants must be measured for casual inferences and preventative action (p. 885).

The casual participant will probably have a different approach to an activity than the highly competitive athlete. Also, what motivates a female may be quite different than what motivates the male.

Women are vulnerable to the same musculoskeletal problems that occur in men but carry a predelection for certain injuries based on the female anatomy. Women tend to suffer more sprains and strains than any other type of injury (Means and Siegel, 1982). It has been speculated that peculiarities of the female anatomy account for women's propensity for certain types of injuries. In an article concerning female knee injuries, Glick (1973) points out that there is no anatomical difference between male and female knees. But he presents the following clinical findings: (1) Women do not appear to tolerate pain as well as men, (2) patella injuries are more frequent in women, and (3) women's knee joints generally are looser than men's. Also, the kneecap is more flexible laterally, and it is more hyper-extensible.

It has been stated that women have a wider pelvis, and therefore, the angle of the femur to the pelvis is more acute than in men. The assumption is that the wider pelvis contributes to the potential problem of subluxation or dislocation of the patella, which can result ultimately in chondromalacia (Bauman et al., 1982). Because of their wider pelvis, women have a more acute angle between the axis of the patellar ligament and the quadriceps mechanism, and the contraction of the quadriceps tend to pull the patella laterally. As a result, women have an increased incidence of lateral displacement of the patella, which results in chondromalacia (Haycock, 1981). In a group of patients with the diagnosis of recurrent patellar subluxation seen in his office over a period of 25 years, Powers (1979) found that 67% were female and 33% were males. Smillie (1978) further stated that recurrent patellar subluxation is the most common cause of internal derangement of the knee in women, especially young women.

Military programs and the interscholastic athletic programs are the two major sources of information on injuries to women resulting from physical activity. Several studies have been conducted involving male and female basic trainees. Kowal (1980) found that approximately 25 percent of male subjects and almost 60 percent of female subjects suffered overuse injuries to the lower extremities during the eight week basic training cycle. The injury data was correlated with prior fitness measures suggesting that the major causes of injury in women might be attributed to the lack of conditioning, greater percent of body fat, and to the rapid introduction of heavy training which does not allow for a progressive exposure to stress. It appears that women in the military were not in condition to perform to male standards at the onset of training. They needed additional time for their bodies to respond to the stresses of a vigorous training program. Nearly all of the military studies to date clearly demonstrate that female trainees are highly susceptible to stress-related injuries in basic training (Kowal, 1980; Protzman, 1979; Reinker and Ozburne, 1979).

A comparison of men's and women's professional basketball injuries was made by Zelisko et al. (1982). Injuries sustained over two consecutive seasons in two professional basketball teams, one men's and one women's, were reviewed. In analyzing relationships between sex, nature of injury, and body part injured, the researchers found that women sustained significantly more knee and thigh injuries as well as sprains, strains, and contusions. Men had significantly more muscle spasms. The women's injury frequency was 1.6 times that of men. The body part most frequently injured on both teams was the ankle.

Requa and Garrick (1981) compared the injury patterns of an interscholastic track and field program in both sexes. In this two year study in four high schools, 308 boys and 208 girls participated, and they sustained 101 and 73 injuries, respectively. Seventy-five percent of the injuries occurred during practice. Musculotendinous injuries were the most common and 85% of the injuries involved the lower extremities. The thigh was the most common site of injury for both sexes, followed by the leg and knee. Thigh strains, primarily involving the hamstrings, were common, constituting 55% and 52% of the strains and 28% and 21% of all injuries for boys and girls, respectively. Ankle injuries were relatively uncommon, constituting only 6% of boys and 10% of girl's injuries. More than 70% of the track-event injuries in girls occurred in distances of 440 yards or less, compared with only 36% in boys. There were differences arising from other sources due to the variation of events. However, four out of five injuries occurred in track events as opposed to field events and the injury patterns between boys and girls differed considerably.

Moretz and Grana (1978) identified injuries sustained by male and female participants in a basketball program of an Oklahoma City high school. Injuries occurred more frequently in practice, 39 for the girls and 6 for the boys, than in games. The girls had a higher injury rate and sustained more injuries. The girls' injury rate was .72 injuries per player and the boys' was .16 per player. Fractures were uncommon.

Clement et al. (1981) reviewed the clinical records of two sports physicians who identified 1,819 injuries in 1,650 running patients during 1978 through 1980. The records revealed that both sexes had a similar distribution of injuries by major anatomical sites (hips, thigh, knee, leg, ankle, foot), but certain specific conditions were observed more frequently in one sex or the other. The knee was the most common site of complaint, accounting for 42 percent of all injuries, and patellofemoral pain syndrome was the most frequent disorder, accounting for 26 percent of all injuries. This study found that men sustained more Achilles tendinitis and patellar tendinitis, while women suffered more from so-called patellar pain and tibial stress syndromes.

Shively et al. (1981) compared the injury rates between male and female high school athletic participants in eight similar sports. The study revealed that sprains and strains were the most frequent injuries. Female athletes had a significantly greater number of knee injuries and major ankle injuries than male athletes, but the pattern of injury for other major anatomical sites was similar. There were no significant differences in overall incidence of injury between male and female athletes, although the women suffered a greater number of serious injuries.

The National Athletic Injury/Illness Reporting System (NAIRS) is a national surveillance system that compiles intercollegiate and interscholastic injury data submitted by athletic trainers or other health care personnel. A preliminary overview of injuries among collegiate women athletes during NAIRS's first three operational years (1975 through 1978) indicated that injuries to women athletes are essentially related to sport, not gender. The data reveals that matched sports demonstrated similar patterns of injury for men and women and that the major differences of injury patterns were between sports. It appears from this study that there are more dissimilarities between women's sports than between comparable men's and women's sports (Clarke and Buckley, 1980).

Another study using NAIRS's records was conducted by Whiteside (1980) with data from the 1975-76 and 1976-77 seasons. The study characterized and analyzed injury patterns in men's and women's sports as basketball, baseball/softball, and gymnastics. Two specific areas were involved in this research study: Game and practice-related injuries and injuries according to body part. The investigator found more similarities than differences between the sexes.

Health concerns of women in sports are expected to rise proportionately among women participating in sports especially with those engaged in athletics. The approach to the problem of sport trauma is expanding. Haycock (1981) reports that the most common injuries to female athletes are to the ankles and knees, with back injuries, compartment disorders, fractures and dislocations occurring essentially in that order. Albohm (1981) points out that sprains to ligaments and strains to muscle tissue have been shown to be the most common injuries. The quadriceps, hamstrings and groin musculature are the muscle groups most often strained. She ranks the ankle above the knee in terms of injury incidence. Devine (1975) and Kulund (1982) indicated a number of shoulder injuries because of a lack of conditioning and weak musculature in that particular area. Graham and Bruce (1978) conducted an injury survey among twenty-nine colleges in Virginia involving 129 female athletic teams during the 1974-75 school year. The study indicated that the most common injuries in all sports were sprains, strains, contusions, and simple fractures. Of these injuries, 44 percent were reinjuries and nearly twice as many injuries occurred to the right side of the body as to the left side. The results of the survey support previous findings which indicate that the most common injuries involve the lower extremity, specifically the ankle and knee.

Kosek (1973) reported on injury rates and types in a two-year surveillance study on women participating in intercollegiate athletics at the University of Washington in Seattle. Kosek hypothesized that the three sports with the greatest potential for injury were field hockey, basketball, and track and field. The most common injuries in women competing in those sports were sprains, muscle strains, tendinitis, contusions, and patellar or knee problems. Haycock and Gillete (1976) studied the susceptibility of women athletes to injury by combining the results of three independent studies. From the first survey, the researchers found that the greatest number of injuries occurred in basketball, volleyball, field hockey, and gymnastics, while the fewest injuries occurred in golf, swimming, squash, and archery. The data was compiled from respondents covering 19 major sports.

Types of injuries were compiled by Gillete from a second survey sent to 300 certified trainers in the United States who were asked about specific injuries recorded in each sport. Haycock also sent a third survey to the same 300 trainers to determine if the injuries from Gillete's survey occurred primarily because the athlete was female. Haycock asked for opinions concerning the participation of the female in contact sports including football, soccer, and ice hockey. Results from Gillete's survey on types of injury showed that the more serious injuries such as major fractures, head injuries, and dislocations occurred in basketball, field hockey, softball, and gymnastics. The most common injuries to female athletes from Gillete's survey related to types and body part affected are depicted as follows: Sprained ankles, knee, contusions, lower back, muscle pulls and strains, shin splints, fractures, hand and finger, lacerations, dislocations, blisters, soft tissue, concussions, wrist, and eye.

Albohm (1976) conducted a study on high school female athletes for 7 different sports throughout the United States. Injury questionnaires were used to collect data on types and number of injuries, body part affected, and sports season when the injury occurred. The results of this study are as follows: In basketball, ankle sprains occur most frequently, with twice as many sprains occurring in practice as in games. In volleyball, contusions are most common, also occurring mostly in practice rather than games and affecting most often the knees and elbows. Several finger sprains were recorded and knee and elbow abrasions were common. Most track and field injuries fell into three categories: (1) Muscle strains of the quadriceps, hamstring and groin areas, (2) abrasions of the extremities, and (3) shin splints. A significant number of ankle sprains were recorded in track and field during practice, along with some blisters. The high incidence of shin splints among women athletes, especially in track and field, are attributed to several factors: The mechanics of walking, weight-bearing techniques caused by types of shoes worn, and/or lack of proper conditioning of the lower leg. In gymnastics, several types of injuries occurred frequently, such as contusions to the hip area, blisters (especially to the hands), fractures, and dislocations. The elbow was the joint most often dislocated. Tennis brought on blisters of the feet most frequently and some upper body muscle strains. Swimming caused muscle strains of the upper body, specifically in the shoulder, and a large number of leg muscle cramps were reported. In golf, blisters of the hands and feet were most common.

In a study conducted by Ritter et al. (1980) a total of 256 injuries were incurred by women participating in one of six varsity sports (Field hockey, basketball, gymnastics, volleyball, tennis, and softball) offered at Indiana University during the 1977-78 season. Gymnastics accounted for nearly 40% of the injuries, while tennis accounted for only 3%. The leading causes were determined. The ankle was involved in the greatest percentage of injuries. Nearly 70% of all injuries reported in this study were by females 19 years old or younger. The younger female athlete accounted for 85% of all the tumbling injuries in gymnastics, as well as 73% of all the dive-roll injuries in volleyball. The researchers suggested more extensive conditioning programs as preventive measures.

In order to learn more about types of injuries in women, a group of 110 women varsity athletes aged 17 to 23 was followed for one season by Eisenberg and Allen (1978). These athletes participating in eight varsity sports had a total of 114 injuries over the period from September 1, 1975 through May 30, 1976. Ankle and knee injuries made up the majority of injuries in all sports (55.2%), except golf, with deltoid tears being the most common severe ankle sprain. Soft-tissue contusions and lacerations of the lower extremities were most frequently found in volleyball and softball players. Softball players reported with three finger sprains and two shoulder muscle strains, the latter of which were probably related to an abbreviated conditioning program and old injuries. Members of the track team and gymnasts incurred the highest number of sprains and strains, the injury which was most frequently reported (60%). Head, neck, and face injuries were generally minor, the most serious being two nasal fractures in basketball players, one of which was subsequently refractured.

Bobb (1975) conducted a survey primarily to determine the number and type of injuries occurring in women's intercollegiate basketball. Also, an effort was made to determine the circumstances of each injury, the body part affected, the days of disability, and whether or not the services of a physician were required. The schools surveyed were members of Southern Region II of the Association for Intercollegiate Athletics for Women, which includes 72 colleges and universities in Kentucky, North Carolina, South Carolina, Tennessee and Virginia, 55 of which participated in the survey (a 76% return). A total of 245 injuries were reported. The number of injuries ranged from 1 to 14 per school, an average of 4.8 injuries per school. One hundred and forty-four of the injuries (59%) occurred during practice, 91 (37%) occurred during or preceding a game. The ankle was by far the most frequently injured body part, accounting for 35% of the injuries. Injuries to the knees, fingers and legs each accounted for 16% of the injuries reported. Sprains were the most common injuries with 145 (59%). Contusions were the second most frequent injury with 31 (13%) being reported. In this study an attempt was made to determine the degree of severity of each injury by reporting the number of days of disability, and whether or not a physician was consulted. The days of disability for injuries ranged from 0 to 12 weeks. A total of 1,332 days of disability were reported, averaging 5.4 days per injury. One hundred and twenty-five (51%) of the reported injuries required the services of a physician; 111 of the injuries did not require a physician's services.

Possible injuries to the female breast have been of concern, but the literature states that injuries to the breasts are the least common and where such injuries do occur they are minor taking the form of contusions (Gillete, 1975). Hunter and Torgan (1982) conducted a survey for the 1976 through the 1981 seasons at the University of Washington reviewing the injury records among female athletes participating in the school intercollegiate program. In a questionnaire given to 85 female athletes, the investigators found that of the 85 women specifically questioned about breast pain or breast injury during competition (participating in varsity track and field, basketball, crew, volleyball, and tennis), 20% reported occasional breast pain usually associated with cold weather or the onset of their menstrual periods. Only one woman sustained a direct blow to her breast, but the area of ecchymosis cleared within ten days. Both researchers found that no woman reported any complaint to trainers or team physicians during the five years related to breast problems.

Summary

It would appear, from the review of the literature, that injuries to women in athletics may be due to a number of causative factors. The following highlights of this chapter represent the findings of the research from the review of the literature:

(1) In recent years, the role of women in athletic participation has been changing, especially because of the contribution and impact of Title IX on women's and men's sports participation.

(2) Physiological research reveals that when compared to male athletes, highly trained female athletes are very similar in their capacities with respect to exercise.

(3) The literature is divided on the definition of the term 'injury.' The definitions vary according to actions and circumstances and interactions involved between the victim and environment.

(4) A general development in the level of skill and proficiency in any sport activity will minimize acute and chronic sports injuries.

(5) Research has suggested that warm-up before training session or before any sport-directed activity is of great value for the prevention of muscle injury.

(6) The literature is divided on the subject of flexibility and strength training, specifically on which of the techniques for flexibility and which of the programs for strength development

are the best.

(7) Research on flexibility and strength training is abundant and some authors believe that there is an association between a lack of flexibility and muscle strength imbalance, and the incidence of muscle injury.

(8) The desirable hamstrings-quadriceps strength ratio within the same leg is placed by many investigators as 60 percent, but some discrepancy still exists.

(9) There are very few research studies dealing with the incidence of sports injuries trends and patterns strictly at school and college settings.

(10) The literature is more inclined to reveal comparisons between men's and women's injuries especially in comparable sports.

(11) The sports medicine literature is not conclusive on the efficacy of health care procedures at college and universities toward minimizing the amount of varsity related sports injuries.

(12) Available information has been gathered in small and limited amounts largely from presumably reliable sources concerning injury occurrence in specific populations. This information is presented in terms of injury exposure rates for commonly known sports such as basketball, gymnastics and track and field.

CHAPTER III

METHODS AND PROCEDURES

This chapter describes the procedures followed in this study. The procedures are described in terms of: a) The selection and/or gathering of data, b) Operational procedures, and c) Analysis of data.

Selection and/or Gathering of Data

The researcher contacted the athletic trainers of the varsity female intercollegiate athletics teams at Oklahoma State University and The University of Oklahoma. By this means permission was obtained to gather data from the trainer's records. The information gathered via the records was treated confidentially and athlete's names were not noted. The athletes were not contacted by the researcher and the data for this study was based strictly on the information accumulated for sports injuries, both treatment and rehabilitation, for the years 1979-80, 1980-81 and 1981-82 using only the female athletic training records at Oklahoma State University and The University of Oklahoma.

Operational Procedures

Because of the geographical distance between schools and the time involved in the traveling to The University of Oklahoma at Norman, the researcher received permission to photocopy each of the relevant pages from the trainer's records corresponding to the purpose of the study. Photocopies were taken for each year related to the research. This procedure was followed at both schools. To avoid repetition in the counting of injuries, the knowledge and expertise of the trainers regarding the recognition of an injury and each patient was utilized. At The University of Oklahoma this was accomplished with the help of one student trainer. The raw data for this study was tabulated separately for each year of competition and for each sport analyzed. Tally marks were used to accurately count the injuries taking into consideration the various body parts since body parts were the only descriptors for injuries in both school's records. Information regarding the nature of the injury and type of injury was not present. To differentiate injuries from each sport in the records, a color was given to each one of the sports studied. Utilizing this procedure through all the pages of the record books, the color red for basketball, blue for track and field and yellow for softball was assigned to The University of Oklahoma records. For the Oklahoma State University records the color blue for basketball, green for track and field and purple for softball was assigned. Tracing a colored circle around the sport's name in the pages served as an effective method for injury identification in each particular sport, and an accurate resource to avoid repetition in the counting.

Analysis of Data

The primary purpose of the analysis of the data was twofold: Description and comparison. The descriptive portion consisted of an analysis of the injuries under three major areas, each one sub-divided into six anatomical areas. The data was tabulated in the following format: (1) Joints, referred as: Neck, shoulder, back, elbow, wrist, hip, knee, and ankle; (2) Body part affected, referred to as: Upper arm, lower arm, hand, groin, upper leg, lower leg, and foot; and (3) Miscellaneous sites, referred to as: Thumb, eye, arch, heel, achilles tendon, finger, toes, abdomen, and gluteal. The comparative portion consisted of a comparison of the frequency distributions and totals of each of the major descriptive areas and their anatomical sub-divisions between the two schools. This comparative technique was used to determine if any substantial difference existed between both schools. For each category and its respective anatomical area, a distribution of injuries by percentage was computed. This distribution contains the results for each school, each year compared and each sport analyzed. For each category, comparisons were made in each of the athletic years separately and also combined. Conclusions were drawn from the comparisons based on the percentage differences between both schools. The mathematical computation of a percentage unit was made using the following formula:

$$\frac{\text{frequency of injuries}}{\text{total frequency}} = \text{proportion of injuries X 100}$$

Conclusions and comparisons were presented based on a 10% criteria in the difference of the computations between both schools to establish any substantial differences.

CHAPTER IV

RESULTS AND DISCUSSION

The problem in this study was to determine if any substantial difference existed for athletic injury patterns or trends between Oklahoma State University and The University of Oklahoma. Three female varsity intercollegiate sports and three athletic-competitive years were analyzed and compared. This chapter presents an incidence analysis of the data. The percentages for the frequencies of the selected analytic criteria were computed. The results of the calculated percentages are presented in Table I to Table VIII.

Results

The three varsity sports evaluated for this study were basketball, softball, and track and field, and three consecutive athletic seasons were analyzed. The seasons were the athletic competitive years for: 1979-80, 1980-81, and 1981-82. Oklahoma State University showed 481 injuries during these three years. This represents a substantial amount of injuries for three sports. This incidence of injuries comes from a total of 141 participants in the three years. The rosters at Oklahoma State University for the years in this study were made up of: Athletic year 1979-80: Basketball - 12 athletes, softball - 16 athletes, track and field - 14 athletes; athletic year 1980-81: Basketball - 13 athletes, softball - 17 athletes, track and field - 22 athletes;

TABLE I

TOTAL PERCENTAGE OF INJURIES IN THE 1979-80 ATHLETIC YEAR BY SCHOOL AND MAJOR AREAS AFFECTED

	Oklahoma State University			The University of Oklahoma		
	Softball	Basketball	Track & Field	Softball	Basketball	Track & Field
Joints	64%	75%	38%	45%	50%	30%
Body Parts	28%	6%	51%	36%	28%	45%
Miscellaneous Sites	8%	19%	12%	18%	21%	24%
Total	100%	100%	100%	100%	100%	100%

TABLE II

TOTAL PERCENTAGE OF INJURIES IN THE 1980-81 ATHLETIC YEAR BY SCHOOL AND MAJOR AREAS AFFECTED

	Oklahoma State University			The University of Oklahoma		
	Softball	Basketball	Track & Field	Softball	Basketball	Track & Field
Joints	74%	79%	33%	65%	65%	45%
Body Parts	26%	18%	60%	31%	28%	48%
Miscellaneous Sites	0%	3%	7%	4%	7%	7%
Total	100%	100%	100%	100%	100%	100%

TABLE III

TOTAL PERCENTAGE OF INJURIES IN THE 1981-82 ATHLETIC YEAR BY SCHOOL AND MAJOR AREAS AFFECTED

	Oklahoma State University			The University of Oklahoma		
	Softball	Basketball	Track & Field	Softball	Basketball	Track & Field
Joints	67%	82%	43%	86%	66%	40%
Body Parts	31%	9%	47%	7%	31%	47%
Miscellaneous Sites	2%	9%	10%	7%	3%	12%
Total	100%	100%	100%	100%	100%	100%

TABLE IV

TOTAL PERCENTAGE OF INJURIES IN THE THREE SPORTS BY SCHOOL AND MAJOR AREAS AFFECTED

	Oklahoma State University			The University of Oklahoma		
	1979-80	1980-81	1981-82	1979-80	1980-81	1981-82
Joints	51%	50%	57%	40%	58%	55%
Body Parts	38%	46%	36%	39%	35%	37%
Miscellaneous Sites	11%	4%	7%	21%	7%	8%
Total	100%	100%	100%	100%	100%	100%

TABLE V

DESCRIPTIVE DISTRIBUTION OF INJURIES SUSTAINED IN BASKETBALL BY ANATOMICAL SITES (FREQUENCY AND PERCENTAGE OF TOTAL INJURIES)

		Oklahoma State University			The University of Oklahoma		
		1979-80	1980-81	1981-82	1979-80	1980-81	1981-82
Joints:	Neck	0 (0%)	1 (3%)	0 (0%)	0 (0%)	1 (3%)	1 (3%)
	Shoulder	0 (0%)	0 (0%)	1 (4%)	2 (14%)	2 (7%)	2 (5%)
	Back	1 (6%)	3 (9%)	1 (4%)	0 (0%)	4 (13%)	8 (21%)
	Elbow	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (7%)	0 (0%)
	Wrist	1 (6%)	0 (0%)	1 (4%)	0 (0%)	0 (0%)	0 (0%)
	Hip	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (3%)	1 (3%)
	Knee	6 (37%)	10 (30%)	9 (39%)	4 (28%)	4 (13%)	5 (13%)
	Ankle	4 (25%)	12 (36%)	7 (30%)	1 (7%)	5 (17%)	8 (21%)
Body Parts:	Upper Arm	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (7%)	1 (3%)
	Lower Arm	1 (6%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Hand	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (3%)
	Groin	0 (0%)	1 (3%)	0 (0%)	0 (0%)	0 (0%)	1 (3%)
	Upper Leg	0 (0%)	2 (6%)	0 (0%)	0 (0%)	2 (7%)	3 (8%)
	Lower Leg	0 (0%)	2 (6%)	2 (9%)	2 (14%)	1 (3%)	3 (8%)
	Foot	0 (0%)	1 (3%)	0 (0%)	2 (14%)	3 (10%)	3 (8%)
Miscellaneous Sites:							
	Thumb	1 (6%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Eye	1 (6%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Arch	1 (6%)	0 (0%)	2 (9%)	0 (0%)	1 (3%)	1 (3%)
	Heel	0 (0%)	1 (3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Achilles	0 (0%)	0 (0%)	0 (0%)	3 (21%)	0 (0%)	0 (0%)
	Finger	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Toes	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (3%)	0 (0%)
	Abdomen	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Gluteal	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
TOTAL		16	33	23	14	29	38

TABLE VI

DESCRIPTIVE DISTRIBUTION OF INJURIES SUSTAINED IN SOFTBALL BY ANATOMICAL SITES (FREQUENCY AND PERCENTAGE OF TOTAL INJURIES)

		Oklahoma State University			The University of Oklahoma		
		1979-80	1980-81	1981-82	1979-80	1980-81	1981-82
Joints:	Neck	0 (0%)	3 (7%)	2 (3%)	1 (3%)	1 (4%)	0 (0%)
	Shoulder	5 (13%)	7 (18%)	8 (13%)	4 (12%)	5 (19%)	4 (28%)
	Back	4 (10%)	5 (13%)	5 (9%)	2 (6%)	2 (8%)	2 (14%)
	Elbow	3 (8%)	1 (2%)	5 (9%)	0 (0%)	2 (8%)	1 (7%)
	Wrist	2 (5%)	0 (0%)	0 (0%)	0 (0%)	1 (4%)	0 (0%)
	Hip	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (4%)	0 (0%)
	Knee	8 (20%)	8 (19%)	15 (26%)	4 (12%)	3 (11%)	3 (21%)
	Ankle	3 (8%)	7 (18%)	4 (7%)	4 (12%)	2 (8%)	2 (14%)
Body Parts:	Upper Arm	2 (5%)	1 (2%)	3 (5%)	1 (3%)	1 (4%)	0 (0%)
	Lower Arm	3 (8%)	0 (0%)	2 (3%)	2 (6%)	0 (0%)	0 (0%)
	Hand	0 (0%)	1 (2%)	1 (2%)	0 (0%)	0 (0%)	0 (0%)
	Groin	1 (3%)	3 (7%)	1 (2%)	0 (0%)	0 (0%)	0 (0%)
	Upper Leg	2 (5%)	5 (12%)	7 (12%)	4 (12%)	5 (19%)	1 (7%)
	Lower Leg	3 (8%)	1 (2%)	2 (3%)	2 (6%)	1 (4%)	0 (0%)
	Foot	0 (0%)	0 (0%)	2 (3%)	3 (9%)	1 (4%)	0 (0%)
Miscellaneous Sites:							
	Thumb	0 (0%)	0 (0%)	0 (0%)	1 (3%)	0 (0%)	1 (7%)
	Eye	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Arch	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Heel	2 (5%)	0 (0%)	0 (0%)	3 (9%)	0 (0%)	0 (0%)
	Achilles	1 (2%)	0 (0%)	1 (2%)	1 (3%)	0 (0%)	0 (0%)
	Finger	0 (0%)	0 (0%)	0 (0%)	1 (3%)	1 (4%)	0 (0%)
	Toes	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Abdomen	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Gluteal	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
TOTAL		39	42	58	33	26	14

TABLE VII

DESCRIPTIVE DISTRIBUTION OF INJURIES SUSTAINED IN TRACK AND FIELD BY ANATOMICAL SITES (FREQUENCY AND PERCENTAGE OF TOTAL INJURIES)

		Oklahoma State University			The University of Oklahoma		
		1979-80	1980-81	1981-82	1979-80	1980-81	1981-82
Joints:	Neck	2 (3%)	4 (3%)	5 (6%)	0 (0%)	0 (0%)	1 (2%)
	Shoulder	1 (1%)	4 (3%)	3 (4%)	0 (0%)	1 (3%)	1 (2%)
	Back	5 (7%)	12 (10%)	6 (7%)	3 (9%)	2 (7%)	4 (7%)
	Elbow	0 (0%)	2 (2%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Wrist	2 (3%)	1 (>1%)	1 (1%)	1 (3%)	0 (0%)	1 (2%)
	Hip	0 (0%)	1 (>1%)	1 (1%)	0 (0%)	0 (0%)	1 (2%)
	Knee	3 (4%)	11 (9%)	10 (13%)	5 (15%)	6 (21%)	8 (14%)
	Ankle	13 (19%)	6 (5%)	8 (10%)	1 (3%)	4 (14%)	7 (12%)
Body Parts:	Upper Arm	1 (1%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)	0 (0%)
	Lower Arm	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Hand	1 (1%)	0 (0%)	0 (0%)	1 (3%)	0 (0%)	1 (2%)
	Groin	1 (1%)	1 (>1%)	0 (0%)	0 (0%)	0 (0%)	1 (2%)
	Upper Leg	8 (11%)	24 (20%)	16 (20%	4 (12%)	6 (21%)	9 (16%)
	Lower Leg	21 (30%)	44 (30%)	15 (19%	8 (24%)	6 (21%)	12 (21%)
	Foot	3 (4%)	4 (3%)	5 (6%)	2 (6%)	2 (7%)	4 (7%)
Miscellaneous Sites:							
	Thumb	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Eye	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Arch	5 (7%)	4 (3%)	0 (0%)	0 (0%)	0 (0%)	2 (3%)
	Heel	0 (0%)	1 (>1%)	3 (4%)	3 (9%)	0 (0%)	2 (3%)
	Achilles	2 (3%)	1 (>1%)	3 (4%)	3 (9%)	0 (0%)	2 (3%)
	Finger	1 (1%)	1 (>1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Toes	0 (0%)	0 (0%)	1 (1%)	2 (6%)	0 (0%)	0 (0%)
	Abdomen	0 (0%)	1 (>1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Gluteal	0 (0%)	0 (0%)	1 (1%)	0 (0%)	2 (7%)	1 (2%)
TOTAL		69	122	79	33	29	57

TABLE VIII

DESCRIPTIVE DISTRIBUTION OF INJURIES SUSTAINED FOR THE THREE SPORTS COMBINED (FREQUENCY AND PERCENTAGE OF TOTAL INJURIES)

		Oklahoma State University			The University of Oklahoma		
		1979-80	1980-81	1981-82	1979-80	1980-81	1981-82
Joints:	Neck	2 (2%)	8 (4%)	7 (4%)	1 (1%)	2 (2%)	2 (2%)
	Shoulder	6 (5%)	11 (5%)	12 (7%)	6 (7%)	8 (9%)	7 (6%)
	Back	10 (8%)	20 (10%)	12 (7%)	5 (6%)	8 (9%)	14 (13%)
	Elbow	3 (2%)	3 (2%)	5 (3%)	0 (0%)	4 (5%)	1 (>1%)
	Wrist	5 (4%)	1 (>1%)	2 (1%)	1 (1%)	1 (1%)	1 (>1%)
	Hip	0 (0%)	1 (>1%)	1 (>1%)	0 (0%)	2 (2%)	2 (2%)
	Knee	17 (14%)	29 (15%)	34 (21%)	13 (15%)	13 (16%)	16 (15%)
	Ankle	20 (16%)	25 (13%)	19 (9%)	6 (7%)	11 (13%)	17 (16%)
Body Parts:	Upper Arm	3 (2%)	1 (>1%)	4 (3%)	1 (1%)	3 (3%)	1 (>1%)
	Lower Arm	4 (3%)	0 (0%)	2 (2%)	2 (2%)	0 (0%)	0 (0%)
	Hand	1 (1%)	1 (>1%)	1 (>1%)	1 (1%)	0 (0%)	2 (2%)
	Groin	2 (2%)	5 (3%)	1 (>1%)	0 (0%)	0 (0%)	2 (2%)
	Upper Leg	10 (8%)	31 (16%)	23 (14%)	8 (9%)	13 (15%)	13 (12%)
	Lower Leg	24 (19%)	47 (24%)	19 (12%)	12 (14%)	8 (10%)	15 (14%)
	Foot	3 (2%)	5 (3%)	7 (4%)	7 (8%)	6 (7%)	7 (6%)
Miscellaneous Sites:							
	Thumb	1 (>1%)	1 (>1%)	0 (0%)	1 (1%)	0 (0%)	1 (>1%)
	Eye	1 (>1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Arch	6 (5%)	4 (2%)	2 (1%)	0 (0%)	1 (1%)	3 (3%)
	Heel	2 (2%)	1 (>1%)	3 (2%)	6 (7%)	0 (0%)	2 (2%)
	Achilles	3 (2%)	1 (>1%)	4 (3%)	7 (8%)	0 (0%)	2 (2%)
	Finger	1 (>1%)	1 (>1%)	0 (0%)	1 (1%)	1 (1%)	0 (0%)
	Toes	0 (0%)	0 (0%)	1 (>1%)	2 (2%)	1 (1%)	0 (0%)
	Abdomen	0 (0%)	1 (>1%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)
	Gluteal	0 (0%)	0 (0%)	1 (>1%)	0 (0%)	2 (2%)	1 (>1%)
TOTAL		124	197	160	80	85	109

athletic year 1981-82: Basketball - 13 athletes, softball - 16 athletes, and track and field - 18 athletes.

During 1979-80, 124 injuries were recorded for the three sports; 1980-81 showed 197 injuries, and 1981-82 presented 160 injuries. These results represent 26%, 41% and 33% of the total number of injuries over the years. Softball injuries accounted for nearly 29%, basketball accounted only for 15%, and track and field accounted for 56% of the total number of injuries.

The University of Oklahoma evidenced 273 injuries in the three years investigated. This incidence of injuries comes from a total of 149 participants. The rosters at The University of Oklahoma for the years in this study were made up of: Athletic year 1979-80: Basketball - 14 athletes, softball - 18 athletes, track and field - 15 athletes; athletic year 1980-81: Basketball - 13 athletes, softball - 17 athletes, track and field - 21 athletes; athletic year 1981-82: Basketball - 14 athletes, softball - 16 athletes, and track and field - 20 athletes.

During the year 1979-80, 80 injuries were recorded for the three sports studied; 1980-81 showed 84 injuries, and the 1981-82 year showed 109 injuries. These results accounted for 29%, 31% and 40% for each year, respectively, out of the total of 273 injuries. Softball accounted for 27% of the total for the three years; basketball for 29% and track and field nearly 44%. For a complete overview of these data, see Appendix A.

The total percentage of injuries in the 1979-80 athletic year were computed. The results of the calculated percentages for the two schools are presented in Table I. The results presented in Table I indicate that for softball for the 1979-80 athletic year the Joint areas had the higher incidence of injuries. Oklahoma State University had a higher percentage of joint injuries than The University of Oklahoma. The University of Oklahoma presented a higher incidence of injuries in Body Parts and Miscellaneous sites. With respect to basketball, the data showed that the Joints were the major area affected, Oklahoma State University had a higher incidence in this area than The University of Oklahoma, but The University of Oklahoma showed the highest incidence in Body Parts. Both schools are similar in their incidence in Miscellaneous sites. The analysis in track and field for the first year of the study indicated Body Parts as the category with the higher incidence of injuries in that particular year. Oklahoma State University was at the top of this category. In the area of Joints, both schools were similar in the incidence of injuries; although in Miscellaneous sites The University of Oklahoma doubled the Oklahoma State University amount.

The results for the calculated percentages for both schools in the athletic year 1980-81 are represented in Table II. In Table II the results indicate that for softball for the 1980-81 athletic year the Joint areas had the higher incidence of injuries. Again, as in the previous year, Oklahoma State University had the highest percentage of Joint injuries in comparison to The University of Oklahoma. Body Parts showed practically the same incidence from the previous year for both schools. Miscellaneous sites evidenced the lowest incidence by comparison with the previous year. The results for basketball in this particular year indicated an increase for both schools in Joints injured in comparison with the previous year. Joints again had the highest incidence in injuries for both schools; Oklahoma State University doubled its incidence in Body Parts from the previous year. There was a substantial decline in Miscellaneous sites in each school from one year to another. The results in Table II indicate that Body Parts in track and field are higher in incidence at Oklahoma State University in comparison to The University of Oklahoma. It is of importance to note that in comparison with the previous year, Oklahoma State University increased its incidence in injuries to Body Parts and The University of Oklahoma lowered its percentage. The same differentiation occurred in the Joint area but inversely for both schools. Oklahoma State University lowered the percentage from the previous year while The University of Oklahoma increased its incidence. Both schools equaled their percentages in Miscellaneous sites in the 1980-81 athletic year.

The results in the calculated percentages with regard to the athletic year 1981-82 can be found in Table III. The results for the 1981-82 competitive year in softball indicated that the Joint areas had the highest incidence of injuries. During this year, The University of Oklahoma excelled Oklahoma State University in injuries to the Joints by comparison with the two previous years. The University of Oklahoma also dropped its incidence in Body Parts substantially in comparisons to the 1980-81 season. Miscellaneous sites showed the lowest incidence for both schools for the 1981-82 athletic year. The results for basketball indicated an increase in the rate of injuries to the Joint areas with a substantial increase through the three years of competition in basketball for Oklahoma State University. The University of Oklahoma had an increase in the Joint area but not substantially. There was a substantial difference in the percentage of injuries to Body Parts in the 1981-82 year when both schools are compared. The injured track and field athletes showed a great deal of similarity in both schools in the incidence of injuries in the 1981-82 competition period. Both schools are very similar in the three major areas, but both schools showed some variability in their results for the sport of track and field along the three years. In dealing with the three sports combined in each of the athletic years studied, a computation of percentages was done. A comparison of the results is shown in Table IV. Table IV indicates that in the three sports analyzed for the 1979-80 athletic year, Oklahoma State University had a higher incidence for injuries in Joints, although The University of Oklahoma doubled the rate over Oklahoma State University in Miscellaneous sites in the three sports for that particular year. Table IV shows that The University of Oklahoma surpasses Oklahoma State University in the incidence of Joint areas in the three sports studied for the 1980-81 athletic year. In comparison with the previous year, The University of Oklahoma had a substantial increase in injuries for the three sports, particularly in the Joint areas. Both schools substantially lowered their percentages in Miscellaneous sites from one athletic year to the next. From the athletic year 1981-82 some dissimilarities can be observed in the incidence of injuries between both schools in contrast with the two previous years. The percentage obtained show a slight increase in the incidence of Joints injured at Oklahoma State University along the three years of the study and for the three sports combined. Nevertheless, The University of Oklahoma showed some variability immediately after the 1979-80 season for Joints and Oklahoma State University for Body Parts specifically in the 1980-81 season. For the 1981-82 year the schools showed a dissimilarity in the incidence for Miscellaneous sites injured. The rates in this particular area are substantially different in the first two years for both schools.

For further understanding of the evaluation done in the incidence of injuries between both schools, specifically in the analysis of the anatomical subdivisions, documentation is presented in Tables V through VIII. This is in consideration to the three years analyzed in the study as executed for the major areas in the tables previously presented. A detailed overview in the propensity and/or incidence of those anatomical parts that appeared relevant in the analysis is presented by year, respective school and related percentage.

The results of the distribution of injuries sustained in basketball by anatomical sites are presented in Table V. In Table V the data reveals that injuries to the knee had the highest incidence for basketball at Oklahoma State University. The ankle was most frequently injured in basketball at Oklahoma State University by comparison with the incidence in the same Joint area and the same sport at The University of Oklahoma. Injuries to the lower leg accounted for 15% of the total number of injuries at Oklahoma State University. Conversely, the foot was the Body Part with the highest incidence in basketball at The University of Oklahoma accounting for 32% of the total number of injuries. Miscellaneous sites was the category with the lowest incidence of injuries in basketball. As a measure of comparison, Oklahoma State University incurred 14% of the total number of injuries to the arches in basketball. The University of Oklahoma showed 21% of the total number of injuries to the Achilles tendon in the same sport.

Table VI reports the results of the distribution of injuries sustained in softball by anatomical sites. As can be seen in Table VI, the knee accounted for the highest incidence of injury between Joints affected in softball at Oklahoma State University. To the contrary, at The University of Oklahoma, shoulder injuries topped the list in softball. The incidence of ankle joint injuries were comparatively similar at both schools. A difference occurred when both schools are compared in their injury propensity to the upper leg in the Body Parts area. The results in the Miscellaneous sites indicated a high incidence for Oklahoma State University in the heels followed by injuries to the Achilles tendon. Conversely, at The University of Oklahoma the thumb was the anatomical area more prone to injuries at Miscellaneous sites followed by the heel.

The computation in the distribution of injuries sustained in track and field by anatomical sites are presented in Table VII. The results presented in Table VII indicate that The University of Oklahoma had its higher indicence of injuries in the Joint area at the knee in comparison to Oklahoma State University which had its highest incidence in the Joints area at the ankle. Track and field and softball were comparatively similar in the incidence of injuries to the ankle joint. Track and field also accounted for the highest incidence in lower leg injuries when the three sports are compared in both schools. This incidence in lower leg injuries in track and field must be attributed to shin splints trauma. Injuries in the upper and lower arm accounted for a very low percentage at both schools when Body Parts were evaluated. In respect to Miscellaneous sites, the results showed that for The University of Oklahoma injuries to the heels and Achilles tendon had the highest incidence in percentage for track and field followed surprisingly by injuries to the gluteal area. The highest incidence in track and field at Oklahoma State University was the arches followed closely by the Achilles tendon.

The three sports combined were analyzed in the distribution of injuries. The computation was attained combining the three sports in each of the athletic years studied. The results are presented in Table VIII. The data reveal that the anatomical trouble spot, the knee, was the joint receiving the most injuries for both schools in three years. The ankle was the second most frequently injured joint by comparison between the schools. Ankle injuries accounted for about 40% of the total joint injuries at both schools in the three years of the study. Body Parts followed the Joints in injury incidence for both schools. The lower leg was the Body Part most often injured. Injuries to the upper leg or thigh usually involving the hamstrings and quadriceps group muscles were second in incidence to the lower leg. Injuries to the hand and groin showed the lowest percentage of injuries for both schools. Injuries to the upper and lower arm accounted for a very low percentage also at both schools. Miscellaneous sites was the category with the lowest incidence of injuries per year and also by sport. Injuries to the arches, heels, and Achilles tendons are notable. The University of Oklahoma showed a higher propensity to injury in this category than Oklahoma State University.

Discussion

For the purpose of this investigation, an injury is defined as any medical problem recorded as musculo-skeletal and orthopaedic in nature encountered by female varsity athletes requiring the attention of the trainer, medical staff, or other medical care provider at each of the schools studied. From the results of this study the researcher interpreted that there was a positive answer to all the pertinent questions posed at the initiation of this study. For the purpose of this study, the following questions were posed by the researcher. If the answer to the question proved to be substantial, a "yes" is found after the question.

(1) Is there a substantial difference in the trends of sports injuries related to varsity female sports between Oklahoma State University and The University of Oklahoma? Yes.
The data analyzed revealed that a substantial difference existed in the trends of sports injuries specifically to basketball and track and field.

(2) Is there a substantial difference in the trends of sports injuries related to the joint areas affected between Oklahoma State University and The University of Oklahoma? Yes.
The data analyzed revealed that a substantial difference existed in the trends of sports injuries related to joint areas. The knee joint was the joint most often injured with a difference in incidence between schools around sports. The ankle was the second most frequently injured joint.

(3) Is there a substantial difference in the trends of sports in-

juries related to body parts and miscellaneous sites affected between Oklahoma State University and The University of Oklahoma? Yes.

The data analyzed revealed that a substantial difference existed in the trends of sports injuries related to body parts affected. The lower leg was the body part most often injured but there was a difference in the incidence between schools yearly. Miscellaneous sites was the category with the lowest incidence rate for both schools but variability existed between sports.

(4) Is there a substantial difference in the trends of sports injuries related to a three year span between Oklahoma State University and The University of Oklahoma? Yes.

The data analyzed and presented specifically in Tables I through IV indicate that there is not any similarity in the percentages computed. This shows that there is a substantial difference in trends.

The researcher interpreted from the results of this study that there was a substantial difference in the incidence of injuries by year and by sports between both schools, specifically in the last two years in which the study was concerned. There was a higher incidence of injuries in track and field in both schools than in the other two sports. This observation is inconsistent with the observations of La Cava (1961) who concluded that there is much less danger in a sport being performed individually, as track and field, than in team sports. A survey of injuries incurred by female athletes conducted by Klaus (1964) three years after La Cava's conclusions appeared contradictory. Klaus found that in the overall incidence of athletic injuries occurring in women, the largest percentage occurred in sports that required explosive efforts such as sprinting and the long jumping. This variability in injury incidence between individual and team sports, as revealed by previous studies and the data presented here, may be attributed to those changes which have occurred during the last 15 years regarding competition schedules and the athlete's amount of participation in a particular sport. The length of season ranges from a low of three or four months in team sports as in softball, volleyball and basketball, to a high of ten months as in track, tennis and swimming. These sports have both an outdoor and indoor competitive season. Also, many women athletes today are multirole athletes, athletes who participate in more than one position/event as in the case of track and field.

The results from the data in this study reveal that the knee was the joint of most injuries for both schools. This result is not in close agreement with the findings of Garrick and Requa (1978) who suggested the ankle joint as the most common anatomical trouble spot by their observations. Klafs and Lyon (1978) have suggested that the delicate ligamentous structures and frequent laxity of joints found in the female athlete may account, in part, for the large number of injuries to joints areas.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This chapter contains a summary of the study, the findings derived from the analysis of the data, conclusions, and recommendations.

Summary

This study was designed to determine:

a) If a substantial difference existed in the trends of sports injuries related to varsity female sports between Oklahoma State University and The University of Oklahoma.

b) If a substantial difference existed in the trends of sports injuries related to joint areas affected between Oklahoma State University and The University of Oklahoma.

c) If a substantial difference existed in the trends of sports injuries related to body parts and miscellaneous sites affected between Oklahoma State University and The University of Oklahoma.

d) If a substantial difference existed in the trends of sports injuries related to a three year span between Oklahoma State University and The University of Oklahoma.

The athletic trainers of the varsity female intercollegiate athletics team at Oklahoma State University and The University of Oklahoma were ocntacted and permission was obtained to gather the data from the trainers' records. The data for this study was based specifically on the information recorded for sports injuries, treatment and rehabilitation for the years 1979-80, 1980-81, and 1981-82 in the record logs at Oklahoma State University and The University of Oklahoma. The raw data for this study was tabulated separately for each year and for each sport analyzed. The sports involved were: Softball, basketball, and track and field. Human subjects were not contacted for this research study.

The data was descriptively tabulated under three major areas and sub-divided around six anatomical areas. The data was comparatively evaluated analyzing the computed frequency distributions and totals of each category for each major descriptive area and sub-division. The analytic technique used to determine any substantial difference existed between schools was the percentage (%) analysis. For each major category at its respective anatomical area, a distribution of injuries by percentage was computed. For each category, comparisons were made in each of the athletic years separately and also combined within each school.

Findings

The data collected in this study were analyzed and yielded the following findings:

(1) Question one was answered positively indicating that a substantial difference existed in the trends of sports injuries related to the three varsity female sports studied between Oklahoma State University and The University of Oklahoma. The substantial difference in the trends of sports injuries related to the three sports studied is

substantiated when the results indicated that at Oklahoma State University injuries to softball, basketball and track and field accounted for 29%, 15% and 56%, respectively, for the three years analyzed and 27%, 29% and 44% at The University of Oklahoma.

(2) Question two was answered positively indicating that a substantial difference existed in the trends of sports injuries related to joints affected between Oklahoma State University and The University of Oklahoma. The substantial difference in the trends of sports injuries related to joints affected is substantiated when the data indicated that for some sports the joint injured differed in incidence between schools. The knee accounted for the highest incidence of injury between joints affected in softball but at The University of Oklahoma the shoulder joint was most frequently affected in softball.

(3) Question three was answered positively indicating that a substantial difference existed in the trends of sports injuries related to body parts and miscellaneous sites affected between Oklahoma State University and the University of Oklahoma. The substantial difference in the trends of sports injuries related to body parts and miscellaneous sites affected is substantiated when the results reveal that for body parts the lower leg was most often injured at Oklahoma State University with 55% of the total number of injuries over the three years and the three sports jointly computed. The University of Oklahoma had 38% of the injuries occurring in the lower leg. In relation to miscellaneous sites the results reveal that The University of Oklahoma showed a higher propensity to injury in this category than Oklahoma State University in the order of, for example, 4% in arches, 9% in heels, and 10% in

the Achilles tendon to 8%, 5% and 6% at Oklahoma State University.

(4) Question four was answered positively indicating that a substantial difference existed related to a three year span between Oklahoma State University and The University of Oklahoma. The substantial difference in the trends of sports injuries related to a three year span is substantiated when computations were made and the percentages showed some variability during the different years specifically when Major Areas Affected were evaluated in Tables I through IV. Each school showed some degree of dissimilarity in each of the years when analyzed and compared.

Conclusions

Based upon the results and findings, and within the limitations of this study, several conclusions can be drawn:

(1) The knee and the ankle accounted for the highest percentage in injury incidence when comparing joint areas.

(2) By comparison to basketball and softball, track and field had the highest incidence in injuries to the body part areas, and particularly to the lower leg.

(3) Injuries to the heels, arches, and Achilles tendon showed a higher incidence at both schools than any other miscellaneous site.

(4) Injuries to the gluteal appear to have a high incidence in track and field competition.

(5) Neck, back, hip, elbow, groin and eyes injuries were generally minor in all three sports at both schools.

(6) Fractures were minimal in the analysis of injuries in this

study. The data in this study revealed just two fractures at Oklahoma State University. It is proper to conclude in relation to the revelations of the data herein presented and the review of literature in this study that fractures account for a very minimal percentage of injuries in female sport participants.

Recommendations

In reviewing the literature, methods, procedures, results and findings of this study, several recommendations are warranted and could be made with regard to further study. These recommendations are as follows:

(1) The topic of women in athletics has been insufficiently researched and until recently underrepresented in the literature on sport and physical education; therefore, there is a need for research to counteract predominant myths concerning women and sport.

(2) There is also a need for facts documenting the motor performance capabilities of women and the effects of exercise according to sex.

(3) In relation to this study, of particular importance is documentation of various indices of conditioning (the time of injury, the age of the participant, and length of involvement in the sport), since lack of conditioning seems to play a major contributing role in any athletic injury.

(4) At the occurrence of each injury, the trainer should complete a survey documenting the nature, extent, and apparent cause

of injury and any extenuating circumstances.

(5) The time lost from competition must be recorded in the trainer's log to be utilized as a definition of injury and as an admittedly rough index of severity.

(6) As competition for female athletes continues to increase, more research regarding prevention of injuries is imperative. This research might well begin with an analysis of conditions in training methods. Improvement in training techniques must be considered for: Pre-season, in-season, and off-season, as to individualized training, specificity for the sport in competition and weight training.

(7) Development of standards of protective equipment and improvement in sports facilities must be achieved.

(8) There is a need for more state licensing of female athletic trainers to serve as the liason instrument between the athletic field and the sports medicine field for the best purposes of the female athlete.

(9) Additional research is necessary using a variety of sports as well as other injury-contributing variables such as equipment, conditioning, techniques, level of participant and surface type. Too many researchers, coaches and trainers have speculated as to possible causes of injury but have not supported their speculations by controlled research.

(10) A longitudinal study consisting of pre-injury indices with a follow-up of injuries occurring to a specific athletic group might produce meaningful insights into the topic of sports trauma.

(11) It is strongly recommended that another researcher follow up this study, if possible, to establish trends and patterns in the incidence of injuries for both schools on a long term basis.

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APPENDIXES

APPENDIX A

RAW DATA (INJURIES TABULATED BY SCHOOL, SPORT,

YEAR AND FREQUENCIES IN BODY PARTS)

THE UNIVERSITY OF OKLAHOMA - 1979-80

Basketball 1979-80

Body Part	No. of Injuries
Ankle	1
Achilles tendon	3
Knee	4
Foot	2
Shoulder	2
Lower leg: shin	2
	14

Softball 1979-80

Body Part	No. of Injuries	Body Part	No. of Injuries
Lower leg: shin	1	Ankle	4
calf	1	Foot	3
Shoulder	4	Neck	1
Upper leg	2	Achilles tendon	1
Hamstrings	2	Heel	3
Knee	4	Arm	2
Finger	1	Back	2
Thumb	1	Upper arm	1
	16		17

Track and Field 1979-80

Body Part	No. of Injuries	Body Part	No. of Injuries
Ankle	1	Foot	2
Heels	3	Toe	2
Achilles tendon	3	Hand	1
Knee	5	Upper leg: hamstrings	2
Back	3	thigh	2
Lower leg: calf	3	Leg	2
shin	3	Wrist	1
	21		12

THE UNIVERSITY OF OKLAHOMA - 1980-81

Basketball 1980-81

Body Part	No. of Injuries	Body Part	No. of Injuries
Knee	4	Lower back	2
Ankle	5	Upper leg	1
Upper arm	2	Hip	1
Elbow	2	Thigh	1
Foot	3	Shoulder	2
Toe	1	Lower leg: shin	1
Back	2	Neck	1
	19	Arch	1
			10

Softball 1980-81

Body Part	No. of Injuries	Body Part	No. of Injuries
Upper leg	1	Back	1
Hamstrings	1	Upper back	1
Thigh	3	Wrist	1
Elbow	2	Neck	1
Shoulder	5	Upper arm	1
Knee	3	Hip	1
Finger	1	Lower leg: shin	1
Ankle	2	Foot	1
	18		8

Track and Field 1980-81

Body Part	No. of Injuries	Body Part	No. of Injuries
Back	2	Ankle	4
Upper leg	1	Shoulder	1
Hamstrings	2	Gluteal	2
Quadriceps	1	Lower leg: calf	3
Thigh	2	shin	3
Knee	6	Foot	2
	14		14

THE UNIVERSITY OF OKLAHOMA - 1981-82

Basketball 1981-82

Body Part	No. of Injuries	Body Part	No. of Injuries
Back	2	Ankle	4
Upper leg	1	Shoulder	1
Hamstrings	2	Gluteal	2
Quadriceps	1	Lower leg: calf	3
Thigh	2	shin	3
Knee	6	Foot	2
	14		15

Softball 1981-82

Body Part	No. of Injuries
Shoulder	4
Back	2
Knee	3
Elbow	1
Thigh	1
Ankle	2
Thumb	1
	14

Track and Field 1981-82

Body Part	No. of Injuries	Body Part	No. of Injuries
Upper leg: thigh	2	Foot	4
quadriceps	2	Back	1
hamstrings	5	Lower back	3
Lower leg: shins	4	Gluteal	1
calfs	7	Shoulder	1
Knee	8	Hip	1
Ankle	7	Hand	1
Heel	2	Wrist	1
Achilles tendon	2	Neck	1
Arch	2	Groin	1
	41	Legs	1
			16

OKLAHOMA STATE UNIVERSITY - 1979-80

Basketball 1979-80

Body Part	No. of Injuries	Body Part	No. of Injuries
Wrist (fracture)	1	Eye	1
Knee	6	Back	1
Forearm	1	Arch	1
Thumb	1	Ankle	4
	9		7

Softball 1979-80

Body Part	No. of Injuries	Body Part	No. of Injuries
Knee	8	Calf	3
Shoulder	5	Quadriceps	2
Back	4	Elbow	3
Forearm	1	Biceps	2
Arm	2	Groin	1
Ankle	3	Heel	2
Achilles tendon	1	Wrist	2
	24		15

Track and Field 1979-80

Body Part	No. of Injuries	Body Part	No. of Injuries
Foot	3	Hamstrings	2
Wrist	2	Shoulder	1
Upper leg: quadriceps	6	Knee	3
Groin	1	Hand	1
Lower leg: shin	20	Tricep	1
Achilles tendon	2	Arch	5
Ankle	13	Leg	1
Back	5	Neck	2
Finger (fracture)	1		16
	53		

OKLAHOMA STATE UNIVERSITY - 1980-81

Basketball 1980-81

Body Part	No. of Injuries	Body Part	No. of Injuries
Knee	10	Hamstrings	1
Foot	1	Shin	1
Ankle	12	Leg	1
Back	3	Neck	1
Quadriceps	1	Heel	1
Groin	1		5
	28		

Softball 1980-81

Quadriceps	2	Hand	1
Calf	1	Back	5
Knee	8	Ankle	7
Shoulder	7	Hamstrings	2
Elbow	1	Neck	3
Thigh	1	Groin	3
Upper arm	1		21
	21		

Track and Field 1980-81

Body Part	No. of Injuries	Body Part	No. of Injuries
Shin	27	Hamstrings	14
Finger	1	Foot	4
Shoulder	4	Arch	4
Back	12	Thigh	1
Quadriceps	9	Neck	4
Elbow	2	Hip	1
Calf	13	Abdomen	1
Ankle	6	Leg	4
Knee	11	Groin	1
Wrist	1	Heels	1
	86	Achilles tendon	1
			36

OKLAHOMA STATE UNIVERSITY - 1981-82

Basketball 1981-82

Body Part	No. of Injuries	Body Part	No. of Injuries
Knees	9	Shoulder	1
Ankle	7	Wrist	1
Arch	2	Back	1
Shin	2		3
	20		

Softball 1981-82

Body Part	No. of Injuries	Body Part	No. of Injuries
Shoulder	8	Upper arm	3
Foot	2	Back	5
Knee	15	Calf	1
Achilles tendon	1	Neck	2
Ankle	4	Groin	1
Hamstrings	5	Hand	1
Elbow	5	Quadriceps	2
Forearm	2	Leg	1
	42		16

Track and Field 1981-82

Body Part	No. of Injuries	Body Part	No. of Injuries
Quadriceps	4	Back	6
Knees	10	Foot	5
Heel	2	Thigh	3
Hamstrings	9	Shins	3
Toe	1	Gluteal	1
Achilles tendon	3	Wrist	1
Neck	5	Leg	2
Hip	1	Shoulders	3
Ankle	8	Calfs	12
	43		36

APPENDIX B

ANALYTIC CRITERIA IN MAJOR AREAS (JOINTS, BODY PARTS, AND MISCELLANEOUS SITES) TABULATED BY SCHOOL, SPORT, YEAR AND FREQUENCIES OF INJURIES

THE UNIVERSITY OF OKLAHOMA

Basketball 1979-80

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	0	Upper arm	0	Achilles	
Shoulder	2	Lower arm	0	tendon	3
Back	0	Hand	0		3
Elbow	0	Groin	0		
Wrist	0	Upper leg	0		
Hip	0	Lower leg	2		
Knee	4	Foot	2		
Ankle	1		4		
	7				

Basketball 1980-81

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	1	Upper arm	2	Toe	1
Shoulder	2	Lower arm	0	Arch	1
Back	4	Hand	0		2
Elbow	2	Groin	0		
Wrist	0	Upper leg	2		
Hip	1	Lower leg	1		
Knee	4	Foot	3		
Ankle	5		8		
	19				

Basketball 1981-82

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	1	Upper arm	1	Arch	1
Shoulder	2	Lower arm	0		1
Back	8	Hand	1		
Elbow	0	Groin	1		
Wrist	0	Upper leg	3		
Hip	1	Lower leg	3		
Knee	5	Foot	3		
Ankle	8		12		
	25				

THE UNIVERSITY OF OKLAHOMA

Softball 1979-80

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	1	Upper arm	1	Finger	1
Shoulder	4	Lower arm	2	Thumb	1
Back	2	Hand	0	Achilles Tendon	1
Elbow	0	Groin	0	Heel	3
Wrist	0	Upper leg	4		6
Hip	0	Lower leg	2		
Knee	4	Foot	3		
Ankle	4		12		
	15				

Softball 1980-81

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	1	Upper arm	1	Finger	1
Shoulder	5	Lower arm	0		1
Back	2	Hand	0		
Elbow	2	Groin	0		
Wrist	2	Upper leg	5		
Hip	1	Lower leg	1		
Knee	3	Foot	1		
Ankle	2		8		
	17				

Softball 1981-82

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	0	Upper arm	0	Thumb	1
Shoulder	4	Lower arm	0		
Back	2	Hand	0		
Elbow	1	Groin	0		
Wrist	0	Upper leg	1		
Hip	0	Lower leg	0		
Knee	3	Foot	0		
Ankle	2		1		
	12				

THE UNIVERSITY OF OKLAHOMA

Track and Field 1979-80

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	0	Upper arm	0	Heels	3
Shoulder	0	Lower arm	0	Achilles tendon	3
Back	3	Hand	1	Toe	2
Elbow	0	Groin	0		8
Wrist	1	Upper leg	4		
Hip	0	Lower leg	8		
Knee	5	Foot	2		
Ankle	1		15		
	10				

Track and Field 1980-81

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	0	Upper arm	0	Gluteal	2
Shoulder	1	Lower arm	0		2
Back	2	Hand	0		
Elbow	0	Groin	0		
Wrist	0	Upper leg	6		
Hip	0	Lower leg	6		
Knee	6	Foot	2		
Ankle	4		14		
	13				

Track and Field 1981-82

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	1	Upper arm	0	Heel	2
Shoulder	1	Lower arm	0	Achilles tendon	2
Back	4	Hand	1	Arch	2
Elbow	0	Groin	1	Gluteal	1
Wrist	1	Upper leg	9		7
Hip	1	Lower leg	12		
Knee	8	Foot	4		
Ankle	7		27		
	23				

OKLAHOMA STATE UNIVERSITY

Basketball 1979-80

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	0	Upper arm	0	Thumb	1
Shoulder	0	Lower arm	1	Eye	1
Back	1	Hand	0	Arch	1
Elbow	0	Groin	0		3
Wrist	1	Upper leg	0		
Hip	0	Lower leg	0		
Knee	6	Foot	0		
Ankle	4		1		
	12				

Basketball 1980-81

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	1	Upper arm	0	Heel	1
Shoulder	0	Lower arm	0		1
Back	3	Hand	0		
Elbow	0	Groin	1		
Wrist	0	Upper leg	2		
Hip	0	Lower leg	2		
Knee	10	Foot	1		
Ankle	12		6		
	26				

Basketball 1981-82

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	0	Upper arm	0	Arch	2
Shoulder	1	Lower arm	0		2
Back	1	Hand	0		
Elbow	0	Groin	0		
Wrist	1	Upper leg	0		
Hip	0	Lower leg	2		
Knee	9	Foot	0		
Ankle	7		2		
	19				

OKLAHOMA STATE UNIVERSITY

Softball 1979-80

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	0	Upper arm	2	Achilles	
Shoulder	5	Lower arm	3	tendon	1
Back	4	Head	0	Heel	2
Elbow	3	Groin	1		3
Wrist	2	Upper leg	2		
Hip	0	Lower leg	3		
Knee	8	Foot	0		
Ankle	3		11		
	25				

Softball 1980-81

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	3	Upper arm	1	Thumb	1
Shoulder	7	Lower arm	0		1
Back	5	Hand	1		
Elbow	1	Groin	3		
Wrist	0	Upper leg	5		
Hip	0	Lower leg	1		
Knee	8	Foot	0		
Ankle	7		11		
	31				

Softball 1981-82

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	2	Upper arm	3	Achilles	
Shoulder	8	Lower arm	2	tendon	1
Back	5	Hand	1		1
Elbow	5	Groin	1		
Wrist	0	Upper leg	7		
Hip	0	Lower leg	2		
Knee	15	Foot	2		
Ankle	4		18		
	39				

OKLAHOMA STATE UNIVERSITY

Track and Field 1979-80

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	2	Upper arm	1	Achilles tendon	2
Shoulder	1	Lower arm	0	Arch	5
Back	5	Hand	1	Finger	1
Elbow	0	Groin	1		8
Wrist	2	Upper leg	8		
Hip	0	Lower leg	21		
Knee	3	Foot	3		
Ankle	13		35		
	26				

Track and Field 1980-81

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	4	Upper arm	0	Arch	4
Shoulder	4	Lower arm	0	Abdomen	1
Back	12	Hand	0	Heels	1
Elbow	2	Groin	1	Achilles tendon	1
Wrist	1	Upper leg	24	Finger	1
Hip	1	Lower leg	44		8
Knee	11	Foot	4		
Ankle	6		73		
	41				

Track and Field 1981-82

Joints	No. of Injuries	Body Part	No. of Injuries	Miscellaneous Sites	No. of Injuries
Neck	5	Upper arm	1	Toe	1
Shoulder	3	Lower arm	0	Achilles tendon	3
Back	6	Hand	0	Gluteal	1
Elbow	0	Groin	0	Heel	3
Wrist	1	Upper leg	16		8
Hip	1	Lower leg	15		
Knee	10	Foot	5		
Ankle	8		37		
	34				

VITA

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