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A STUDY OF THE EXTRINSIC FACTORS ASSOCIATED WITH KNEE INJURIES IN THE 1979 EDMONTON HIGH SCHOOL FOOTBALL LEAGUE

by

Nancy M. Jette

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

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ABSTRACT

The purpose of this study was to examine the extrinsic factors (equipment, techniques, rules) associated with knee injury in high school football. It was hoped that such factors, once identified, could be used as a screening device to help prevent knee injuries from occurring in high school football, or at least aid in minimizing their severity.

The study was conducted during the 1979-80 Edmonton High School Football season. The sample included 1189 players from both the junior and senior varsity teams. Data was gathered by means of a questionnaire which was completed by any player who incurred a "reportable knee injury" while participating in the 1979-80 football program. Upon completion, the questionnaires were collected, knee injury rates were calculated and the data was assembled into frequency tables.

There were nineteen knee injuries reported during the 1979-80 Edmonton High School Football season. Fifteen of the total nineteen knee injuries were sustained by senior varsity players, while the remaining four were incurred by junior varsity players. Players on the defensive teams sustained nine knee injuries, players on the offensive teams sustained seven knee injuries and offensive specialty team players sustained the remaining three knee injuries. When playing position was examined in relation to knee injury, linebackers were the most frequently injured players, sustaining five knee injuries.

Game play was associated with nine of the nineteen reported knee injuries (47.37 percent) and practice sessions were associated with ten knee injuries (52.63 percent). Of the ten knee injuries which were sustained during practice sessions, eight (80 percent) occurred to

players while they were participating in contact drills or practice scrimmage situations. This contact portion of the practice sessions accounted for only 47 percent of the total practice time. Collisions between players accounted for nine of the nineteen reported knee injuries. Twelve of the nineteen knee injuries were associated with the act of blocking, being blocked, tackling or being tackled.

It was suggested that because of the nature of the game, a certain degree of knee injury is inherent to the sport of football. Emphasis should be placed on the instruction of the fundamental skills at the outset of a football player's career to ensure development of safe, effective blocking and tackling techniques. Because of their position and role in relation to the offense, defensive players were viewed as being more susceptible to knee injury. The contact drills and scrimmages used in practice sessions should be critically examined, because of their frequent association with the occurrence of knee injury in the present study.

NOTES OF APPRECIATION

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Cherny; for being a good listener.

My "running mate"; who provided those few minutes of laughter each day.

To Dad and Mom,

who seemed to have endless amounts of

faith, understanding and toleration;

even during Chapter IV.

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and there is nothing that stokes fire like, ..."

Vincent Thomas Lombardi

CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

It has been stated that "there is no team sport played anywhere in the world in which the occurrence of injury is more frequent than in American football." (32) Most certainly, a degree of injury is inherent to such a physical sport, but how much of it could be prevented or minimized is a question yet unanswered. Numerous studies (1, 3, 13, 27) have reported on the incidence of injury in the sport of football, but few have concentrated on a particular injury and its causes. If, for a specific injury type, a successful injury prevention program is to be instituted, an understanding of the causes of injury to a particular anatomical area and the factors relating to it must be attained. Such factors may range from physiological and anatomical characteristics of the athletes, to the playing conditions, to the nature of the game itself.

There is perhaps no other injury in the realm of sports that receives as much publicity as that which occurs to the knee. Whether its notoriety is the result of the calibre of athlete frequently affected (Joe Namath and Bobby Orr for examples) or whether the nototiety stems from its possible chronic effects is irrelevant. The fact that knee injury is commonly cited as being one of the most frequently occurring injuries at all levels of football (13, 29, 32) makes it a matter requiring attention. As stated by Dr. James Garrick (39) with reference to the large number of injuries in football, "If the United States ignored an annual epidemic striking a million and a

half youngsters each autumn, Americans would revolt."

The Problem

The knee appears to have the highest incidence of injury where the sport of high school football is concerned. Factors relating to the high incidence of knee injury may be classified as being intrinsic (physiological and anatomical) or extrinsic (equipment, technique, rules) in nature. The purpose of the present study is to examine the extrinsic factors that are most closely associated with the occurrence of knee injury in high school football. These factors may serve as a screening device to help prevent the occurrence of, or to minimize the severity of knee injury in the high school football population.

Need For The Study

To the writer's knowledge, very few studies have examined the incidence of injury in Canadian High School Football. There appears to be no published information available which concentrates solely on knee injury at this level of the sport. A comprehensive summary of the factors leading to knee injury in football is not available in the published literature. The present study was designed to fill this gap. Once the extrinsic factors contributing to knee injury are examined these factors may serve as a much needed screening device for potential high school football players. Ultimately, the number of knee injuries in the sport of football may be reduced.

Delimitations

1. The study was restricted to the 1979-80 football season, which was nine weeks in duration.
2. The sample included only junior and senior varsity football players active in the Edmonton Public and Separate School Divisions.

3. The study was restricted to the influence extrinsic factors had on the incidence of knee injury and did not examine the possible effect of intrinsic factors.

Limitations

1. The possible influence of various physiological and anatomical factors on the occurrence of knee injury were not examined.
2. Even though the knee injury report form was explicitly written with much care to detail; some players, coaches or trainers could have misinterpreted some questions; thereby supplying improper information.
3. The assessment of the knee injury by the physician, trainer or coach was assumed to be correct. The administrator of the form also interviewed each subject to clarify any discrepancies in information.
4. Only those players who missed practice or game time due to the knee injury, or those who received medical attention, were considered. Presumably, an athlete could have suffered a minor knee injury, and for one reason or another, never reported it.
5. Errors in data collection, or analysis may have been present, but were hopefully minimized.

Definition of Terms

1. Reportable Knee Injury. An injury to the structures of the knee joint (as opposed to the muscle body) which results in:
   - the player missing any portion of a game or practice,

- medical advice being sought regarding some knee injury,
- the player being unable to participate fully in practice.

2. Extrinsic Factor. Any factor associated with knee injury, that is not directly associated with the physiological or anatomical state of the athlete. Examples: equipment, playing conditions, playing technique and previous history of injury.

3. Intrinsic Factor. Any factor, associated with knee injury, that is directly associated with the physiological or anatomical state of the athlete. Examples: physical fitness, strength, leg length discrepancy and ligament laxity.

CHAPTER II

REVIEW OF THE RELATED LITERATURE

Incidence of Knee Injury in High School Football

Although numerous studies have examined the incidence of injury in football, few have dealt with the problem solely at the high school level. A review of various published studies reveals similarities in the incidence of injury to various body regions at all levels of football. The knee and ankle are the most frequently injured body parts (2, 3, 13, 18, 27, 32).

In a recent four-year study (3), Blyth and Mueller found that the injury rate among football players in selected North Carolina High Schools was approximately 48 percent. This figure was arrived at through the following formula.

$$\text{Injury Rate} = \frac{\text{Number of student athletes incurring a new injury during the year}}{\text{Average number of student athletes at risk during the season or year}}$$

Of a total 2,711 injuries, the knee accounted for the most, being injured 652 times. The nature of the injury included contusions, sprains, fractures, strains, lacerations and torn ligaments. The majority of injuries to the knee were sprains and strains, which occurred 188 and 183 times respectively.

Dufresne (13) found the knee to be second only to the ankle in its incidence of injury in high school football players. Of a total 275 injuries, 49 of these involved injury to the ankle and 45 involved the knee. Once again the most common types of injury to the knee were sprains and strains.

In a study of 903 football players in an Oklahoma High School District, Moretz, et al. (27) reported the knee to be the most frequently injured anatomical area. Of a total 241 injuries, 53 involved the knee.

Earlier studies (2, 18, 40) reported similar results in that the authors found the knee to be either the first or second most frequently injured body region in high school football.

Extrinsic Factors Associated With Knee Injury

It has been suggested that terming American or Canadian football as a "contact sport" is an error, and that the phrase "collision sport" would more aptly suit them. The application of a basic mechanical principle, known as Newton's second Law of Motion; force is equal to mass times acceleration, clarifies how and why injury occurs in a sport such as football. As today's athletes partake in better training and conditioning programs, it is to be expected that one, or both of the components of force increase. The increased force is responsible for much of the bodily damage sustained in a "collision sport".

Dufresne (13) found that collisions between players resulted in 211 of the total 275 injuries (approximately 85 percent). All levels of competition considered, such collisions were associated with 79.9 percent of all ligament sprains; 43.1 percent of this total occurred at the knee.

Contrary to this, Blyth and Mueller (3) found collisions between players to be associated with injury in only 20.1 percent of the total number of cases. They found collisions with objects (usually in the form of the ground following a block or tackle) to be the cause of

8.6 percent of the total number of injuries. The study did not divide either of these percentages into the body regions involved.

If one were to assume that contact with another player was a contributing factor in injury in football, it may be thought that stricter enforcement of the rules would eliminate the problem. Underwood (39) refutes this statement by quoting a NFL official as saying, "It has been shown through special study that only 1 percent of injuries were on plays that were illegal." Blyth and Mueller (3) supported this statement in reporting that 3.8 percent of the injuries were caused by illegal acts: 1.7 percent of the total injuries were associated with clipping. Roughing and blocking from the rear comprised the illegal plays which caused 1.8 percent of the total number of injuries in a study of Canadian football (13).

If "illegal" plays does not contribute to injury in football, what aspects of "legal" play seem to contribute most to the problem? Peterson (31) lays the blame on a technique referred to as the "cross-body block", and claims that it "causes more knee injuries than all other factors combined." This claim is supported by a seventeen-year study of 259 knee injuries, in which 88 percent of these were associated with contact (blocking, tackling and pileups); 54 percent of the total being directly related to the cross-body block.

Peterson (31) described the cross-body block as an offensive blocking technique ultimately aimed at preventing a defensive player from impeding the forward movement of the football. In an attempt to upset the opponent, the offensive player throws his body horizontally at the defensive man. Apparently used most often in the open field area where

momentum is easily gained, this blocking technique is made even more hazardous by being delivered when the defensive player is often unaware as what is about to happen. Thus, when contacted from the side, referred to as blindsiding, the defensive man has no time to prepare himself for the blow. Defensively, the cross-body block is sometimes substituted for other tackling procedures as is seen when a runner is pushed out of bounds or a pass receiver is upended by an opponent.

The most common pathologic finding with this particular mechanism of injury is sprain or rupture of the stabilizing ligaments of the knee. Peterson (31) contrasts this with knee injuries which occur in the abscence of contact with other players. In these "non-contact" situations, the damage is usually a result of torsional stresses, resulting in tearing of the meniscus, without accompanying ligament damage.

Blocking from the rear or "clipping" may be in the form of a cross-body block. Realizing its threat to players' safety, the NFL ruled it illegal in 1922. The Canadian football leagues followed suit, but in both instances, there remains a legal clipping zone, referred to as the "close line play area." The Canadian interpretation of this zone is that it extends "laterally from offensive tackle to tackle, from one yard behind the line of scrimmage to one yard ahead of the neutral zone (3 yards)" (17). Both leagues have similarly outlawed the use of "crack back" blocking in which a flanking man or wide receiver starts down field and then turns back towards the line of scrimmage to take out a linebacker or defensive end. This blocking technique usually resulted in the defensive player being blind-sided

while his foot was firmly planted in preparation for push-off: all factors involved in a medial collateral ligament sprain.

Neither the clipping or crack back block ruling appear to have solved the threat of knee injury posed by the legal cross-body block which is commonly delivered to the side of a player, and below the waist. As stated by Peterson (31), "linebackers continue to suffer disabling knee injuries because most of these are due to the cross-body block with clipping hardly a factor". Coaches at all levels have been quoted as saying, "below the waist blocks,..., are not necessary at all", and the "more effective block (in downfield play) is the one where you go through your man and not down at his knees" (39). However, it is unlikely that there will be a change in the rule relating to blocking below the waist. An attempt was made to have it ruled illegal in 1977 by the American Football Coaches Association, but the motion was resoundly defeated. Still, others believe that this blocking technique will be ruled as being illegal within the next few years because of its damaging consequences. (12)

It is an accepted fact that foot fixation is a common element in the mechanism of injury to knees where the sport of football is concerned. Foot fixation is suspected to be a function of both the number and length of cleats on a shoe. In the case of few cleats, with narrow tips, the weightbearing surface is less, resulting in more force being transmitted through each cleat. This combined with a longer cleat leads to greater penetration of the cleat into the turf, allowing a greater chance of fixation. Fixation due to rigid cleating sets up the opportuni-

ty for torquing or sheering forces to act on the knee. Torque is by far the more damaging of the two, and is implicated in many of the meniscal lesions incurred during "non-contact" injuries in football. The above components describe the "traditional" football shoe with seven cleats (five on the ball of the foot and two on the heel); each being three-quarters of an inch in length and having a tip diameter of three-eighths of an inch. Cameron and Davis (8) explained how the traditional football shoe predisposed an athlete to injury.

> The foot is a lever system with an ankle joint fulcrum (flexion-extension) attached to two levers, the forefoot and heel. This system is attached to the body through two rotatable joints: the knee (minimal rotation) and the hip (maximal rotation). To prevent knee and ankle torsion injury, the foot must be able to rotate in the direction of the body after the extreme of hip rotation is reached. If the foot cannot, the superimposed body weight applies dangerous torque to the knee and ankle. However, if the foot follows the body through this motion, then torque is absorbed. To do this, there must be one axis of rotation in the foot, making it mandatory that there be no rigid heel cleats upon the posterior lever of the foot (heel) and only a single, central axis around which the forefoot lever can rotate.

Because of the principles underlying the above caption, many football players have begun wearing soccer type shoes, shoes with swivel heel plates, or shoes with shorter cleats on natural turf. An attempt has been made to institute a "swivel shoe" (8). Numerous long term studies have been conducted to determine which alternative, if any, would have an effect on reducing the number of knee injuries while still allowing the athlete the agility required by the sport.

The "swivel shoe" is free of any heel cleats, and those on the forefoot are in the form of "rotatable moveable cleats mounted upon a simple 360 degree turntable." This last innovation acts as a torsion joint by allowing the foot to follow the body (even though the cleats

are fixed), thus reducing the torque which would otherwise be placed on the knee. Klein (23) accounts for the cleatless heel by saying that players do not run on their heels, and "any coach who understands the mechanics of the human body should realize how useless the heel cleat is and how it locks the heel in cutting, turning and player contact, intensifying major strains thrown on the knee."

Cameron and Davis (8) reported that the "swivel shoe" allowed football players to achieve the same agility as a conventional shoe did. Following their data collection of knee injuries occurring to the subjects, the authors calculated what they termed a "safety factor" of the "swivel shoe". The results allowed them to conclude that against the average (cleated shoe, heel plate and soccer shoe combined) the "swivel shoe", was 3.41 times safer where the prevention of knee torque injuries were concerned.

Torg and Quendenfeld (37) believed the "molded sole, soccer type shoe", because of its construction, had the ability to prevent or lessen the amount of foot fixation. The soccer shoe possessed twice as many cleats (fifteen) as the traditional shoe. The cleats were also shorter, three-eighths of an inch in length; and had a larger cleat tip diameter, one-half an inch wide. These differences allow the soccer shoe 3.5 times as much effective cleat tip surface than that of the traditional shoe resulting in a decreased force being transmitted through each cleat. Over a two-year study period with 594 high school football players as subjects, Torg and Quendenfeld (37) concluded that the "conventional shoe with seven long cleats is the major factor responsible for the epidemic of knee injuries occurring in all levels

of football." Their solution was to have the players wear cleats with a synthetic molded sole, psssessing a minimum of fourteen cleats per shoe, each no longer than three-eighths of an inch, and each cleat tip being at least one-half inch in diameter. Mueller and Blyth (3) agreed with these findings, but as well, stated that there was a reduction of knee and ankle injuries to players wearing soccer shoes performing on well maintained fields. Poor field maintenance was viewed as a contributing factor.

Various surface conditions have also been credited with influencing the icidence of knee injuries, as they relate to shoe type. Torg, et al. (38) conducted a laboratory study to "determine the safety characteristics of various shoe surface-interface conditions", on the assumption that changes in turf characteristics could also effect the degree of foot fixation, and consequently, the stress applied to the knee. An "assay device" designed to measure the torque required to release an engaged shoe surface-interface was applied to various combinations of three categories of cleats and nine surface classifications. Arbitrarily, assigning release coefficients to classifications of "Not Safe", "Probably Not Safe" and "Probably Safe", the following were concluded (38).

- Release coefficients vary with number, length and diameter of cleats as well as the nature and condition of the surface.
- The conventional shoe with seven, three-quarter inch cleats was "Not Safe" on grass. The same shoe with one-half inch cleats (mandatory in the NCAA at the time of the study) was "Probably Not Safe" on grass.
- The "molded sole soccer type" shoe (fifteen cleats, one-half inch long with a tip diameter of three-eighths inch) commonly used on Astroturf as "Probably Not Safe".
- The "molded sole soccer type" shoe (fifteen cleats, one-half inch long with one-half inch tip diameter) proved to be "Probably Safe" on all surfaces under all conditions. The only stipulation

was that the sole had to be of a synthetic material and not of natural soft rubber. Rubber was found to have an inherent frictional quality resulting in certain shoes being termed "Probably Not Safe" on Astroturf and Poly-Turf regardless of other factors.

From the preceding information, it would appear that the "synthetic molded sole soccer type" shoe with fifteen cleats, one-half inch in length and a tip diameter of no less than one-half inch is the best equipped shoe where the prevention of torsional forces is desired. With reference to natural turf, the Canadian Intervarsity Athletic Union requires that all amatuer football players wear a shoe having a minimum of twelve cleats with the tip diameter being no less than three-sixteenths. Metal cleats or tips are ruled illegal (17). No stipulations are made with regard to artificial turf.

The artificial playing surfaces which are in use today, vary according to the material used in their construction, and are therefore slightly unique from one another. Basically these surfaces are made of three layers: a hard base surface, a middle base which provides cushioning, and affects the turfs' water absorption qualities, and a top carpet like layer of closely packed fibres which determine the traction qualities of the surface. Merritt and Thomson (25) delineated the main construction differences among the artificial turfs in use today.

Unlike natural turf, foot fixation on artificial turf is unrelated to cleat penetration, leaving only the friction between the cleat surface and playing surface as a factor (5). As mentioned previously, the material of which the cleat surface is constructed has an influential role in the incidence of knee injury. Torg, et al. (38) and

Bowers and Martin (5) all reported that cleats made of rubber, urethane or other soft malleable material resulted in more cleat-surface friction than other sole materials. Unfortunately, it is difficult to draw the line between how much friction (traction) is required for optimum performance by the athlete, and the point where traction becomes hazardous in relation to the torsional forces placed on the knee joint. Contrary to what was found on natural turf, Bostingl, et al. (4) determined that in the case of a shoe with a more effective cleat-surface area, shoe-surface friction was increased, thus adding to the likelihood of foot fixation. They concluded that the use of a shoe with more numerous cleats should be cautioned against on artificial turf. Merritt and Thomson (25) summarized the frictional qualities of the various brands of artificial turf. Wetting the surface decreased cleat-surface friction, as did hot dry weather in the case of "Poly-Turf". Bramwell, et al. (6) reported a decrease in the number of knee injuries when the artificial turf was wet. Ryan, et al. (34) reported an increase in cleat-surface friction when the player was pushing off against the grain of the turf. Adkinson, et al. (1) found the incidence of injury to be significantly greater on "Astroturf" (.63 injuries per game), than on grass (.51 injuries per game) or "Tartan Turf" (.28 injuries per game).

Intrinsic Factors Associated With Knee Injury

When all the extraneous contributing factors to injury are removed, the athlete must rely on his knee joint, ligaments, its capsule and its associated muscle tendons to aid in the stability and protection of the joint. Unfortunately, the structural components of a football players knee

are no better equipped to protect it from the sport's inherent blows and torsional stresses than that of the general population. To compensate for the additional stresses to which the knee is subjected, the player must train and condition all the supporting structures of the knee to their optimum level.

Numerous researchers have attempted to relate ligament laxity and muscular strength to the incidence of knee injury (22, 26, 28, 35). Kaplan (20) closely relates the three by stating that "stability is maintained by the ligamentous apparatus" of the knee, but "without the action of the muscles which move the joint, the ligaments are insufficient to maintain stability." The ligaments and musculature of the knee contribute to joint stability through what is known as the proprioceptive stretch reflex (20). A proprioceptive stimulation is sent to the surrounding musculature from the ligaments when they (the ligaments) are placed in a situation of abnormal stress. The muscles respond by stabilizing the knee and thereby reducing the likelihood of ligamentous injury. When the stress is placed on a ligament that has been previously stretched, the stretch reflex will allow more torsion within the joint before it calls to the muscles for assistance. By the time the muscular stabilizing action is initiated, joint motion may have exceeded its normal limits, thus making it to late to prevent injury. Herein lies the reasoning for partly naming ligament laxity as a contributing factor in knee joint injury.

Even though the role of ligament laxity in knee injury has been recognized, it is still questionable whether it can be used to predict injury, largely due to the lack of objective testing methods available.

Nicholas (28) used five indices of ligamentous-capsular-muscular looseness to determine if 139 professional football players were loose or tight jointed. Of the 39 players who had at least three indices of looseness, 72 percent ruptured their knee ligaments. In contrast, only 4 percent of those in the tight category ruptured knee ligaments.

Using the same joint laxity indices with 282 high school athletes, Grana and Moretz (16) found no correlation between injury and the number of positive laxity tests. He proposed that "results from a group of professional football players could not be extrapolated to other age groups or levels of performance."

Kalenak, et al. (19) used both objective and subjective joint laxity testing procedures to assess knee joint ligament stability on 401 college football players. Results showed with those assessed subjectively, 19 knee ligament injuries occurred in "loose-jointed" players and 24 in "tight-jointed" players. The authors concluded that it was not possible to predict knee injuries through assessment of ligament laxity.

Even though there appears to be much controversy with respect to the influence knee ligament stability has on the occurrence of knee injury, Klein (24) reviewed the following findings which may be useful in implicating injury.

- As the related supporting structures (muscles) of the knee are strengthened, the ligaments seem to increase in density and strength, provided they are not put in stressful situations by the exercises.
- The best protection for the ligaments is balanced muscle strength.
- Ligament tension varies with age and appears to be at its loosest during puberty (high school age).

The player with ligament laxity is more susceptible to abnormal movement between the tibia and femur when subjected to a forceful blow or a forceful change of direction. In such a case, well conditioned

thigh and calf muscles (responsible for strength and specific habit patterns), must act to ensure joint stability and the development of the tensing action which is necessary to bind the tibia and femur together. Goldfuss, et al. (15) showed that conscious contraction of the hamstrings and quadriceps had a stabilizing effect on the knee to help prevent the extremes of abduction and adduction (valgus and varus stress).

In the discussion of muscular strength as it relates to knee stability, muscular imbalance seems to be implicated. The muscle groups most involved appear to be the quadriceps and hamstrings, and the correct strength balance between these antagonists in each leg and between the two legs may be important. Klein (21) found that athletes with a quadriceps strength to hamstring strength ratio of 2:1 possessed greater ligament laxity than those with a ratio of 10:6. With reference to Bender's work done at West Point, Klein (21) found a total strength imbalance of 10 percent or more made that athlete more susceptible to knee injury. Klein, in his own study, found that 79.5 percent of the athletes with injured knees had at least 9.8 percent strength imbalance and all were injured on the weak side.

Klein (22) believed that discrepancies in leg length could be implicated as a contributor to knee injury because of a change in the mechanics of movement and increased torque to the knee during running. He drew his conclusion from a study of 260 football players in which 80 percent of them suffered knee injuries to their short leg.

A lack of pre-season conditioning may predispose a football player to knee injury. Since muscular strength plays such a large role in knee

stability; fatigue, and an accompanying loss of thigh strength, may be a factor in the incidence of knee injury. In a study of 2,480 high school football players, Cahill and Griffth (7) found a total of 135 knee injuries. The group of non-conditioned players suffered 85 knee injuries, 19 requiring surgical correction; as opposed to the conditioned players with 50 knee injuries, 7 being surgical in nature.

The potential of reinjury to a knee looms in the minds of most athletes who have suffered previous knee injury. Cerny (9) reinforces this belief by stating, "a knee never forgets an injury". Clayton and Weir (10) investigated the comparative strength of injured ligaments that were surgically repaired, with those left to heal on their own (scar tissue-healing). They concluded that after six weeks, the ligaments repaired surgically were stronger than "scar tissue-healed" ligaments. This finding could explain the problem of recurrent injury to the knee experienced by athletes who have a history of a mild ligament sprain which was treated conservatively (i.e., a non-surgical knee).

Identifying the Causes of Knee Injury in Football - Other Factors

Blyth and Mueller (3) and Dufresne (13) listed several other factors which relate to injury in football. These will be briefly reviewed to allow later comparison with the influence they may have where the incidence of knee injury is concerned. Caution should be taken in directly comparing the two studies (3, 13) because of the differences between the Canadian and American games of football. These differences involve both the technical aspects of the game as well as the physiological characteristics (particularly size) of the players.

1. Varsity players had a significantly greater incidence of injury than those on the junior varsity squad (3).
2. Those participants with a larger number of years of playing experience had the highest incidence of injury (3). Dufresne (13) found that those with three to five years of playing experience suffered the highest incidence of injury (27 percent).
3. The positions most commonly played at the time of injury were those of fullback, quarterback, defensive tackle and offensive halfback (3). In contrast, Dufresne (13) found that at all levels of football, defensive halfbacks, linebackers, defensive ends and defensive tackles were injured most frequently. The two sets of data are contrasted in Table 1.

TABLE 1 POSITION RELATED TO INCIDENCE OF INJURY

POSITION	DUFRESNE'S RANKING	BLYTH AND MEULLER'S RANKING
Fullbacks	8	1
Quarterbacks	12	2
Defensive Tackles	4	3
Offensive Halfbacks	6	4
Linebackers	2	7
Defensive Ends	3	6
Defensive Halfbacks	1	10

CHAPTER III

METHODS AND PROCEDURES

METHODS

Knee Injury Report Form. A questionnaire which was designed for use in this study served as the survey instrument by which data could be gathered. The nature of the questions centred around the extrinsic factors which could lead to knee injury in high school football. Some of the questions were adapted from the injury report form used by Dufresne (13). The remainder of the questions were developed following an extensive review of the literature concerning knee injuries in football, and consultation with coaches, trainers and players.

To outline the purpose of the study and the correct procedures for completing the survey form, an instruction sheet was attached to each report form. A copy of the "Knee Injury Report Form" and the instruction sheet are included in Appendices A and B

Sample. The subjects for the study were 1189 Edmonton high school football players active during the 1979-80 playing season. This season was approximately nine weeks in length; extending over September, October and the first week of November. Players in both the junior and senior varsity leagues were included in the study. The size of the total sample was based on the number of players on each team prior to the first game.

PROCEDURES

Following approval from the Edmonton Public and Separate School Boards, and their football coaches to conduct the study, the "Knee

Injury Report Form" and the accompanying instruction sheets were distributed to the coach and/or trainer of each football team. They were instructed that a report form was to be completed by the injured athlete with the aid of the coach and/or trainer as soon after the occurrence of knee injury as possible. Upon completion, the questionnaires were collected from the schools by the form administrator. To assist in the data analysis, additional information regarding the number of players at each position and information detailing the practice schedules was also gathered. This was acquired through personal communication with the various coaches.

Data Analysis. Frequency tables are used to illustrate the occurrence of knee injury relative to each category within each of the factors associated with knee injury. The percentage of the total number of knee injuries occurring in each category within each factor is also included in each table.

The overall knee injury rate was calculated through the use of a formula similar to that used by Blyth and Meuller (3).

$$\text{Overall Knee Injury Rate} = \frac{\text{Number of knee injuries}}{\text{Total number of athletes at risk}}$$

Because of the descriptive nature of this study, the use of an experimental design or inferential statistical analysis was ruled out.

CHAPTER IV

RESULTS AND DISCUSSION

The results presented below were arrived at by compiling the data from the nineteen knee injury report forms collected during the present study. The variables are discussed in the order in which they were listed on the report form, with only the data which appeared meaningful, being examined.

The overall knee injury rate was calculated by dividing the total number of participants at risk into the total number of reported knee injuries.

Incidence

In the sample of 1189 high school football players, there were nineteen cases of reported knee injury. The overall knee injury rate was calculated as being .0159 or approximately 1.60 percent. Of this total; four injuries occurred among the 591 junior varsity players, representing .68 percent of the junior sample. The remaining fifteen knee injuries occurred to participants classified as senior varsity players. There were 598 senior varsity players in the sample. The injury rate for the senior varsity players was 2.51 percent.

Playing Position

Of the total number of nineteen knee injuries; nine (47.4 percent) occurred to the 627 athletes at the defensive positions, seven (36.84 percent) occurred to the 555 offensive players, and the remaining three (15.78 percent) occurred to players on the offensive specialty teams.

Of the nine defensive players who were injured, five were line-

backers, accounting for 26.32 percent of the total number of knee injuries. Defensive tackles suffered one knee injury as did defensive backs, corner backs and safety men.

Offensive tackles sustained three knee injuries, running backs sustained two knee injuries, and the tight ends and wide receivers sustained one knee injury each. Table II represents a summary of these findings.

TABLE II FREQUENCY OF KNEE INJURY RELATED TO PLAYING POSITION

POSITION	FREQUENCY OF KNEE INJURY	PERCENTAGE OF TOTAL KNEE INJURIES
Centre	-	-
Offensive Guard	-	-
Offensive Tackle	3	15.79
Tight End	1	5.26
Wide Receiver	1	5.26
Running Back	2	10.53
Quarterback	-	-
Defensive Tackle	1	5.26
Defensive End	-	-
Linebacker	5	26.32
Defensive Back	1	5.26
Corner Back	1	5.26
Safety	1	5.26
Specialty Team(Off.)	3	15.79
Specialty Team(Def.)	-	-
TOTAL	N = 19	

Three of the five injured linebackers suffered knee injuries during game play, while a fourth was hurt in a scrimmage situation. Two of the four injuries reported above occurred when the players were tackling, another when the player was blocked, and the fourth occurred during a clipping infraction. Two of the linebackers were injured through a collision with another player; where, in each case, the foot of the injured leg was fixed. One of the knee injuries occurring in a game was the result of another player falling on the linebacker's knee, while the fourth linebacker injured his knee when he was executing a tackle during a practice scrimmage.

The next most frequently injured players were the offensive tackles, sustaining three injuries during blocking situations in either a game or scrimmage. Of the three reported injuries that occurred to the offensive tackles, one occurred during a fall, the second when another player fell on the injured leg, and the third in a collision. The two latter cases had the offensive tackles positioned in such a way that the leg of the affected knee was weight-bearing at the time of injury.

Specific Activity and Cause of Injury

The occurrence of knee injury during contact drills, scrimmages and games may be associated with blocking (six injuries), being blocked (three injuries), tackling (three injuries) and being tackled (four injuries). When "being blocked" was the activity at the time of injury, all three knee injuries were attributed to a collision with another person. Two of these collisions took the form of clipping infractions. "Blocking" injuries occurred three times when the injured player collided with another player, once when the injured player fell and

twice when another player fell on the injured player's knee.

A collision with another person accounted for all three of the injuries that were experienced while the player was "tackling". Injuries sustained while the players were "being tackled" occurred once when the injured player fell, twice when the injured player was fallen on, and once when a player sustained a rotational force to his knee. The information regarding the specific activity and the cause of injury is tabulated in Table III.

TABLE III SUMMARY OF THE ACTIVITY AND CAUSE OF KNEE INJURY DURING CONTACT DRILLS, SCRIMMAGES AND GAMES

CAUSE OF INJURY	BLOCKED	BLOCKING	TACKLED	TACKLING	TOTAL	PERCENTAGE OF TOTAL
Collision	3	3	-	3	9	56.25
Fall	-	1	1	-	2	12.50
Fallen On	-	2	2	-	4	25.00
Rotational Force	-	-	1	-	1	6.25
TOTALS	3	6	4	3	16	100.00

Illegal Plays

In two of the nineteen cases of knee injury in the present study, the injured athletes claimed that a clipping infraction should have been assessed to the opposing players. If such was the case, the number of knee injuries that occurred in conjunction with illegal plays would be 10.52 percent of the total. One of the injuries was sustained by a player at a corner back position, while the other occurred to a line-

backer. The block on the corner back was delivered from behind and below his knees as he was in pursuit of the ball carrier. The linebacker received the other alleged illegal block from the rear and in the area of his mid-thigh.

Protective Taping or Support

Of the nineteen players suffering knee injuries, 47.37 percent (nine players) wore no form of protective tape or support wrap on any portion of the injured leg prior to sustaining injury. Three players (15.79 percent) had the ankle of the injured leg taped, two players (10.53 percent) had the involved knee taped prior to injury, and five players (26.32 percent) wore a tensor bandage on the affected knee prior to injury.

Game and Practice Sessions

On the average, each team in the 1979 Edmonton High School Football Leag[illegible]ght games, resulting in a total of eight hours of game time [illegible] In contrast, each team devoted a total of approximately 81 h[illegible] practice time during the nine week playing season. Therefore, o[illegible] total amount of participation time, nine percent was allocated to [illegible]e play and 91 percent was allocated to practice time. Of the practic[illegible] time 52 percent (42 hours) was centred around non-contact drills, [illegible] percent (21 hours) involved contact drills, and the remaining twenty percent (16 hours) was devoted to scrimmage situations.

The overall number of knee injuries occurring in either game or practice sessions were 47.37 percent and 53.63 percent respectively. Of the nine knee injuries sustained during games, three (33.33 percent) were sustained during first quarter play, and of the remaining six knee

injuries (66.67 percent) two occurred in each of the second, third and fourth quarters of play.

Five of the ten knee injuries (50 percent) which occurred during practice sessions were incurred by players involved in contact drills. Three knee injuries (30 percent) were sustained by players participating in scrimmage situations, while the remaining two knee injuries (20 percent) were sustained during non-contact drills.

When the time spent in the various phases of a practice was examined in conjunction with the number of knee injuries occurring in each phase, contact drills were associated with approximately five times the number of knee injuries that occurred during non-contact drills. Similarly, the section of the report form denoted as scrimmage situations was associated with four times the number of knee injuries that occurred during non-contact drills.

Experience at a Position

A lack of familiarity with the playing skills and role of a particular position does not appear to be a possible causal factor in the nineteen cases of knee injury reported in the present study. Players who had been at their position "since the beginning of the season" received fourteen of the nineteen knee injuries, resulting in a knee injury rate of 73.68 percent. Players at a position which they had been at for only "one week prior to injury" received three knee injuries (15.78 percent), while the remaining two injuries were sustained when the players were at a "new position" (change made during the game or practice in which the injury occurred).

Portion of the Season

Of the nineteen knee injuries that were reported during the 1979 playing season, ten (52.63 percent) were sustained during the first half of the season. The remaining nine (47.37 percent) reported knee injuries occurred during the second half of the playing season. This information is presented in Table IV.

TABLE IV TIME INTO THE PLAYING SEASON RELATED TO KNEE INJURY OCCURRENCE

WEEK OF THE SEASON	NUMBER OF KNEE INJURIES	PERCENTAGE OF THE TOTAL KNEE INJURIES
1	-	-
2	3	15.79
3	3	15.79
4	4	21.05
5	4	21.05
6	3	15.79
7	1	5.26
8	-	-
9	1	5.26
TOTAL N = 19		

Number of Cleats on Playing Shoes

Of the nineteen football players in the present study who sustained a knee injury, only one was wearing a pair of shoes which possessed less than twelve cleats per shoe. This individual was wearing low cut running

shoes at the time of knee injury. Four of the nineteen injured athletes were wearing shoes with twelve to fifteen cleats on the sole, and another four had shoes possessing sixteen to twenty cleats. The remaining ten athletes who received knee injuries were playing in shoes which possessed 21 cleats. The shoes with 21 cleats were associated with the highest percentage of the total number of knee injuries at 52.63 percent. Table V represents a summary of the number of knee injuries which occurred with the various types of shoes.

TABLE V NUMBER OF CLEATS ON A SHOE RELATED TO KNEE INJURY OCCURRENCE

NUMBER OF CLEATS ON A SHOE	NUMBER OF KNEE INJURIES	PERCENTAGE OF THE TOTAL KNEE INJURIES
None	1	5.26
12-15	4	21.05
16-20	4	21.05
21	10	52.63
TOTAL N = 19		

Additional Comments

The nature of the knee injuries incurred by players in the 1979 Edmonton High School League varied, with the most frequently occurring injury being ligament sprains. Such sprains accounted for twelve of the nineteen knee injuries, or, 63.16 percent of the total number of knee injuries. Six of these twelve reported instances of ligament sprain required surgical repair. Four of the total number of nineteen knee injuries were not appraised by medical personnel. Of the remain-

ing three knee injuries, one was recorded as a patellar dislocation, another as a meniscus tear, and the third as a fracture of the tibial plateau.

In fifteen of the nineteen knee injuries (78.95 percent) which occurred in the present study, the knee had not been previously injured. Three of the four remaining knee injuries had a history of being sprained within the year prior to the 1979-80 football season. The nature of the reinjury in two of these three instances was that of ligamentous sprain.

Discussion

The knee injury rate in the 1979 Edmonton High School Football League appears appreciably lower than any of those found in the literature. A tabulation of the various rates may be found in Table VI.

TABLE VI KNEE INJURY RATES IN HIGH SCHOOL FOOTBALL

YEAR OF THE STUDY	NUMBER OF KNEE INJURIES	KNEE INJURY PERCENTAGE
1979	19	1.60
1970-78 (29)	94	2.09
1975-76 (27)	53	5.87
1969 (13)	45	3.75
1969-72 (3)	827	9.42

The apparent decline in the overall knee injury rates may be attributed to numerous factors. For instance; coaching certification, improved training and conditioning techniques, equipment modifications (cleats)

and rule changes (elimination of clipping, crack-back blocking) have all been instituted by the Canadian Amateur Football Association, the governing body of the Edmonton High School League.

Because different recording, survey and sampling procedures were utilized in each of the above mentioned studies, caution should be taken not to draw direct comparisons between the various knee injury rates.

Similar to the findings of Blyth and Mueller (3) with regards to injury in general, the senior varsity players in the present study sustained a higher number of knee injuries than did their junior varsity counterparts. Such results would suggest that it may be premature to assume that a higher degree of skill and a consequent improvement in skill execution leads to a decrease in the number of injuries which occur. However, the suggestion (3) that physical size and strength dominate as the criteria for selecting the senior varsity athletes may explain the higher knee injury rate at the senior level. Such practices may result in an athlete being placed on the senior squad, despite inadequacies in the necessary skill and performance parameters. Such inadequacies, in combination with a larger body mass, may predispose the athlete and those around him to a greater chance of injury. It has also been suggested that because the larger body masses and strength components lend themselves to larger impact forces, the senior varsity game is of a much more physical nature than that which is played at the junior varsity level (3).

As was shown in the present study, defensive players, particularly linebackers, experienced the greatest number of knee injuries. This finding may indicate the need for a reevaluation of the current block-

ing techniques and rulings, but more than likely, the higher rate of knee injury must be viewed as an inherent risk associated with the defensive positions. When the role and position of the defensive players on a football team are considered, one can understand why they may be predisposed to a greater frequency of injury than their offensive counterparts. In a game of football, it is the offensive players who know the direction the play will follow and consequently are able to deliver the blows. In contrast, the defensive players must "read" the play and react appropriately to the actions of the offensive players. When the basic defensive alignments are examined, the position of the outside linebackers or the defensive ends in relation to the offensive players facilitates their being blocked from the side opposite that to which the play is moving, making them particularly susceptible to knee injury. Dufresne (13) supports this conclusion by ranking linebackers, defensive halfbacks, defensive ends and defensive tackles as being the four playing positions most frequently experiencing injury. Blyth and Mueller (3), on the other hand, report that offensive players (quarterbacks, fullbacks and offensive tackles) occupy three of the four most frequently injured positions. Blyth and Mueller (3) rank defensive tackles as the third most frequently injured player.

The discrepancy between these findings may be explained by the fact that Blyth and Mueller incorporated a denominator which calculated the frequency of injury according to the number of positions played. This was deemed necessary because of the varying numbers of players at a given position during a game. For example, depending on the defensive formation used, there may be anywhere from two to five defensive backs

and as many as four linebackers on the field at one time. In contrast, there is only one quarterback and one centre active at any given time. Because of these differences in personnel requirements, a team carries a larger number of linebackers and defensive backs, which leads to a larger number being at risk during a game or practice. This variable may also have contributed to the higher number of knee injuries which was experienced by the linebackers in the present study.

Collision with another player contributed to just slightly less than half of the knee injuries in the present study. Two of these were the direct result of illegal blocking techniques. Because "collision" between players is an integral part of the sport of football, the correct techniques of both receiving and delivering blows must be instructed and emphasized, particularly at the high school level of football. It is at this level of play where the athlete will acquire the majority of the fundamental skills that he will utilize for the duration of his football career.

Although the number of knee injuries occurring in either a game or practice situation (ten and nine respectively) appear almost equal, the former may be viewed as being high when all points are considered. The fact that an athlete's exposure time is much less during a game than in a practice (3), combined with the observation that a high school football player spends approximately only one-tenth of his playing season involved in games makes this knee injury rate appear high in comparison with that which results from practices.

When the amount of time which is devoted to the "contact" portion of the practice (47 percent) is considered in comparison with that

devoted to non-contact situations, the former would appear to predispose an athlete to a greater chance of knee injury. Because 78 percent of the knee injuries were incurred during less than half of the total practice time, one should question the use of contact drills and scrimmages from the standpoint of the athlete's safety. However, if this portion of the practice was totally eliminated, the football player would never be exposed to the type of contact experienced in a game situation, and consequently would lack the knowledge and skill required to deliver and receive blows effectively and safely. The lack of contact in itself may lead to even a higher incidence of injury during games.

The amount of practice time devoted to contact drills and scrimmage situations is ultimately the decision of the coaching staff. It is essential that they be equipped with concrete information as to the amount of time that is required for the athletes to learn and maintain the skills associated with safe, effective blocking and tackling. The coaches must be made aware of unsafe techniques and at the same time be offered feasible alternatives. Safety measures such as matching player's weight, strength, and skill should be incorporated into the contact drills which have proven most beneficial where skill acquisition is concerned. Only when the above considerations are implemented will contact drills and scrimmages serve a useful, yet safe purpose.

Contrary to what is reported in the literature (3, 13, 27) with regards to injury in general, the frequency of knee injury in this study remained relatively constant throughout the season. This may indicate that knee injuries are not as closely associated with physical conditioning as

muscle-related injuries are. Rather, the knee injury pattern of the present study seems to revolve around the format of the playing season. During the first week of practice when the emphasis is on conditioning and technique, there is an absence of knee injury. As the season progresses, and the teams prepare for the first game (i.e. more contact and scrimmage situations during practice), the number of knee injuries increases. It is uncertain as to why the occurrence of knee injury is so low during the last three weeks of the playing schedule, but it may be due to a reduction in the amount of contact during practices, well developed habits of safety or improved skill level.

Because the purpose and design of this present study did not include the gathering of data regarding the shoes worn by uninjured players, any conclusions regarding the relationship between the number of cleats on a player's shoe and the occurrence of knee injury are not possible. Also, because of the Canadian Amateur Football Association's ruling which stipulates that if the athlete wears a cleated shoe, it must contain no less than twelve cleats, it is hypothesized that the majority of the players in the 1979 Edmonton High School Football League wear such a shoe. Therefore, the sample in question is obviously biased where shoe type is concerned, and the forming of any relationship between this factor and the incidence of knee injury must be cautioned against.

CHAPTER V

SUMMARY, IMPLICATIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to examine the extrinsic factors associated with knee injury in high school football. The study was conducted over the nine week playing season of the Edmonton High School Football League. The sample consisted of the 1189 players who participated in the 1979-80 playing season. Data was collected by means of a Knee Injury Report Form which was to be completed by any football player who sustained a knee injury while participating in the 1979-80 Edmonton High School Football Program. When necessary, the coach or trainer of the injured athlete was to assist in the completion of the form. The Report Forms were collected, knee injury rates were calculated and the data was assembled into frequency tables.

The present study observed nineteen cases of reported knee injury, a number lower than any of the knee injury rates previously recorded in the literature. Fifteen of the nineteen knee injuries were sustained by senior varsity players, while the remaining four knee injuries were sustained by junior varsity players. The occurrence of the greater number of knee injuries in the senior varsity league was associated primarily with one factor. It was suggested that because of the larger body mass and greater strength of the senior varsity players, the senior varsity level of play possesses a potential for greater impact forces than the junior varsity level of play.

The nineteen reported knee injuries were distributed among the defensive, offensive and specialty team players, with the defensive players sustaining nine knee injuries, the offensive players sustaining

seven knee injuries and the offensive specialty team players sustaining three knee injuries. When viewed according to playing position, linebackers sustained five knee injuries and consequently were ranked as having incurred the largest number of knee injuries. The higher rate of knee injury among the defensive players was considered to be an inherent risk accompanying the defensive positions. The players at the positions of linebacker, defensive end or defensive halfback appeared to be prone to a greater chance of knee injury because of their positional relationship to the offensive players.

Collisions between players were associated with nine of the nineteen knee injuries in the present study. Because collisions are an integral part of the sport of football, it is essential that an emphasis be placed on the instruction of the correct blocking and tackling techniques, along with the teaching of the correct method to receive, deflect and distribute the impact forces associated with a collision sport. This is deemed particularly essential at the high school level of competition.

Nine of the nineteen knee injuries that were reported were sustained during game play. These nine injuries occurred in spite of the fact that an athlete's exposure time is much less during game play and, the finding that only one-tenth of the playing season was allocated to game play. The remaining ten knee injuries were sustained during practice sessions, with eight being associated with the contact portion (contact drills and scrimmages) of the practice schedule. Because 80 percent of the knee injuries occurred in 47 percent of the total practice time (contact drills and scrimmages), the value of the contact phases of a practice should be questioned from a safety point of view. The coach should have access to information concerning the most effective methods of

teaching and maintaining the skills associated with safe, effective blocking and tackling techniques. The coaches must also be made aware of every possible safety precaution that may aid in the reduction of the number of knee injuries incurred through contact drills and scrimmages.

No conclusions regarding the relationship between the number of cleats on the injured players' shoes and the occurrence of knee injury can be made because the design of the present study did not facilitate a control among the uninjured athletes. The sample was viewed as being biased because of the Canadian Amateur Football Association's ruling that required its athletes to wear a shoe with no less than twelve cleats on the sole.

Implications and Recommendations

1. Within the past few years, the appropriateness of football in the high school system has been questioned because of its reported high injury rates and its budgetary requirements. The results of the present study may serve to lessen the concern that surrounds injury occurrence, particularly where knee injury is concerned. The public should be made aware that the advancements made in the area of athletic training and conditioning, the methods of skill instruction and maintenance, and the education of coaches all serve as deterrents to a high incidence of injury. Where it has proven necessary, the governing body has passed rulings to aid in a further decrease of the knee injury rate. The findings of this study suggest the need for a reevaluation of the present injury patterns occurring in football within the high school system. Although at one time the public may have been correct in assuming that football produced more than its share of injuries, such an impression

today may be erroneous in nature. However, such a trend of thought is perpetuated as a result of injuries being reported in gross numbers, with little or no reference being made to an athlete's exposure time or the total number of participants in that sport.

2. The knee injuries which did occur in the present study seemed to be largely a function of a player's position and the amount of force imparted through the collision aspect of football. No doubt, because collision is an integral part of football, and because some positions are more prone to injury than others, the occurrence of injury must be expected. However, injury will be kept to a minimum if the athlete is taught, from the outset of his football career, to use safe, effective methods of receiving and delivering the impact forces associated with tackling and blocking. To accomplish this, the coaching staff must possess a working knowledge of the safety, conditioning and technical (rules, equipment) aspects of the game, along with the ability to instruct the required skills to the athletes.

3. When selecting players for the senior varsity squads, the coaching staff must realize that strength and size alone do not constitute a good football player. To be successful, the athlete must possess the performance factors and physical skills required by the sport, along with an appropriate mental attitude. An absence of even one of these attributes may predispose an athlete to knee injury.

4. Because 80 percent of the knee injuries occurred during the contact and scrimmage portions of the practice sessions, a critical analysis of practice requirements should be made. The coach must be supplied with information that is applicable to the practical situation

before he will be able to conduct the safest and most efficient practice possible. Just [illegible]ch of a practice must be allocated to contact drills and practice s[illegible]o facilitate learning and skill maintenance has yet to be deter[illegible]though there is an abundance of information regarding [illegible]ious [illegible]s of instruction, and numerous drills which can be used in t[illegible]ching [illegible]e blocking and tackling aspects of football, there appears to [illegible]e no[illegible]ata regarding the judicious use of contact drills. Preventative [illegible]sures such as matching players for their weight, size and skill du[illegible]g the contact portion of practice may also lead to a further reduc[illegible]on in the occurrence of knee injury in the sport of football.

5. The k[illegible]e Injury Report Form which served as the survey instrument in the present study should be reevaluated if it is to be used again. As the data was being assembled for the Results section of this study, it became apparen[illegible]that the wording of some of the questions could have caused the injur[illegible]athlete to misinterpret the meaning of the question. The revised questions are presented in Appendix C. If the present study were to be repeated, a control should be instituted to allow collection of data relating to the type of shoes worn by uninjured players. This would facilitate an analysis of the effect of shoe surface interface on the occurrence of knee injury.

Concluding Statement

The occurrence of injury is the result of an interaction between various extrinsic factors, intrinsic factors, and to a certain degree, chance. Where knee injury in the present study is concerned, it would appear that certain extrinsic factors may predispose a football player

to injury. However, the literature review would also suggest that intrinsic factors, particularly thigh strength and muscular endurance also play a preventative role in the occurrence of knee injury.

No doubt, the occurrence of knee injury in the sport of football is not a predictable event because of the numerous variables involved, and the ever present element of chance. It is the element of chance that in many cases most likely dictates whether an athlete will sustain a serious injury or be part of a near-miss incident. Therefore, it is the responsibility of those people concerned with injury prevention to minimize the controllable extrinsic and intrinsic factors that predispose an athlete to knee injury.

The author believes that further investigation is required to determine the role played by physical conditioning in the occurrence of knee injury. Furthermore, observance of injury occurrence on game films may reveal the need for changes in the rules and technical aspects of the game before a decrease in the knee injury rates among the defensive players is seen.

At the outset of this study, the knee injury rate was expected to be considerably higher than that which actually occurred. This expectation was based on the information contained in the literature and, to a certain extent, on hearsay. The fact that the knee injury rate in the 1979-80 High School Football League was low (1.6 percent) could be viewed as one of the most important findings of the present study; both from the athlete's viewpoint and for the game of football itself.

Traditionally football, particularly at the high school level has been stereotyped as a sport which exposed its athletes to undue injury

risk. As has been stated, the nature of the game is such that injuries will probably occur, regardless of the preventative measures which are taken. However, it is believed that the incidence of knee injury within the sport of football is on the decline, and will continue in this manner as long as the conditioning methods, technical aspects, instructional methods and coaching philosophies continue to be upgraded. The implementation of such advancements into the Edmonton High School Football Program would appear to be largely associated with the low number of knee injuries reported in the present study.

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APPENDIX A

FOOTBALL KNEE INJURY REPORT FORM

1979-1980

FOOTBALL KNEE INJURY REPORT FORM

1979-80

Name of Player: _____

Home Address: _____ Home Phone: _____

Age (yrs.): _____ Height (in.): _____ Weight (lbs.): _____

School: _____

League (circle one): Junior Varsity Senior Varsity

Date of Knee Injury: _____

Name of Physician (if seen): _____

Name of Trainer (if seen): _____

1. Position you were playing when the knee was injured:

( ) centre ( ) quarterback

( ) offensive guard ( ) defensive tackle

( ) offensive tackle ( ) defensive end

( ) tight end ( ) linebacker

( ) wide receiver ( ) safety

( ) running back ( ) other (specify) _____

2. How long had you been playing the position you were at when your knee was injured?

( ) new position (i.e. change made during that game or practice)

( ) one week prior to injury

( ) two weeks prior to the injury

( ) since the beginning of the present season

3. Knee injury occurred during a:

( ) game (proceed to question 4) ( ) practice (proceed to question 5)

4. In which part of the game did the knee injury occur?

( ) warm-up ( ) third quarter

( ) first quarter ( ) fourth quarter

( ) second quarter

5. In which portion of practice did the knee injury occur?

( ) warm-up ( ) contact drills

( ) non-contact drills ( ) scrimmage

6. Specific activity at the time of injury:

( ) blocked ( ) catching a pass

( ) blocking ( ) throwing a pass

( ) tackled ( ) carrying the ball

( ) tackling ( ) punting or kicking

( ) covering a pass ( ) other (specify) _____

7. Probable cause of the knee injury:

( ) collision with another person ( ) trip or fall (specify) ___

( ) collision with an object _____

8. If the knee was injured in a collision, what part of the injured player's body was contacted?

( ) above the waist

( ) above the knee and below the waist - right side

( ) above the knee and below the waist - left side

( ) above the knee and below the waist - front

( ) above the knee and below the waist - behind

( ) below the knee - right side

( ) below the knee - left side

( ) below the knee - front

( ) below the knee - behind

9. Was the foot of the injured leg fixed (weightbearing) at the time of injury?

( ) yes ( ) no

10. Name of the field (eg. Clarke Stadium): _____

11. Field condition at the time of injury:

( ) frozen ( ) wet ( ) soft

( ) snow covered ( ) dry ( ) hard

12. Turf quality in the area of the field in which the knee injury occurred:

( ) excellent ( ) fair ( ) very poor

( ) good ( ) poor

13. Area of field in which injury was incurred (if injury occurred in a game or scrimmage situation):

( ) 5 yards in front of line of scrimmage

( ) 5 yards behind the line of scrimmage

( ) open field in the end zones

( ) open field in the end zones

( ) open field between the goal lines

( ) other (specify): _____

14. Was there a penalty assessed on the play in which the knee injury occurred?

( ) no penalty

( ) injured player was penalized

( ) another player was penalized

15. If a penalty was called, specify what call was made. _____

16. Type of footwear:

( ) high top running shoes ( ) high top cleats

( ) low cut running shoes ( ) low cut cleats

17. Indicate brand name and model of shoe used. (eg. Puma All-Turf).

_____ _____

18. Number of cleats on shoe worn when knee injury occurred:

( ) 12 - 15 cleats

( ) 16 - 20 cleats

( ) none

( ) other (specify): _____

19. Type of supportive or protective taping used on injured leg.

( ) none

ankle ( ) tape

( ) cloth wrap

( ) tensor wrap

( ) other (specify): _____

knee ( ) tape

( ) tensor wrap

( ) brace

( ) other (specify): _____

thigh ( ) tape

( ) tensor wrap

( ) other (specify): _____

20. Which knee was injured?

( ) right knee ( ) left knee

21. Description of knee injury:

( ) sprain of medial collateral ligament

( ) sprain of lateral collateral ligament

( ) sprain of the anterior cruciate ligament

( ) sprain of the posterior cruciate ligament

( ) meniscus (cartilage) tear

( ) dislocation of patella (knee cap)

( ) other (specify): _____

( ) unknown (unappraised)

22. Has the knee that is presently injured ever been injured before?

( ) yes ( ) no

23. If applicable, specify the previous knee injury and how long ago it occurred.

_____ _____

24. If the knee has been previously injured, was it surgically repaired?

( ) yes ( ) no

25. Were you suffering from any other injury at the time the present knee injury was incurred? (include everything; eg. blisters on the left foot).

( ) yes (specify): _____

( ) no

26. Please add any additional comments which would add to explaining how the present knee injury occurred.

_____

_____

_____

_____

_____

_____

_____

_____

APPENDIX B

REPORT FORM INSTRUCTION SHEET

INSTRUCTIONS

A study is being conducted throughout the Edmonton High School Football Leagues to determine the extrinsic factors which play the largest role in the occurrence of knee injury. An extrinsic factor may be defined as any factor contributing to knee injury, that is not directly associated with the physiological or anatomical state of the athlete. Examples would include equipment, playing conditions, playing technique and previous history of injury. The questions on the next two pages are designed to attain such information.

Please read the brief instructions listed below and then proceed to the questions on the following pages.

1. A knee injury should be reported only if:
   - the player misses any portion of a practice or game because of it.
   - medical advice (physician, trainer) is sought regarding some knee problem, or
   - the player is unable to participate fully in practice (eg. "just sweats", "no hitting:, "no pads", etc.) because of a knee injury.
2. The form should be filled out as soon as possible following the injury to ensure accuracy. The team coach or trainer should aide the athlete in the completion of the form, if possible.
3. Place a check in the brackets preceding the most appropriate answer for each question. In some questions, more than one answer may be necessary.
4. The completed form should be returned to the team's coach or trainer. These will be collected from each school every Monday morning.
5. This form is to function only as an information gathering device,

and may not be used as a formal accident report form.

Should any questions or problems arise, please contact:

Nancy Jette 437-7425 (Residence)

432-5503 (U of A)

432-4752 (U of A Athletic Injuries Clinic)

APPENDIX C

1979-80 KNEE INJURY REPORT FORM

REVISED QUESTIONS

1. Position you were playing when the knee was injured?

( ) centre
( ) offensive guard
( ) offensive tackle
( ) tight end
( ) slotback
( ) wide receiver
( ) running back
( ) quarterback
( ) offensive specialty team
( ) defensive tackle
( ) defensive end
( ) linebacker
( ) defensive halfback
( ) corner
( ) safety
( ) defensive specialty team
( ) punter or kicker
( ) other (specify): _____

6. Specific activity at the time of injury (if necessary, circle more than one answer):

( ) blocked
( ) tackled
( ) blocking
( ) tackling
( ) covering a pass
( ) catching a pass
( ) throwing a pass
( ) carrying the ball
( ) punting or kicking
( ) other (specify): _____

7. Probable cause of knee injury:

( ) collision with another person
( ) collision with an object
( ) fallen on by another person
( ) trip or fall (specify): _____
( ) other (specify): _____

19. Type of supportive or protective taping used on the injured leg at the time of the knee injury:

( ) none

ankle ( ) tape

( ) cloth wrap

( ) tensor wrap

( ) other (specify): _____

knee ( ) tape

( ) tensor wrap

( ) brace

( ) other (specify): _____

thigh ( ) tape

( ) tensor wrap

( ) other (specify): _____

22. Has the knee that is presently injured ever been injured before?

( ) Yes (proceed to question 23)

( ) No (proceed to question 26)

23. What was the nature of the previous knee injury?

( ) ligament sprain

( ) muscle strain

( ) meniscus (cartiledge) tear

( ) contusion (bruise)

( ) bursitis

( ) patellar (kneecap) dislocation

( ) other (specify): _____

24. How long ago did the previous injury occur?

_____

25. Was the previous injury surgically repaired?

( ) Yes

( ) No

26. Were you suffering from any other injury at the time the present knee injury was incurred? (include everything; eg. blisters on the left foot).

( ) Yes (specify): _____

( ) No

27. Did the present knee injury require surgical repair?

( ) Yes

( ) No