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ABSTRACT

This report describes a study to demonstrate the effectiveness of applying epidemiologic methods in determining the extent of the problem of high school football injuries in North Carolina and to interrelate certain variables associated with the problem of risk in athletics. It provides a descriptive baseline of data on high school football injuries upon which to design and evaluate further analytic and experimental study. During the 1968 football season, a pilot study was performed a) to determine if the interview items were yielding the desired information, b) to provide a training opportunity for interviewers, and c) to establish a workable schedule for interview visits to participating schools. During the study years 1969-1972, data were obtained from 8,776 student athletes at 43 schools. Of this number 4,287 were injured. Raw data were classified, coded, and placed in computer-acceptable form for analysis. Principal findings are summarized that relate to distribution of injuries; environmental variables; host variables; activity at time of injury; the agent of the injury; coaches' background and experience; and data related to type, condition, and fit of protective equipment. Data upon which to implement countermeasures to protect the student athlete from harm are included. Also, a 279-item bibliography is included, and interview forms, equipment data forms, coding and classification specification, and helmet fit criteria are appended. (PD)

An Epidemiologic Study of High School Football Injuries in North Carolina - 1968 - 1972 -

FINAL REPORT

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CHAPTER I

THE PROBLEM

INTRODUCTION

Organized interscholastic athletics are an integral part of the educational program at almost every school level. As an extracurricular or "cocurricular" function, interscholastic athletic activities have had a phenomenal development in number and diversity during the last twenty-five years. They have had their greatest development in the secondary schools; but have also become prominent at the junior high and elementary levels, especially in the upper grades. There is general agreement among educators today on the potential value of these athletic activities to the total educational program. In support of interscholastic athletics the Educational Policies Commission (68) has stated:

> We believe in athletics as an important part of the school physical education program. We believe that the experience of playing in athletic games should be a part of the education of all children and youth who attend school in the United States .. .

With this growing interest in sports and their inclusion in the programs of more and more schools it becomes increasingly apparent that additional consideration must be given to the inherent danger to participants in these activities. Athletics are hazardous. In sports requiring vigorous activity injuries are bound to occur. However, the organization, administration and supervision of all extracurricular activities, including interscholastic athletics, are the direct responsibility of the school system in which they operate and in exercising this responsibility educators should exert every effort to assure that the potential for injury is kept to the absolute minimum commensurate with the values and the benefits of participation.

One of the primary responsibilities that school administrators, physical educators, recreators, coaches and others involved in school athletic programs must face is that of providing adequate protection and care against injuries that occur in these activities. Injuries in football occur much more frequently and receive much more publicity than do injuries resulting from participation in other athletic activities. In order to meet their growing responsibility to protect the athlete, educators must take a greater leadership position in evaluating the risk of involvement in sports participation, developing preventive measures where applicable, and enforcing greater adherence to accepted safe practices with regard to participation.

Other than the annual survey of fatalities among football players conducted by the American Football Coaches Association, The National Federation of High School Athletic Associations, and the National Collegiate Athletic Association, there seems to be a distinct lack of consideration of athletic injuries, particularly football injuries, as a significant health problem of the schools and of the nation. There is relatively little data available on the extent of the problem of football injuries, or other sports injuries, particularly at the high school level and below. The incidence of fatal injuries directly associated with high school football has been estimated at less than two per 100,000 participants annually. Unfortunately, this apparently low mortality rate, certainly more apparent than real, has tended to divert attention from football and other athletic injuries as a significant problem. When the magnitude of high school football participation across the nation is understood, it is not difficult to accept that the problem of football injuries is of significant proportions to warrant additional study. In the United States more than 30,000 public and private secondary schools field organized football teams each fall with a total of some 1.2 million young men participating. Another 70,000 young men participate at the college or university level. In addition, it has been estimated that some 200,000 boys play football for various community and social agencies. It has been estimated that, if the injury ratios available were applied nationally, the present injury problem would represent from 200,000 to 4,000,000 injuries to football players each fall. Any health problem that affects a million young men annually, in which the population at risk is rapidly growing, should be the concern of secondary school administrators and coaches.

IMPORTANCE OF STUDY

In view of these conditions it appeared that the application of a technical research method which has long guided the attack on communicable and other diseases might be appropriate and useful in determining the extent and nature of football injuries. From the application of the method enough might be learned to enable changes to be made in athletic programs which might reduce the incidence of injury to participants. While its direct attention is focused on high school football, the study's methodology and results are directly applicable to other levels of the sport and to the injury problem in other athletic activity carried out under the auspices and direction of the school program.

Football is a hard, body-contact sport in which injuries and fatalities will never be totally eliminated, regardless of what is attempted to make the game safer. It is important to realize that, while these injuries and fatalities cannot be totally eliminated, they can be drastically reduced through a concerted attempt on the part of coaches, administrators, and the education profession to gain a clearer understanding of the problem. The occurrence of injury in football is, by and large, governed by the interaction of several factors. The following are considered to be among the more important:

1. Responsible and well-trained coaches.
2. The condition, maintenance, and quality of protective equipment provided to participants.
3. Properly supervised fitting of this equipment.
4. Adequate supervision and instruction in the tactics, techniques, and fundamentals of play.
5. Strict adherence to the rules of the game directed toward safer playing conditions.

STATEMENT OF THE PROBLEM

This investigation was a study of the extent of the problem of football injuries in North Carolina high schools. A scientific methodology, descriptive epidemiology, directed toward the causes of the injuries, not just who was injured, the diagnosis of the injury, and how soon the injured was able to return to participation, was used.

The purpose of the study is as follows:

1. To demonstrate the effectiveness of applying a standard health research method to measuring the distribution of football injuries, and the determinants of the noted distribution, to the problem of risk in athletics, specifically high school football.

2. To [illegible]rmine the epidemiology of high school football injuries in North Carolina high schools.
3. To provide a descriptive epidemiologic baseline of data on football injuries upon which to evaluate further analytic and experimental efforts in solving the problem of prevention or mitigation of the injury experience of football participants.
4. To determine the relationship of certain predictor variables associated with the occurrence of high school football injuries.
5. To study the relationships of injuries to high school boys participating in football and the certification, teaching, coaching, and playing experience of their coaches, with a view toward a reduction of the severity and frequency of these injuries through a better understanding of the coaches' role in injury prevention.
6. To determine if there is a relationship between types, condition, and fit of selected types of football personal protective equipment and the incidence of injury to high school football participants.

SIGNIFICANCE OF THE PROBLEM

It is considered that the significance of this problem centers on its uniqueness. It is unique in that it is the first attempt to apply accepted, proven research design techniques to an increasing health problem in our nation's schools. It is significant because it will, for the first time in athletic medicine research, direct attention to the differences between the injured and the non-injured participant in an athletic activity. Without such differential data, the potential for planning for prevention will remain in the realm of speculation rather than scientific hypotheses testing.

At present, it cannot be stated with any degree of confidence what type of background or training a football coach should possess to do a competent job in our public secondary schools. On the other hand, it may be quite easy to list the type of background or training needed for a coach to have a winning record. School administrators all over the country would be interested in the type of background required for prospective coaches to do a competent job in all areas of coaching, not just in compiling a winning record. The North Carolina Study will relate the training and experience of high school football coaches to injury data. Hopefully, this information will indicate the type of training a high school football coach needs to operate a successful program.

In addition to the experience and training of football coaches, the investigators hope to determine what types of football drills and fundamentals were associated with a high injury rate. This problem has never been investigated, but it stands to reason that, if a football player is taught an incorrect method of blocking or tackling, his chances of injury are increased. Additional research is needed in this area if reliable information is desired.

The one area in football injury research that has been completely overlooked is that of the type, fit, and condition of football protective equipment. This is the first study to relate the type, fit, and condition of protective equipment to the incidence of injury. Most importantly, the study evaluates not only the equipment of the injured boys but also the equipment of the boys who were not injured. Researchers believe there is a relationship between protective football equipment and injuries, but the exact nature of that relationship has not been established. An example would be the football helmet: it has been held responsible for many of football's fatal injuries, for the increased head and neck injuries, and for the number of injuries caused by punishing blows delivered by the hard outer shell of the helmet. There is a complete lack of evidence to support these statements.

LIMITATIONS OF THE PROBLEM

This study was concerned generally with the demonstration of the effectiveness of the application of a research methodology, little used in educational research, to an educational and health problem in the public schools. Specifically, it was an attempt to determine the extent of the problem of football injuries in the state, to provide leads to possible prevention or intervention techniques, and to form a baseline for the analysis of future preventive research applications more experimental in nature.

It is readily admitted that factors other then those mentioned in the problem definition of this project may have an important role in football injury causation. As indicated earlier, however, this study was one of hypothesis seeking rather than hypothesis testing and was directed to ascertaining from the injured student and others directly involved with the injury the frequency of such injuries and the sequences of events resulting in injury.

The randomness of the sample for this study was affected by certain administrative requirements. Also, none of the state's remaining all negro high schools fell in the sample population. Two schools were lost from the study during the pilot phase of the project because of consolidation. Although these sampling abberations depart from the more stringent and acceptable sampling techniques, it is felt to be compensated for to some degree by the nature of the subject activity under study. Football, is played in much the same manner in every part of the state. The sample is large, is representative of most of the student athletes and schools of the state, and should reflect the overall incidence of football injuries in North Carolina. It is recognized, of course, that one must use extreme caution in drawing generalizations regarding the injury incidence in all of the secondary schools in the state on the basis of a student athlete sample from only 43 schools within a 100 mile radius of the center of the state.

As data for this study was gathered by interview techniques, there was certainly the possibility of the interviewer bias. No precautions were taken to measure the equivalency or stability of interviews by either having the same interviewer interview the same respondent twice, or by having different interviewers perform the same interview on the same respondents. However, the investigator had considerable professional and on-the-job training in the use of the interview technique, and considerable experience in observing and doing interviews with the U. S. Public Health Service's National Health Survey and National Health Examination Survey. This experience, to the extent possible, was passed on during training sessions to other interviewers on the staff of the project. In spite of these precautions, bias may have influenced the observations.

DEFINITIONS OF TERMS USED

Epidemiology.-- This term was defined by a group of epidemiologists as the study of all the factors (and their interdependence) that effect the occurrence and course of health and disease in a population. The general definition of the word is a return to the original Greek epi, upon, and demos, people. Thus, epidemiology is the study of health of human groups in relation to a total environment: the study of human ecology.

For the purpose of the study, epidemiology will be interpreted along the general lines of MacMahan and his associates (149) as the study of the distribution and determinants of disease prevalence in man. Two principal areas are underlined in this definition: (1) The study of the distribution of the disease (descriptive epidemiology) and (2) the search for determinants of the exhibited distribution (analytic epidemiology).

Injury.-- Throughout this report, an injury will be defined as an injury which occurred as a result of participation in an organized football program at the high school level, for which professional treatment was received, or which resulted in restriction of the boy's usual activity for one day beyond the day of the injury.

Incidence.-- The incidence of new events is a necessary measure in a historical or descriptive study in seeking causes that might produce disease or physiologic change, in estimating individual risk, or in assessing attempts at prevention. Incidence will be defined in this study as a measure of new cases of injury, disease or other atypical physiologic state related to the objectives of the project.

Protective Football Equipment.-- Protective football equipment in this study will include the helmet, shoulder pads, hip pads, and shoes.

Spearing.-- In the North Carolina Study, spearing involves the use of the football helmet as a means of punishment to opposing players while they are in vulnerable positions. An example would be a boy being tackled by one or more players, who is battered by the helmet of yet another opposing player. The North Carolina Study does not consider spearing a fundamental of football.

CHAPTER II

REVIEW OF THE RELATED LITERATURE

Much has been written with regard to the very broad aspects of the epidemiology of disease. In addition, considerable attention has been paid by the literature to the treatment of "typical" athletic injuries. The need to focus attention on determining the frequency of athletic injuries has been reflected in many attempts to determine the number of injuries on specific teams, in certain school districts, or in other defined groups. The review of the literature will include a summary of the work done on the application of epidemiologic methods to injury prevention and applicable studies of sports mortality and morbidity.

Application of Epidemiologic Methods in Accident Research

Any review of the literature pertinent to the application of epidemiologic methods to accident research must begin with the impressive definition of the many aspects of human ecology that are of prime import to the occurrence of accidents in human populations expressed by Gordon (98). He first conceptualized the way in which the epidemiologic method, from its original restriction to communicable disease, had been expanded to include chronic diseases and the occurrence of accidents in man. It was not well accepted before the time of his efforts that accidents would be equally amenable to the epidemiologic approach, that accidental injuries occurring in populations would conform to the same biologic laws as do diseases and therefore exhibit similar behavior.

It has long been recognized that the situation called "good health" in man is brought about by an established and adequately maintained equilibrium between man and his environment. A significant disruption of that equilibrium is the foundation for disease or injury. Preventive medicine practitioners have accepted for a long time the tenet that disturbance in this balance may occur through some characteristic of the host, some action of the agent, or some function of the environment, but more often than not, through a combination of the three: host, agent, and environment. The 1948 essay by Gordon on methodology points out the similarities in measuring the extent of the problem of disease.

Logan's (142) discussions on the epidemiology of accidents occurring in Birmingham, England in 1952 presented data on 50,000 accidental injury patients treated in the local hospital annually. Sixty-one per cent of those injured were working age males with an average age of thirty-five years. Each of these workers had an expectance of an additional thirty years of working life. This was extrapolated as fifteen thousand years of working life affected each year by accidents in a group of 500 men injured each week.

From an epidemiologic point of view, Logan stated that:

> Certain features of orthodox epidemiological theory can be transferred direct to the study of accidents. The virulence of the noxious agent applies equally to the bacterium as to the type of road traffic vehicle, the production machine or the inflammable nature of clothing fabrics in domestic home burn accidents. The introduction of a new virulent agent or some combination of agents may cause an epidemic of accidents. For example, open gas or fireplace fires, together with a change in fashion--undergarment--may cause an epidemic of burning injuries in the home. The resistance of the host has its equivalent in the varying liabilities to accidents in different age groups or different socio-economic groups. The population at risk can be computed for different types of accidents. For example, the number of workers in industry and the number of their accidents; the number

> of road users and the number of their accidents. There are many similar matters worthy of close study in the field of epidemiology.

Thompson and Chambers (247) conducted a study of the epidemiology of car window accidents at the Brooke Army Hospital during the six-year period ending in July, 1952. Ninety-five men were treated at the hospital for injuries to the elbow which had protruded through open car windows. Eighteen of those resulted in the loss of an arm. The types of injuries varied so widely that consideration of treatment would have covered almost the entire field of trauma surgery. The epidemiologic analyses of these data evolved from the consideration of three factors: (1) the agent which injured the arm, (2) the environment, and (3) the host, in these cases the victim himself. The agents causing the injury were: (a) movable objects, 81.5 per cent; (b) fixed objects, 11.0 per cent; (c) deceleration, in which the window-frame was usually the agent, 2.5 per cent and (d) over-turning, where the agent varied greatly, 5.0 per cent.

No chemical or biological factors were associated with any of the injuries, so only physical factors were considered under environment. There was a definite seasonal variation in the injury frequency which reached a peak, as would be expected, during the summer months when car windows were open and arms were resting on windows a greater portion of the driving time.

With regard to host factors, the study showed that over half of the injured had no passengers. The absence of a passenger to help watch the road or keep the driver awake appeared contributory. Sixteen per cent of the subjects admitted ingestion of alcohol. With respect to any "genetic inherent susceptibility", some eight per cent of the subjects had had previous accidents. The characteristics of the host vehicle (whether vehicle is considered as a host, environmental factor, or agent characteristic is somewhat debatable even up to the present time) might have been significant. The majority of the victims were driving cars in excess of ten years of age.

McLanahan and Ogilvie (142) in a similar study observing independently a variety of severe injuries resulting from the contact of pedestrians with sharply projecting door handles of autos--which projecting door handles caused massive damage to soft tissue and bone in various parts of the body--used epidemiologic methods to pinpoint the causal agent. The study resulted in the design of door handles with a smooth oval surface rather than a sharp hook-like protuberance. Such injuries are now prevented or at least reduced in severity.

Again in 1954 Gordon (97) reported the applicability of epidemiologic methods to accident prevention in recounting the results of a study of mortality in Massachusetts. The study attempted to determine, by epidemiologic analysis, the features of accident prevention that warranted special consideration by the state. Accidents reportedly ranked fourth among causes of death in Massachusetts during 1946. The state had a considerably lower rate than the nation as a whole. However, when accidents were divided into separate categories by place of occurrence, non-motor vehicle accidents in Massachusetts accounted for a greater proportion of deaths than in the United States as a whole. Rates for accidental death occurring at home placed Massachusetts among states with the highest rates with regard to deaths occurring at that site. Gordon remarked that severe falls were a function of age and that, because Massachusetts had an older population, this in part accounted for the fact that falls were the cause of 26 per cent of all deaths in the United States but 44 per cent in Massachusetts. The place to direct preventive efforts was clearly determined by the epidemiologic study.

Greenberg (210) in a study of pica in relation to lead poisoning in children reported 194 cases of pica (a hunger for ordinarily inedible substances) among the children examined during 1956 and 1957 under the care of child health stations of the New York City Department of Health. Blood concentration of lead was determined by examination and laboratory evidence to determine the presence of lead poisoning. There were 28 certain cases and 20 probable cases of lead poisoning. Sixty-five per cent of the lead poisoning was among two and three-year olds. A relationship was shown between the frequency of lead poisoning among children living in old tenements and paint on the wall and window sills of high lead content. Pica cases living in other housing obtained their low lead blood concentrations probably from paints on toys which are generally lead-free or at very low concentrations. Epidemiologic study and follow-up coupled with centralized exchange of medical and epidemiologic data was demonstrated as a worthwhile measure in preventive medicine practice and as a highly satisfactory case-finding technique.

In the United States, the earliest record of the application of epidemiologic methodology to athletic injury investigation was reported by Haddon and his associates (106) in a study of skiing injuries at Mount Snow, Vermont in 1961. This study determined certain characteristics of the injured skiers and their equipment to be associated with an increased risk of injury. For example, the greater frequency of injuries among females in the study population was demonstrated to be attributable to the musculoskeletal variations in injury thresholds between the sexes, rather than to differences in ankle safety bindings. No significant differences were reported between the injured skiers and selected control group skiers with respect to height and weight, ski length, previous skiing experience, or a history of previous skiing injury. However, certain interesting patterns did emerge in results reported. The snow plow turn group, composed largely of beginners, had the highest injury rate, although they constituted only a small percentage of the skiing population under study. Females also constituted a disproportionate share of those injured. These markedly higher injury rates for two groups of skiers suggest that epidemiologic investigations in accidental injury causation in athletic activities are fruitful with regard to uncovering target groups toward which to direct preventive measures.

An epidemiological study in Norway of acute viral hepatitis among track-finders (ski racing over a three-fourteen kilometer course through forest and other rough terrain) was conducted by Vellar (263) in 1962. This study documented the high incidence of hepatitis among Norwegian track-finders, amounting to fifty per cent of that found in the general population. The majority of the cases were judged from the epidemiologic evidence presented to have been serum hepatitis, and the mode of transmission was reported in all likelihood to have taken place by contaminated blood from injured carriers of the virus being inoculated into other competitors with similar wounds by way of washing water, hand basins, towels and other agents. This epidemiologic investigation led to the institution of certain prophylatic measures including better protection against wounds and scratches, hygienic precautions in connection with washing habits at the termination of races, and personal quarantine of infected participants.

A study similar in many aspects to the Norwegian investigation was carried out by Porter and Baughman (188) in 1965 with regard to the epidemiology of herpes simplex among wrestlers. This study analyzed epidemiologic data of an outbreak of the disease at Dartmouth in New Hampshire in 1964 and data similar in nature from thirty colleges and universities in the Northwest United States during that same year. Extensive cutaneous herpes infections, sometimes called "herpes gladitorium", developed in seven of nineteen wrestlers during a two-week period in 1964. An additional eighty-four cases were reported from the other participating schools in the study. The disease reached epidemic proportions in two of the thirty schools. For example, at one school 15 of 60 wrestlers were infected, and at another, four of 12, both within a similar two-week period. All college teams reporting infected cases had had previous contact with at least three of the schools reporting infection during the season of the investigation. The infection was reported to have been spread by intimate physical contact. A contributing factor was indicated as a break in the skin at the time of contact. Atopic diathesis or previous herpetic infection were not reported as influencing susceptibility of an individual to the infection.

The most recent study by Kraus at the University of Minnesota (131), reported applying epidemiologic techniques to the study of injuries associated with touch football. Data were collected on injuries occurring during the intramural touch football season of 1966 from a study population consisting of 3,254 participants on 228 teams. A total of 283 injuries were reported--indicating a crude injury rate of 8.7 per one hundred players. The injury rate was reported to be correlated with the age of the player. Players with a prior athletic injury experience exhibited a higher injury rate than those without such a history. The data presented also suggested an apparent relationship between previous athletic experience and current injury experience. This study demonstrated the applicability of the epidemiologic method of investigation in the area of team sport injuries.

Studies of Mortality and Morbidity Related to Football and Other Athletic Activities

During the first five years of the twentieth century, injuries resulting from football reached such a magnitude in the nation that severe complaints from leading educators across the country reached the office of the President of the United States. President Theodore Roosevelt called upon the leadership of football, principally at the college or university level, to exert every effort to make the game safer.

Since that time, educational leaders, responsible coaches, trainers, and interested physicians have made many changes in the rules and undertaken many inquiries into the incidence of death and disability due to participation in football.

The earliest study in the area of athletic injuries was carried out in 1929 by the Carnegie Foundation for the Advancement of Teaching (38). Several athletic activities were covered by the investigation. Football was indicated by the study as the most hazardous branch of athletics. The study dealt only with the problems of athletic injuries at the college level. There was a reported incidence of twelve injuries for every one hundred participants. The majority of the injuries were fractures, dislocations, sprains, and concussions.

In Massachusetts, Burnett and O'Brien (34) conducted a survey of the high schools in Massachusetts to determine the extent of injuries in football. The survey encompassed ninety-three schools. Ten per cent of the boys who played were injured; sprained ankles were the most common injury--injured knees were next. Data collected in this study indicated for the first time a difference in injury incidence between squads of differing size. The reports showed that in squads of fifty boys or over, the injury percentage was 7.3 as compared to a percentage of 13.5 among smaller squads.

In 1932 Stevens and Eastwood (243), working under the auspices of the National Bureau of Casualty and Surety Underwriters, conducted a preliminary study of football injuries in colleges and high schools. Through a questionnaire reply from seventy colleges and fifteen high schools, data relating to the incidence of football injuries were analyzed and reported. Unfortunately, responses to the high school requests were too few to tabulate, limiting analysis to college level participants only. Responses from the colleges indicated that the most frequently injured body parts were, in order of frequency of occurrence: the hip-thigh-knee area, the leg-foot area, the head-face-neck area, and the forearm and hand area. For the first in injury studies of football, an attempt was made to assess the most hazardous activity within the game. The activities engaged in by the injured, in order of frequency were: tackling low, line plunging, being tackled low, blocking low, blocking in front, blocking from the side, blocking high, blocking unclassified, tackling high, and being tackled high.

A part of one of the most comprehensive studies of athletic injuries provided data on football morbidity in 1937. Lloyd, Deaver and Eastwood (141) reported on a national investigation of athletic injuries and revealed several interesting new facts with regard to football injuries. Their study indicated that over half of all football injuries occurred before the competitive season actually began. Twice as many injuries were reported as having been a result of game activity rather than practice or scrimmage. The most frequently injured body parts in this study paralleled those reported in earlier studies, as [illegible] the activities engaged in when injured.

During 1932 Neilson (169) investigated injuries occurring to football players in several high schools in California. The purpose of the study was to ascertain whether or not the frequency and types of injuries to players of given age groups were such as to indicate lowering the age-limit for football participation in California high schools from twenty-one to nineteen years of age as a measure to reduce the incidence of injury. Results indicated little or no relationship between age and type or seriousness of injury. In addition, it was considered by the author that before age of players could be determined as a factor related to injury causation, true relationships between age and other factors possibly related to increased risk, such as exposure, must be controlled for.

During the next two decades, many additional attempts were made to study the occurrence of football injuries at the college and high school level (6, 32, 57, 86, 109, 132, 181, 254). The studies have reported much the same thing with regard to the most frequently injured body part, the general football activity engaged in by the victim at the time of the injury, and the most frequently injured player with respect to position played when injured. Also, most of the studies carried out during the years between 1940 and the present have used a questionnaire request for injury information from specific schools, or they have conducted a retrospective review of charts or records at a single school over a period of several years.

This area of the literature review will confine itself to only those projects which have unearthed new information on the character or nature of football injuries, or which have demonstrated the application of new or innovative approaches to research design in the area of football or other athletic injuries.

The North Carolina Study conducted by Henry (115) is representative of the type of morbidity investigation carried out during this time. This study reported a questionnaire response of 50 of 150 high schools in the state requested to submit a report on each participant injured during the fall of 1948. One thousand and nine such injuries reported resulted in an incidence rate of 1.2 per cent. For the first time, an attempt was made to base the injury rate on a measure of exposure. Exposure was defined as one player dressed in football gear for one day. By dividing exposures into the number of reported injuries, an injury rate was calculated. The investigation confirmed earlier studies with respect to the most frequently injured body part, type of injury, and activity engaged in at the time of the injury. It confirmed earlier studies indicating a much lower injury rate in the larger schools compared with smaller schools.

The continuous survey of football fatalities by Blyth and Arnold (24) is the most significant attempt to collect, analyze, and disseminate mortality information with regard to football at all levels--college, professional, high school, and sandlot. Their survey, continuous since 1931--with the exception of 1942, has been under the direction of Marvin A. Stevens, Floyd R. Eastwood, and since 1964, Carl Blyth, and David Arnold. During the past 37 years, fatalities attributed by the survey directly to participation in football have averaged 18.7 per year--less than three per 100,000 participants since 1931. Data for the survey is obtained from a number of different sources: high school athletic association executive officers, high school and college coaches, athletic directors, school administrators, physicians, and a national newspaper clipping agency.

Caution must be exercised in the use and interpretation of the data. For example, the report shows an increase of over 60 per cent in the incidence of fatalities between 1967 and 1968; it associates the relatively high rate of death with activities such as tackling or being tackled. However, a significantly large percentage of the fatalities--almost 30 per cent--are unknown as to the activity engaged in.

Fatal injuries in competitive sports in New York City during the 32-year period from 1918 to 1950 inclusive were reported by Gonzales (95) by frequency of occurrence in eleven sports. The purpose of the study was to determine the type and frequency of the fatal injuries and correlate them with the particular kind of athletic activity. Deaths were categorized as follows: (a) sports characterized by body contact; (b) sports in which missiles are thrown, driven, or batted; (c) sports in which falls from some height might occur, and (d) sports involving aquatic competition. When all deaths were evaluated regardless of category, there were 43 fatalities associated with baseball; then next highest with 22 was football. However, in those sports characterized by body contact, football was the most hazardous; boxing and wrestling were a distant second and third. Unfortunately autopsy records indicated that acute, subacute, or chronic focal infection followed by some form of generalized sepsis was a frequent cause of death in the injuries reported during the earlier years of the data file. Since the introduction of the sulfonamides and the antibiotics, there has been a marked reduction in the incidence of fatality due to infection. The Gonzales report concluded that in thirty-two years, boxing competition had produced fewer deaths, in proportion to the number of participants, than occur in baseball or football, and far fewer deaths than result from daily accidents.

Clark (42) recommended, in his contribution on the calculated risk of sports fatalities, that the risk of fatalities in a given sport be judged against the sports purported benefits. He describes a quasi-statistical method for equating the exposure of football age youths to fatalities due to other causes in "daily living" (e.g., motoring, falls at home, etc.) and demonstrates that the relative risk based on man-hour exposure are approximately the same for the candidate for football activity and the same boy in his "daily living" environmental exposure to other causes of fatality. An exposé approach was used recently by Lindeman (139) to focus public attention on the problem of football fatalities in high school. While hesitant to include an "outcry" type editorializing on sports injuries, one must give just credit to its analytic aspects. His report suggests several points of direct interest to the football injury researcher. Interestingly, all three of the young athletes described in this story died as the result of a brain or head injury; all three had sustained a prior head injury of reportable consequence; in addition, all three were beyond medical help within minutes of their injuries. Lindeman raised questions about the validity of long held "truths" regarding certain safety practices, e.g., the availability of medical resources at the site of games, standards for permitting re-entry to play after a head injury, and the protective adequacy of current football headgear.

The relation of age and experience in athletic activities to injury experience was first approached by Hibbert (116) in 1950. Data on 46,824 athletes in four selected states--one in the Pacific Northwest, one in the Rocky Mountains, one in the Southwest, and one in the South--were evaluated. Particular attention was paid to age and playing experience. Football accounted for 86.3 per cent of all athletic injuries. Of these, tabulations indicated that the 16-year old was five times more likely to be injured than the 18-year old. This phenomena was attributed to the marked physical changes that occur between age 16 and 18. With regard to experience, the data showed a decreasing frequency of injury corresponding to increased number of years of playing experience. Data on injuries for the study were obtained from insurance benefit claims of the Security Life and Accident Company.

Tabrak (246), in 1963, made a very interesting comparison between the risk of disabling injury in high school football and underground coal mining, America's most hazardous industry. Data on football injuries during 1962 in one private and one public Hawaiian high school were compared with injury rates in several high-risk occupations such as logging, underground mining, and construction, to evaluate the hazards of disabling injury in football. Standard formulae from the American Standard Method of Recording and Measuring Work Injury Experience, Code Z16.1- 1954 were used.

With this method it was revealed that the disabling injury experience during football practice and game play, and game play only, was several hundred times greater than the published rates for several hazardous industries--in fact, almost 14,000 times higher for game play alone, compared with the highest reported industrial rate of injury--that of underground coal mining.

The Hawaiian Study also first reported data on the relationship of weight of players and injury experience. The conclusion was reached that weights of players sustaining severe or multiple injuries did not differ significantly from the mean weights of their teams as a whole.

An investigation of the number and nature of athletic injuries occurring in the Edmonton Public School System was reported by Mendryk and Dickau (156) in Canada for 1966 and 1967. In that study an injury was defined as one that occurred during regular physical education class, or during supervised intramural or extramural athletic activity. However, in athletics the greatest risk of injury reportedly was among participants in gymnastics, a departure from published results of any morbidity studies in the United States. The higher rate of 21 per cent for gymnastics, as opposed to 18 per cent for football is certainly a reflection of the greater degree of emphasis and level of participation in gymnastics in that country as compared to the United States.

Recording data on 250 Clark Air Force Base football players in the Far East, Allen (5) reported 111 "major" football injuries. "Major" was defined as "disabled for one week or more following injury." The knee was the most frequently injured area, and sprains were the most frequent type of injury. Thirty-eight players were hospitalized; 22 players were operated upon, and 65 players received injuries so severe that they were unable to finish the season. Three sustained injuries preventing their play forever. There were no deaths due to football injuries during this time. The classification of these injuries and their grading by degree of severity was accomplished through the use of the AMA's standard nomenclature of athletic injuries (11). This appears to be the first such use of that nomenclature. Allen's report was an entirely descriptive, clinical, case study with no attempt to ascertain the cause of injury. However, the author made reference to several multiple-area injuries and related the "suspicion" of a causal relationship between the rather minor, non-disabling injury occurring first, and then the major, disabling injury.

In addition to the cited investigations of "athletic injuries" or football injuries, there have been a great number of studies directed toward obtaining more definitive information about specific types of injuries or injuries to specific body parts (73, 170, 182, 206, 207).

Alley (6), in 1964, described the results of analysis of data on football injuries, with particular reference to the low incidence of head and neck injuries. Some 19,413 high school players made up the group of subjects among whom 4,829 were injured. Only seven per cent, or 377 of these injuries were to the head or neck. The author went on to conclude that factors responsible for head and neck injuries included improper fitting of headgear, the practice of "spearing", violations of basic fundamentals of football technique, and the inadequate physical conditioning of players. It was reported that over 60 per cent of players receiving head injuries and 44 per cent of those with neck injuries were coached to "spear" or to use their helmet-protected heads against the bodies of their opponents. This report also noted that 35 per cent of the boys "spearing" were hitting the opposing player below the belt with their helmet, a practice very frequently associated with injuries sustained from contact with an opponent's knee.

The incidence of cerebral concussion sustained by athletes participating in intercollegiate football was studies by Dickinson (60) during 1966. This study utilized the classification of cerebral concussion by grade of severity as recently defined by a subcommittee of the American Medical Association's Committee on the Medical Aspects of Sports. A cross tabulation consisting of information on location of blow received, grade of severity, conditions present at the time of the injury, player's position and activity, history of prior episodes, and management of the injured athlete was used in the analysis of results. These data showed that the predominating causative instrument of injury was an opponent's knee or helmet, followed distantly in frequency by contact with the turf or playing surface. Mention was made of the fact that five per cent of all cerebral concussions sustained in game activity occurred during kick-off. Further, the report asserted that it was apparent that a young man who had sustained one cerebral concussion was more likely to sustain another. This was evidenced by the significantly greater percentage (40 per cent) of the athletes who suffered concussion that had had a previous concussion.

Schneider (222) reviewed data concerning football injuries of a very serious or fatal neurosurgical nature during a five-year period from 1959 through 1963. From a questionnaire survey of the Harvey Cushing Society and the Congress of Neurological Surgeons, reports of 225 such cases were received and evaluated. Returns represented a questionnaire response of 61.9 per cent. All of the returned questionnaires admittedly did not include all such cases seen by respondents because of lack of cross diagnosis indexes, file purges, and other factors. One hundred and forty-one, or 62.6 per cent of the severe injuries occurred to high school players. Of the total, 88.2 per cent of the fatal or serious neurosurgical injuries occurred in players reportedly well-equipped with protective gear. There were 11 skull fractures with four deaths, five extradural hematomas with four deaths, 69 subdural hemotomas with 28 deaths, 14 intracerebral or intraventricular hemorrhages with eight deaths, and 17 pontine lesions with 16 deaths. Schneider's report indicated that, besides the skull fractures, other lethal lesions occurred as a result of direct transmission of force to the intercranial contents, intimating strongly that the plastic football helmet did not offer adequate resiliency to dissipate energy. In addition to the craniocerebral injuries, there were 78 spine and spinal cord injuries with 16 deaths. Most of the injuries were fracture-dislocations of the cervical spine. By far the most tragic group of cases were 30 youths whose fracture-dislocations resulted in immediate, complete, permanent quadriplegia. Eighteen others had partial neurological deficit and another eight, residual deficit.

In his discussions of the mechanisms of spinal injury, Leidholt (136) reports on the likely contribution of the helmet and faceguard in causing hyperextension injury to the cervical spine. His assessment of the new type football helmet with a tight chin strap and faceguard that moves as a unit with the head can be demonstrated as an effective lever system which from the atlanto-occipital joint fulcrum. This can transfer the force delivered to the front of the helmet or guard to the neck and in doing so increase the force by as much as 100 per cent. The inevitable injury is to the cervical spine.

The most recent report of the frequency of head and neck injuries in contact sports was an effort by Snook (238) to evaluate field injury reports at the University of Massachusetts during four years of football and two years of hockey, basketball, and lacrosse. For the first time, the head was indicated as the most frequently injured body part among football participants. Head injuries were followed by knee injuries and they, in turn, were followed by neck injuries. The definition of an injury during this investigation was one which entailed the loss of at least one day from activity.

Other than the head and neck, and that principally because of the overwhelming number of deaths related to such injuries, no other anatomical part of the athlete has been given as much attention as the knee (193, 206, 270).

Most of the published material related to knee injuries is clinically or treatment oriented. Other than inclusion of the knee in the study of all types of athletic injuries, some interest has been shown in the area of long term effect of knee trauma, and the effect of certain devices and materials in eliminating or minimizing knee injury, or the frequency of knee injury.

McPhee (148) at Princeton, analysed data on 760 individuals from the classes of 1934 through 1956 who had played varsity or junior varsity football at that institution. The group had sustained 211 knee injuries exclusive of minor lacerations and contusions. One hundred and ninety-four of these knee cases responded to a mailed questionnaire regarding their injury. Thirty-one of the men had sustained more than one trauma to the knee. Twenty-four were injured twice; five three times; one four times; and one, five times. The knee injured was almost equally divided bilaterally; 94 right and 100 left. Twenty-one per cent of the 194 injured knees reportedly had given their victim some noteworthy annoyance after five to 27 years from graduation.

Similar results of the long-term effect of football knee injuries was reported by Rall (200) and his associates in a study of 205 former University of Missouri football players asked about later physiologic or medical problems related to knee injuries sustained as active players. A surprising 51.2 per cent of the men indicated a history of knee injury, and all but one reported persistent symptoms. An attempt was made to correlate the persistent symptoms with radiographic findings. Forty-four subjects with a multiple knee injury history volunteered for this part of the study. Of these, 84 per cent had x-ray evidence of joint pathology, of reportedly particular significance, and this in an age group in which degenerative changes are not usually seen.

As mentioned, several studies have been carried out in recent years with respect to the relationship of knee injuries and external factors such as types of cleats (118), ankle taping (267), and artificial turf (268). While a great deal of data has been, and is continuing to be, accumulated in these areas, as yet, without carefully controlled study and compatible design techniques--particularly with respect to the definition of a knee injury--very little reliable data for analysis is available upon which to base any conclusions.

Interest and active research application in the evaluation of the use of mouth protectors has been a very important contribution to athletic safety in the past twenty years. Generally, three concerns have been evidenced in this area. First, the reduction of dental injury by protective devices for the oral cavity. Second, the possible role of the mouth protector in the prevention or mitigation of severity of concussive brain trauma. And, third, the acceptability of these devices by the players themselves.

Banks (18), in 1960, reported that 3,694 college players who did not wear mouth protectors sustained 586 tooth injuries, of which 170 required bridgework. All these players studied wore either single or double bar face-guards.

In 1962, Stevens (244) with the Spokane District Dental Society conducted a study of mouth protectors used by football players on junior and senior high school teams in Spokane, Washington. From results of a mail-out questionnaire to 1,124 schools, the average number of tooth injuries per school was .63, with .27 chipped, .16 broken off, and .10 lost. The schools equipped with mouth protectors had an incidence rate of .0145, compared to a rate of .0309 for those without protectors. Of all players wearing mouth guards, 26.2 per cent were custom made, 50 per cent mouth-formed, and 23 per cent stock type. Although the difference was not reportedly great, the custom made protector had the highest accident experience.

Such divergent results as these on the potential of mouth protectors as injury preventive methods or devices are exemplary of the dichotomies of results that are very common in the athletic injury literature. The widely differing results are due, for the most part, to rather poor quality research applications, lack of uniformity of injury definition and classification, and low levels of reporting or response.

Hickey and his associates (117) used cadavers to determine the relation of mouth protectors to cranial pressure and deformation in 1967. An attempt was made in this study to test the effect of a mouth guard on the transmission of force from a blow on the chin. Earlier work by Guardjian (100) indicated that deformation of bone and the resulting intercranial pressure would be similar in the living skull to that of a cadaver. The mouth protectors tested were similar to those in common use in football at the time. As the primary cause of brain concussion is stress in the brain stem area produced when dynamic pressures are set up in the cranial cavity, the level of that pressure is relevant to possible concussive injury. Results of this work indicated that both intracranial pressure and bone deformation were reduced with the utilization of mouth protectors. Thus, the conclusion was made that mouth protectors in football may be instrumental in prevention of brain concussion as well as mechanical injury to the teeth or oral tissue.

Opinions of high school football players concerning mouth protectors were studied in 1962 by Rosenberg (213) in five parochial schools in Washington, D. C. The study attempted to determine: (a) the degree of use of protectors, (b) problems associated with their use, (c) differences in acceptance in latex and vinyl custom made devices, and (d) whether use of protectors could be predicted from responses to pre-season questionnaires.

Results indicated that more than half of the boys wore their mouth protectors "practically always or always" during games. Only 22 per cent reported no troubles associated with wear. The most common troubles were interference with breathing or nausea and gagging. No significant differences were reported between the groups wearing vinyl or latex protectors with respect to use, trouble in wearing, or opinion of protection afforded. The attitude of coaches was cited as playing an important role in the acceptability of various high school football groups.

Heart disease is not ordinarily a consideration in athletic medicine, except as a cause for restricting participation in certain activities. However, with the awareness of the possibility of injury to the heart by a blow to the anterior chest wall in contact sport, physicians have been concerned to some degree with cardiac trauma as a possible athletic injury.

Rose (212), in 1966, reported a case of cardiac contusion associated with a fractured sternum as a result of football trauma. The fatal case was reportedly the result of "spearing" or the act of using the head as a battering ram against the injured's chest. Combs (46) reported a similar fatal traumautic heart injury when a twenty-five-year-old negro athlete sustained a blow from a helmet on the anterior chest wall. His report recommended awareness of the possibility of cardiac trauma in football and the fact that obvious symptoms of musculoskeletal injury often mask the underlying cardiac trauma.

In an analysis of forty-four cardiac deaths among football players during the period 1961-1967, Rose (211) found that 88 per cent of the victims were between 14 and 19 years of age. Thirty-six occurred during spring practice. Twenty-eight occurred during conditioning exercises before practice sessions. Only eight died in a ball game situation. The age of the victims in the fatal cases were felt to indicate rheumatic fever and congenital defects as prime etiological factors. A case was made for prevention of all these deaths by proper pre-season classification, early diagnosis, and adequate treatment.

As has been pointed out earlier, current data indicates that the incidence of death in organized college and high school football is comparatively low. However, several deaths each year are due to heat stroke and must be considered preventable.

According to Murphy (165), of 30 deaths among high school football players during 1960-1962, five or 16 per cent were due to heat stroke. Heat stroke is defined as a failure of the sweating mechanism characterized by rapidly rising body temperature and unconsciousness in the presence of warm dry skin. As body temperatures reach 105 degrees, irreversible changes occur and death may result. The most effective ways of preventing heat stress involvement were reported.

The effects on thermal balance and energy cost of wearing football equipment during exercise was reported by Fox and his associates (85) in 1962. Central core temperature, energy costs, pulmonary ventilation, heart rate, and sweat loss were measured on five volunteers during a treadmill run of 20 minutes at six miles per hour in both football gear and in loose fitting hospital scrub suits. The marked hyperthermia which was noted while the subjects wore football gear as opposed to the scrub suit was ascribed to two factors: (1) the loss of over 50 per cent of the evaporative surface as a result of the additional clothing and gear, and (2) the added 14.7 pounds of weight of the uniform and equipment which increased the work load. It was concluded from the results of the study that running at six miles per hour in football gear produces significant increases in central core temperature, sweat loss, and heart rate over that produced while working at the same level in a light hospital scrub suit. A period of acclimatization to heat with a gradual introduction of full football equipment was recommended under high temperature and relative humidity conditions.

The Last Section of the Literature Review Will Cover the Following Two Areas:

1. Football studies that have looked into the relationship between the coach's background and football injuries; and
2. Literature related to football protective equipment and injuries.

Coach's Background and Football Injuries

In 1937 Lloyd, Deaver, and Eastwood (141) reported on football injury research done by themselves and by others (86, 98, 27). This national survey recommended that improper leadership accounted for a large number of football injuries. They also recommended that, when the following factors are in effect, the number of accidents and days lost will be lowered:

1. Three years or more of playing experience by the head coach.
2. Nine years or more of coaching experience by the head coach.
3. Employment of football coach for football and some other sport.
4. Six to eight days of preseason training before the first squad scrimmage.
5. An average of not more than thirty minutes devoted to football scrimmage each day.
6. A medical examination given before or during preseason training.
7. The athletic association paying all the costs incurred in the treatment of injuries occurring while students were playing in interschool games.

Harman (111) conducted a study in 1933 which gave added emphasis to the importance of the coach in the overall athletic program. It was his feeling that the coach should be given more responsibility for the proper education of his players and not as much responsibility for their winning games. A questionnaire from fifty-eight school athletic administrators, who represented most of the states, was compiled and the results were put into a number of final conclusions. The main point? The athletic administrators believed that coaches should be held responsible for other areas of more importance in their programs and not just for winning games. The other areas include (1) sanitation and mental hygiene in the dressing room, (2) time allotment to football practice, (3) proper division of daily practice time in football to fundamentals, scrimmage, and lecture, (4) coaches' method of teaching the game, (5) attitude of the coach during the game, and (6) cleaning the dressing room after every practice. Harman concludes by saying:

> In conclusion, the most sane attitude toward athletics is that we consider the athletic program to be an educational program.
>
> Coaches who are promoting an educational program in athletics should have the whole-hearted support of their superiors, regardless of the percentage of games won.

Again, in 1944, a study by Jackson (125) pertaining to the health practices in interscholastic athletics in Illinois came to the conclusion that the training, experience, and attitude of the coach was the first important health element in athletics. It was also concluded that the training of coaches, particularly as related to health practices, was inadequate. With today's emphasis on hiring coaches with winning records, it is obvious that Jackson's recommendations were not taken seriously.

In a study of football injuries in North Carolina high schools in 1948 by Henry (115), a portion of the research was involved with the coach. It was found that there was a difference in the types of college degrees held by the coaches. Most of the larger school coaches had degrees in physical education, while over half the coaches in the smaller schools did not have degrees in physical education. Henry did not relate training of coaches to injury rate, but it was interesting to note that the smaller schools also had the highest percentage of injuries per exposure. In his recommendations Henry pointed out the large number of injuries received to the leg and foot when blocking, and stated that better instruction in how to block was needed.

An editorial written by Charles G. De Shaw (58) in 1950, which was not based on any research or fact, stated the need for more adequate regulations in regard to competitive athletics. It was his belief that many schools, due to inadequate budgets, were forced to hire inexperienced physical education teachers as coaches, or coaches who did not have any physical education training. De Shaw also stated that each school should provide a sufficient number of adequately trained coaches for proper supervision during practice and games, but he did not say what constituted an adequately trained coach. He did go on to say that coaches should have training in first aid. That many people feel the coach to be an important preventer of injuries is shown in the following quote:

> The welfare of the participant in interscholastic athletics is in a large way in the hands of the school administrator and the coach of the sport. If the educational philosophies of these two persons are in keeping with modern thinking in education, the health and safety of the player may be adequately protected. (37)

Many people believe the above to be true, but in reality a coach had better think about his won and lost record if he hopes to keep his job.

Allan J. Ryan (214) discussed the establishment of a Committee on Injuries in Sports in a paper written for the American Journal of Surgery in 1959. One of the main points brought forth in this paper was the cooperation of the American Medical Association and the National Collegiate Athletic Association in the development of "The Bill of Rights for the College Athlete." The section on coaching was developed for college athletes, but it could very well be of more importance in a secondary school program. The role of the coach as a leader in protecting the safety and health of the athlete was pointed out, along with the ability of the coach to give proper technical instruction. In this article, as in many before, the coach was characterized as a major factor in injury prevention; however, nothing was said about the coach's education, experience, or training.

Three basic areas of athletic injury prevention were mentioned in an article by Brashear (28) in 1959. Brashear agreed with others when he stated:

> The first, and probably the most important, is the selection of the coach. The head coach is the number one preventer of serious injuries in athletics.

He went into a little more depth in this area when he mentioned the coaches' responsibilities as including: (1) the preparing of facilities, (2) the buying of protective equipment, (3) the fitting of protective equipment, (4) the teaching of players how to wear protective equipment, (5) the teaching of fundamental skills, and (6) the proper physical conditioning of the players. Brashear believed that, if a school system did not have the funds to hire a competent coach, they should not have a football program.

One of the better studies in the area of football injuries and coaching was completed by Conrad (48) in the Pittsburg, Pennsylvania, area in 1966. His hypothesis stated that the preseason training techniques used by coaches of western Pennsylvania were detrimental to the physical well-being of the athletes. In order to test his hypothesis, he sent a questionnaire to the football coaches in the area around Pittsburgh. Sixty-four of the coaches returned the questionnaires. Conrad found that 45 per cent of the coaches did not have any acclimatization program, and 82 per cent scheduled practices during the warmest part of the day. It was also revealed that 45 per cent of the coaches did not permit their players to drink water at any time during practice. In addition, the coaches who did allow water breaks during practice did not allow an adequate amount. Based on the findings of his study, Conrad concluded that a majority of the coaches in this area of Pennsylvania were using training techniques detrimental to the physical well-being of their athletes.

The responsibilities of the football coach were presented in a paper by Shaughnessy (229) in 1966; Shaughnessy said that the main responsibility of the coach was in prevention. Preventive measures, according to Shaughnessy, would include providing (1) proper practice facilities, (2) proper physical examinations, (3) purchasing and fitting of protective equipment, and (4) the teaching of proper fundamentals. Most of these statements may be valid, but there is no concrete evidence to support them. The writer made a number of other statements most of which had been made before but which are not known by empirical data to be true. A good example would be the following:

> This head-on type of blocking and tackling technique has probably been responsible for more serious football injuries and deaths than any other. (129)

Many people think this to be true, but nobody knows it for fact. It may well be that the head-on type blocking and tackling is, in fact, the safest method of executing these fundamentals.

Protective Equipment and Football Injuries

As stated in the beginning of this chapter, many studies have been conducted in the area of athletic injuries, but nothing has been done in the area of type, fit, and condition of protective equipment related to injuries. This section of the literature review will cover what has been written about football protective equipment.

In a study by Lloyd, Deaver, and Eastwood (141), which was mentioned previously in the section on coaching experience, they found that improper equipment in the high schools accounted for .6 per cent of all accidents and that improper equipment in the colleges accounted for 6 per cent of the injuries. They did not define what they meant by the term, improper equipment.

Football protective equipment was kept in the background until 1959, when people concerned with football injuries put more effort into the idea that protective equipment might play an important role in the prevention of injuries. In their paper on protective football equipment, published in 1959, Rachun and Kavanagh (199) described new football equipment and discussed its merits. They suggested a carefully controlled, large-scale study to evaluate the protective value of football equipment on the field and stated that until such a study is carried out, reliance must be placed on laboratory studies. It is of great importance that the North Carolina Study is conducting, for the first time, this type of study.

The authors also mentioned the use of the hard plastic football helmet as an offensive weapon to inflict injury to the opposing player. They noted that Cornell University covered their helmets, in practice, with an outer panel of foam plastic to protect their own players.

Another important piece of laboratory research on the football helmet was completed by Dye (66) in 1959. Dye's reserach studies the impact blows to the helmet and measured these impact blows using laboratory techniques. The types of helmets tested were put into two general classifications, padded and suspension. Upon completion of this research, the Cornell Aeronautical Laboratory developed the geodetic suspension system which is being used by MacGregor Sports Products. Dye also mentioned the covering of the hard outer shell of the helmet to protect the opposing player.

Allan Ryan (219) stated in March, 1962, the importance of, and urgent need for, research in sports medicine. He placed the major emphasis in three basic areas--clinical observations, physiology and biochemistry, and prevention and treatment of injury resulting from sports participation. Of special importance to this project are two areas listed under the third class. Ryan stressed the need for developing a protective headgear and for determining the role of protective equipment in injury reduction.

In 1962, the American Medical Association Committee on the Medical Aspects of Sports (10) said that the hardshelled plastic helmet was superior to other models. They based this statement on the research that had been completed on the shock-absorbing capacities of various materials and on the head and neck injury rates since the advent of the hard-shelled plastic helmet.

A pioneer program in head injury study for contact sports was started at Northweatern University by Reid, Tarkington, and Healion (205) in 1962. A football player was fitted with a helmet that had a telemeter attached to it. The telemeter measured the number of G's the helmet sustained and telemetered this information to a receiver. The objective of the study group was to locate the blows on the helmet; to asertain the direction, the frequency, and the force of the blows; and to develop criteria for safer football helmets. A severe limitation was that only one player was able to wear the equipment at a given time. This made data collection on a large number of players impossible. This study was performed on college players; there is a possibility that the results would be different in a high school situation.

Two helmet studies that took different points of view were done by Gurdjian (100) and Fenner (78). Gurdjian studied the amount of force needed to produce head injuries in experimental animals and human cadavers. He concluded that the padded helmet was superior to the suspension type and that the hard-shelled plastic helmet was superior to other models.

Fenner's conclusions were that the plastic shell helmets had inherent areas of weakness after impact. He favored a Fiberglas shell with a non-resilient liner, which was designed by Snively and developed by Bell-Toptex, Inc. Bell-Toptex had good results with this helmet both in laboratory testing in energy absorption and infield testing by a high school team for four seasons. The two conflicting articles indicate the urgency for continued research in this area.

A study conducted in Southern California high schools was made from the files of a major insurance company. In addition, a case study was completed on all serious head and neck injuries. This study, completed by Alley (6) in 1964, included 19,413 high school football players. Alley noted that the majority of the boys receiving head injuries were considered excellent in ability and probably played more. He concluded that the longer playing time increased their exposure to injury.

Paul (183) reported at the National Conference on the Medical Aspects of Sports in November, 1964, and did a very adequate job of covering the proper fit of the shoulder pad.

> Only if they are fitted correctly and maintained adequately do present day shoulder pads afford the desired protection. Proper fitting is of paramount importance and represents the first part of the triad in preventing injuries to this area. The triad that reduces shoulder girdle injuries are: a) a well fitting shoulder pad with high arches, b) a properly fitted helmet, and c) a tight long-sleeved jersey.

Paul felt that if the shoulder pad were properly fitted and taken care of, it would protect the wearer.

Lateral flexion neck injury was studied in college athletes over a five-year period by Chrisman (41) in 1965. The range of lateral motion of twenty-two injured and twenty-two normal athletes was measured by photographic and radiographic techniques with both high and low shoulder pads increase the risk of neck injury. Higher, conventional pads offer more protection for this type of injury. Reinjury was common unless collar protection was used.

The football face mask, standard equipment in football today, has recently come under criticism. In two articles, one written by Melvin (155) and the other by Schneider and Antine (224), the face mask was criticized for visual-field impairment and for causing flexion injuries to the cervical spine. Neither article suggested that the face mask be abandoned, but both mentioned the need for continued research in this area and for the wise selection of face masks.

In a study of college football players at U.C.L.A. from 1955 to 1963 by Blazina (22), it was found that eighteen players received head injuries in either practice or games. Blazina came to two conclusions: first, that the helmet is ineffective; second, that a poorly fitted or improperly worn helmet will make a player more susceptible to injury than he would be without one. An outline of directions for proper fitting and wearing of a football helmet is given, but it is not revealed how or where this information was derived.

The football cleat has recently been added to the list of causes of football knee injuries, because of the high number of knee injuries which have occurred in the open field with no contact involved. The largest research being performed in this area was conducted with the Hanley cleat, as described by Hirata (118) in a paper presented to the American College Health Associated in 1968. Hanley tested football shoes with the heel cleats completely removed or replaced by an oval-shaped bar. Studies using the Hanley cleat--conducted in Pittsburgh by Smith, and in New York by Rowe--reveal a definite reduction in both knee and ankle injuries. Similar findings were reported in a study with the Ivy League football teams. It was recommended that carefully designed studies be used in evaluating the cleats so as to accumulate reliable data.

The most recent data on the football shoe and cleat type was conducted in New York by Callahan, Crowley, and Hafner. It was a two-year study that examined the lower extremity injury data on 17,777 high school football players in the state of New York. In 1967, the first year of the study, the research team sought to ascertain the following:

1. Whether modified cleats brought about a reduction in the number and/or severity of lower extremity injuries.
2. Whether there existed an optimum combination of equipment (shoes, cleats, ankle supports) for reduction in the number and/or severity of such injuries.

There was little statistical data available the first year, but the effort helped to identify other variables seemingly related to lower extremity injuries.

In 1968, the second year of the study, data were collected on lower extremity injuries to 17,856 high school football players in New York. In addition to injury data, information was acquired on field condition, shoe type, cleat type, previous injury data, playing experience and type of ankle protection used (tape or ankle wrap). The data indicated the lowest rate of serious knee injuries was incurred by players wearing low shoes, disc heels, and ankle wraps or low shoes, short cleats, and no ankle wraps. It was also stated that players with previous history of knee injury were reinjured at a rate fifteen times greater than playcrs with no prior history.

The investigators made the following recommendations:

1. All high school football players wear low shoes with disc or flat heel cleats.
2. Replace conventional cleat on sole of shoe with shorter cleat.
3. Rehabilitation and screening procedures be strengthened to reduce hazard or reinjury.
4. Effort be made to improve physical conditioning of all football players.
5. Consideration be given to modifying the rules of play to increase player safety.

CHAPTER III

PROCEDURES

Rationale and Background for This Study

For many years the Laboratory of Applied Physiology of the Department of Physical Education at the University of North Carolina has taken a leadership position in the nation with regard to athletic medicine. Staff members and colleagues have served in various capacities with national bodies such as the National Collegiate Athletic Association, the American Medical Association's Committee on the Medical Aspects of Sports, the National Federation of State High School Athletic Associations, and other organizations with similar interests in the health and welfare of the student athlete.

A good deal of the early reserach efforts with respect to the problems of work activity in high ambient temperatures was carried out at this facility. These efforts, and the work of many others across the country, resulted in an increased emphasis on the prevention of dehydration in the working athlete. According to the best fatality data available, these efforts have been instrumental in directing attention to preventive measures which have been adopted throughout the country, and have dramatically reduced the number of heat stroke deaths each year in high school football.

From their participation in studies such as these, and other activities directed toward determining the football injury problem generally, as discussed in the preceding chapter, and from years of experience of working with football and other athletic teams, it was felt that more definitive research was necessary as a point of departure toward better understanding of the safer operation and maintenance of athletic activities at the high school level.

The complete study effort suggested that if adequate attention were given to epidemiologic methods, enough could be learned to enable changes to be introduced in the conduct of football programs which might reduce the incidence and severity of injury to it's players. Direct interview techniques were used to determine factors associated with the occurrence of football injuries, such as certain characteristics of the players themselves, like age, race, playing experience, and others.

The second phase of the project, with which this paper is concerned, deals with the relationship between (1) the football injuries sustained by high school football players and the nature and use of their protective equipment; (2) the football injuries sustained by high school players and the background and training of their coaches.

Method of Selection of the Sample

A stratified, cluster sample of student athletes from forty-five high schools in North Carolina was selected from the 347 schools fielding football teams in the fall of 1968. As stated, the student athlete is the basis for the sample but, instead of selecting individual students, clusters of student athletes were selected by sampling schools. The random sample of forty-five schools was stratified to permit equal representation of student athletes participating in football programs at small rural schools, rural consolidated schools, and larger urban schools. Stratification was accomplished on the basis of school population level. Fifteen schools were selected from each of the following school unit sizes: (4A) over 1,000 students, (3A) from 500 to 1,000 students, and (1A-2A) under 500 students. Locating the particular clusters was an uncomplicated process of randomly selecting fifteen schools of each size from all of the schools of equal type within a radius of 100 miles of Chapel Hill, North Carolina. Each school within the area and size group was assigned a number; selection was made by using a standard table of random numbers. The cluster sample of student athletes resulting from this selection process included 8,776 boys.

Limitation of the Sample

Strict randomization was not administratively feasible for this investigation; since a direct interview technique was used in data collection which required face-to-face contact at least weekly between epidemiologic investigators and individual study athletes, limitations were placed on the distance from potential study schools and the research center. Only student athletes from schools within a 100 mile radius of Chapel Hill were eligible for inclusion in the sample. Therefore, the sample was limited to a geographical area. This limitation is felt to be of some statistical significance. However, since a very large sector of the state is represented on this geographical basis--the eastern area, the Piedmont, and the western area--it is felt that valid extrapolations can be made with regard to selected variables with a relatively high degree of confidence.

All forty-five of the originally selected schools agreed to participate in the study when contacted. Later, two were lost to the project because of their consolidation into another classification during the first, or "pilot" phase of the project. It was not felt necessary to replace these schools for the study year of 1969 as the main thrust of the study was towards differences between individual participant's experience rather than that of schools or teams with regard to the incidence of injuries.

Construction of The Demographic Interview Form--

The interview form seeking population data (see Appendix A) which was utilized in this study to obtain a "prototype" of the respondents in terms of age, race, grade in school, playing experience, and other factors was developed during the summer of 1969. For the most part only structured type and dichotomous answer expectations were used. Those questions related to age, grade, etc.; other straightforward response items were structured to permit fixed, precoded responses. The several dichotomous choice questions were answerable by a yes or no response, and were usually <u>filter</u> questions to determine if the respondent qualified to answer a succeeding question or question-part. An example of the filter type question can be seen by examining the following series of questions taken from Appendix A asked regarding the youth's phsyical examination:

A. Did you have a physical examination prior to the current football season? 1. yes 2. no

If yes, 1. Did physician(s) examine entire team at one scheduled time?

2. Did your family physician examine you?
3. Your family physician filled out appropriate medical form based on prior knowledge of your health?
4. Team physician performed individual examination?
5. Friendly doctor in town?
6. Examined by school physician?
7. Father is a physician and certified health?
8. Examined by physician in Upward-Bound program?
9. Examined by physician at Health Department?
0. Other, explain________________________________?

It will be noted that each response following a filter question was open-ended to the extent that a space was provided for responses other than those preconceived by the investigator. The last part of the demographic data form contained two open-ended questions. One inquired about those activities during the summer which the respondent felt were directed toward improving his physical condition for football. The other asked the respondent why he was playing football at all.

As ambiguity, impreciseness, time indefiniteness, use of complicated words or phrases, and use or words or terms outside the respondent's knowledge or experience were recognized as quite prevalant problems in design and implementation of this type of mass interview-questionnaire function, certain steps were taken to counteract these problems. One investigator led all of the interviews with the exception of four, led by a second staff investigator who had observed the first investigator at as many as twenty sessions. A brief, clear description card or reference card was used to assure that each group interview was asked the same questions in the same manner each time. An example of this for Question A, Part II Physical Examination follows:

Did you have a physical examination prior to the current season?

1. yes 2. no

"If you did have an examination circle the (1) one to the left of the yes answer. If you did not have an examination circle the (2) two to the left of the no answer.

If you answer yes, meaning that a doctor did examine you before you came out for football this season, please answer the next item where it says <u>if yes</u>.

Do that as follows.

If a doctor or group of doctors examined the whole team or a large number of you at one time circle the (1) one in that line of numbers.

If your family doctor examined you privately, circle the (2) two.

If your family doctor filled out the medical permission slip for football for you, but, did not actually examine you, but was able to determine your health because he knows you well, circle the (3) three.

If your team physician examined you privately, circle the (4) four.

If there is a doctor in town that is well know for his help in getting your medical permission slip signed without an examination, circle the (5) five.

If the school physician examined you individually, circle the (6) six.

If your father is a doctor and he certified your health for football, circle the (7) seven.

If you were examined by a doctor in the Upward-Bound Program, circle the (8) eight.

If you were examined by a doctor at the Health Department circle the (9) nine.

If you were examined by a doctor in some other situation, or if you were examined by someone other than a doctor, please circle the (0) zero, and write in on the blank line who examined you."

Construction of the Injury Interview

The injury interview form (see Appendix B) which was utilized in this study was developed during the summer of 1968. It was modified during the pilot year and again just prior to its application during the study year of 1969. Changes made during these modifications were to reduce the amount of information to be secured using the instrument, but in no way were the items that remained altered. This permits comparison of data collected on injuries during the pilot year of 1968 with data collected during the first study year of 1969. The reason for reducing the number of items has been discussed earlier. Most of the items removed were placed on the demographic data form or eliminated entirely because of the lack of quality of data collected on these items during the pilot phase of the project.

The interview method of obtaining data from injured subjects was elected over more traditional survey questionnaires because of its flexibility and application to different types of problems. As certain provisional hypotheses that have been put forth by other researchers in the field have been based on rather fragmented data, the present study was one of hypothesis seeking rather than hypothesis testing, therefore, the research staff did not wish to limit its scope with regard to possible variables or factors which might emerge as relevant to the football injury problem. The principal reason for the choice of the direct interview was to enable research staff to obtain data directly from the injured subject. In the event that a respondent did not understand one or more of the queries, the interviewer could rephrase the question in order to obtain a more critical response.

Construction of the Coaches' Interview

During the period of time when the sample of coaches was being selected, questionnaires were developed to be used in obtaining the necessary information on the coaches' training and background. It was evident after reviewing the literature that people were concerned about background and training of high school football coaches, but that nothing was being done. The research staff at the Laboratory of Applied Physiology had a number of staff meetings in order to determine what criteria should be used in selecting high school football coaches. The coaches' interview form (see Appendix C) was used to obtain applicable information, particularly as the data might be related to greater or lesser rates of injury among their players. These forms were concerned with the following information regarding the coach:

1. Age
2. Playing experience
3. Coaching experience
4. Education
5. Number of assistant coaches
6. Philosophy on practice planning and giving liquids
7. Philosophy of football

The staff concluded unanimously that these seven variables would exhibit the strongest relationship between the coaches' backgrounds and the type and frequency of injuries incurred by their players. Age was felt to be an important variable when comparing the injury rate of the older, more experienced coaches. Under playing experience, it was desired to know whether a coach who had had little playing experience would differ from one who had a greater amount of playing experience. When considering previous coaching experience, it was throught important to know how long a coach had been coaching and at what levels. In addition to the above, the staff questioned the possibility of a football staff with a greater number of assistant coaches doing a better job of coaching the fundamentals of football than a staff with fewer coaches. Every coach has a philosophy of football which affects the entire football program. A coach's philosophy of football was considered to be of great importance. A study by Plesent found education to be an important variable in the coach's background. The North Carolina staff considered this an important area and included questions on the coaches' major area of college study, especially whether or not he had had classes in football coaching, sports training, and first aid. It was considered important to ask the coaches open-ended questions concerning their philosophy about giving liquids to their players during practice, about the amount and type of contact they expected of their players, and, finally, about their general attitudes and procedures in planning practice sessions. An example of questions in this area are as follows:

> During the season, (after your first game) what is your usual pattern of practice organization from Monday to Friday, with respect to the same three areas:
>
> Conditioning:
>
> Instruction and Fundamentals:
>
> Team play:
>
> What is your practice with regard to contact from Monday to Thursday?

It is the opinion of the investigator that this is the type of information needed to help school administrators in selecting their football coaching staff.

Construction of the Equipment Form

There has never been a study that evaluated the football protective equipment worn by selected high school football players and related that information to injury data. It was the purpose of this study to evaluate the make, model, condition, and fit of each piece of equipment worn by all subjects in the 45 sample schools. The form used to gather this information (see Appendix D) was developed during the summer of 1969. It was essential for the form to be constructed in a manner which classified all protective equipment in the areas mentioned above. An additional concern was that of developing a form which could be used with maximum efficiency. This type of question is exemplified in the following questions concerning the outer shell of the football helmet:

1. Shell
    (1) Hard Shell
    (2) Soft Shell
    (3) Soft Strip
    (4) Other

When evaluating the outer shell of the helmet, the investigator only had to circle the appropriate number. The only writing needed was the indication of the manufacturer of the equipment and the model number. The fit of the protective equipment was obtained by writing the manufacturer and requesting information on the suggested fit of their products. Nine of the leading manufacturers were contacted requesting this information. Only one responded. The company that did respond did not have any printed material. The investigator met on an individual basis with representatives of the leading manufacturers. The representatives indicated that the information on proper was not available in printed form. The best information concerning the proper fit of protective equipment was supplied in training sessions, led by the equipment manager at the University of North Carolina. The entire project staff was involved in these training sessions.

The definition of condition was determined by the project staff after observing all types and conditions of equipment during the 1968 season. The following code was used in determining the condition of the helmet:

one: new helmet

two: reconditioned this year, or adequate helmet with no visible signs of webbing rot, missing components, loose rigging or rivets.

three: obvious signs of rot and wear in webbing, missing components, loose rivets, rotted and worn padding.

four: broken or cracked exterior shell, missing rivets, torn webbing or suspension rigging, or missing padding units.

The definition of shoulder pad condition:

one: new shoulder pad

two: reconditioned this year, or adequate pads with no visible signs of rot of cushioning materials, loose or rotted stitching, missing components.

three: obvious signs of rot and/or undue wear of padded areas, broken or rotted stitching, misplaced or ill-matched components, fiber rot or damage.

four: broken plastic or fiber protective material or surfaces, loose cantilever bar, missing components.

Similar condition definitions were applied to hip pads, thigh pads, and shoes.

Collection of Data

The major portion of the data for this study was obtained through the use of both structured and combination structured/open-ended interviews with each of the student athletes in the sample. Several components of the data acquisition system will be discussed in some detail:

Basic Technique Used for Collection of Data--

During the pilot year of 1968, both demographic and injury information was collected by direct structured interview technique on only the injured athletes. During the remaining years, demographic information was obtained by structured interview at the beginning of the football season from all of the student athletes in the study. At each school, all football players were given the questionnaire/interview and led through it's completion by the investigator The injury interview form was thereby substantially shortened and use for the study participants who were actually injured during 1969. The purpose for this change in data collection methodology from the pilot phase in 1968 to the second part of the study was twofold. First, the time spent elucidating personal characteristic data from respondents severely limited the time available during injury interviews to obtain more detailed information with regard to the circumstances surrounding the injury. Second, knowledge of the demographic information on non-injured football participants was determined to be equally as valuable to the analysis of the study as the same data on the injured subjects only.

Coaches Interview Data--

The coaches' questionnaire was originally planned to be completed in a direct interview. It was to take place when the project staff visited each school to carry out the evaluation of the protective equipment. Upon completion of fifteen schools, it was found to be more desirable if the coach were to be given the questionnaire and asked to complete it at his leisure. During football season the coach is always in demand or is in the process of carrying out one or the other of his many duties. It became obvious that the coaches needed more time to think about the open-ended questions; the investigator made the decision to allow the coach to complete the questionnaire during his free time and to mail it to the Laboratory of Applied Physiology. In some cases the questionnaire was picked up at the individual school by an investigator.

In some additional cases, the investigator used both the direct interview technique and the questionnaire method. The first three sections would be completed during the direct interview. The remainder of the form would be completed by the coach at his convenience. The coaches' interview form was completed by forty-one of the forty-three study coaches, and it was felt that each coach put his total effort to the task.

Protective Equipment Evaluation Data--
In order to evaluate the protective equipment of both the injured and non-injured player, it was necessary to visit each school. After much preparation, it was decided that the best time to do this would be between August 15 and September 1. August 15 was selected due to its being the first day the players would be allowed to wear all protective equipment. September 1 was the date of the first games and the staff realized that time would be an important factor once the season started. Each school was contacted and a date and time were established for all forty-three schools. To visit 43 high schools and evaluate the protective equipment of 2,252 football players meant a great deal of work for the research staff and total cooperation by the study schools. The coaches were asked to give up valuable practice time to make this evaluation possible, and all forty-three coaches responded in a positive manner. The cooperation in all phases of this project has been tremendous and the project staff is indebted to these study schools.

When the evaluation appointments were set, the coaches were asked to have all their football players dressed in full protective equipment at the designated time. In addition, in order to get a true evaluation, the coaches were asked not to alert their players ahead of time. Some of the evaluations took place before practice, others after practice, and some during practice. A team of four to six investigators would arrive at the correct time and begin the evaluation. This investigator and one other evaluated the protective equipment of all 8,776 football players. We were both involved in the training sessions and worked together during the first five evaluations.

The procedure used in this phase of the project followed these steps:

1. All players were dressed in full game protective equipment.
2. Players were asked to pass through one of two lines for the evaluation.
3. At the head of each line were two investigators--one evaluating the protective equipment and the other checking the information on the equipment form.
4. The investigator first evaluated the condition of the equipment and then its fit.
5. The players carried their helmets in their hands and removed their football and shoulder pads for condition.
6. The evaluation followed the order of the equipment form--helmet, shoes, shoulder pad, hip pads, and thigh pads.

Injury Data--

Collection of the injury data was carried out by a team of investigators who were assigned to a specified number of schools. It was the duty of these investigators to visit each of his schools on the same day and time each week. A list of the players injured that week was posted by the coach; in some cases, the coach assigned as assistant coach or trainer to this task. The injured boys were interviewed by an investigator either during the school day or during practice. The cooperation of school officials and coaches demonstrates their concern in the area of athletic injuries. The data collected by the injury form (see Appendix B) covered all aspects of the injury. It is important to mention that this information came directly from the injured boy.

Experimental Phase of Study

The final two years of the study, (1971-1972), were called the experimental phase. It was during these two years, that the investigators planned to make certain changes in the football programs of selected schools. Twelve schools were supplied with football helmets that were not previously used by the 43 study schools. Four schools were randomly selected to wear the Riddell air padded helmet, four schools the Bell Toptex helmet, and four schools the Rawlings JRC helmet. These schools were supplied the helmets by the study and players were either fitted by an investigator or by a representative of the manufacturer. In addition to helmets, Gladiator G-25 shoulder pads were placed in three study schools. The schools were randomly selected and players fitted by study investigators.

Another change initiated during the final two years of the study was to randomly select nine study schools and completely resurface their game and practice fields and maintain their good condition during the 1971 and 1972 football seasons. Three of the schools were supplied with soccer shoes and the other six schools kept the conventional football cleat.

The final change was to select six study schools to follow a limited contact practice program for the 1971 and 1972 football seasons. The program is outlined in Figure I. These schools were supplied with field equipment they felt necessary to carry out this program.

Analysis of Data

In handling all the data collected in this study, the investigator was obliged to use a statistical technique giving a reliable measure of the probability of difference between and within groups on several variables. One example would be the problem of determining whether the rate of injury to players coached by a person with a certain coaching history would be significantly different from the rate of injury of those coached by a person with a different coaching history. In addition, it was necessary to determine if a difference in frequency of injury existed within groups of players. In order to do this the investigator had to determine whether injured players using one type of protective pad differed significantly in their injury experience from non-injured youths wearing the same or different protective pads.

The chi-square test was selected as the most appropriate for use in the analysis for this study. This technique provides a reliable estimate of whether observed differences between and within each group are statistically significant. The chi-square test looks at the difference between frequencies actually obtained and those expected by chance or theoretical frequencies This is accomplished by squaring the observed and theoretical frequencies and dividing the results by the expected number. The sum of these quotients is the chi-square. The expected frequencies for injured and non-injured players was computed by multiplying the percentage of each group by their respective totals. The smaller the chi-square, the more closely the observed number is to the expected. The higher the chi-square, the greater the difference between the observed and expected, and the lower the probability of the difference being due to chance. In this study, a difference between two items was considered significant if the chi-square was equal to that required to satisfy the .05 level of probability. Above this chi-square a relationship would be expected to appear by chance less than five times in one hundred.

In comparing frequency of injury, the following injury rate formula will be used:

$$\text{Injury rate} = \frac{\text{Number of student athletes specified as newly manifesting injury during the year}}{\text{Average number of such persons at risk during the season or year}}$$

CHAPTER IV

THE PILOT PROJECT

The actual design of the football injury study began August of 1968. A pre-test or pilot survey was conducted during the 1968 football season to iron out administrative difficulties and data inconsistencies, and to reveal interviewing difficulties. By the end of the football season, the pilot study experience had been used to determine the final design of the study, the data collection forms, the interviewing techniques to be used, the visitation schedules, staffing requirements, and expectations.

The specific purposes of this phase of the total project were: (1) to establish the prerequisite cooperation of the 45 study school coaches and administrators, (2) to provide an opportunity to field test the data collection forms and methods, (3) to provide for an extended training period for selected interviewers/investigators in interviewing techniques, (4) to initiate and maintain a workable schedule for data collection visits to participating schools which would assure the smallest possible delay between the injury occurrence and data acquisition, with continuity expectations for the complete study period of at least three years, and (5) to determine, from pilot phase data, the character and nature of responses to individual interview items in order to modify them as necessary to assure a constant flow of consistently reliable information on injuries prior to the initial study year of 1969.

During 1968, data were obtained for analysis in the initial phase of the project by interviewing 867 student athletes at the 45 sample schools. In order to determine the extent of change or modification in study design necessary prior to the initiation of the baseline study in 1969, the pilot data were analyzed for three areas: (a) distribution of injuries by certain personal characteristics of the injured players, (b) distribution of injuries by various environmental and other factors, and (c) distribution of the injuries by type, part of the body affected, and severity. All of the data gathered during the pilot phase of the study is neither presented or commented on here. Only those items which ultimately led to some modification of design or data collection procedures involved in the second year of study have been displayed.

Table I shows the distribution of samples schools by classification and number of injuries occurring in each classification during this phase of the project. This table indicates that a greater percentage of the injuries to participants occurred in the larger, urban schools. The second highest frequency was found in the small-city, or rural consolidated classification of school and the lowest frequency in the small, rural school. The range in number of injured players was much the same by school classification being four to 33 in the smaller schools, five to 49 and nine to 42 respectively, in the two large classes.

TABLE I.--FREQUENCY DISTRIBUTION OF INJURY TO STUDY PARTICIPANTS BY CLASSIFICATION OF SCHOOL, DURING PILOT PHASE OF STUDY

School Class	School Population	Number of Schools	Number of Injuries	Percent of Injuries
1A-2A	Less than 500	15	256	29.5
3A	501 to 1,000	15	287	33.2
4A	Over 1,000	15	324	37.3
Total		45	867	100.0

Table II describes the frequency and percentage of injuries occurring to student athletes during the pilot phase of the study. Three variables, associated with the player himself, are represented: (1) race, (2) age, and (3) the level of play in which the player participated. An examination of the table reveals that injuries were most frequent among the white participants. Eighty-seven per cent of all the injuries occurred to members of this group, with only 12 per cent occurring to Negroes.

The sixteen and seventeen-year-old players were the most frequently injured if age is considered. More than 36 per cent of the injuries occurred to seventeen-year-old players, and 31 per cent to the sixteen-year-old boys. Twenty per cent occurred to the fifteen-year-old youths. With respect to player status, 83 per cent of all the injuries occurred to varsity players and less than 15 per cent to junior varsity players. It seemed quite obvious, at first, that most of the boys participating at the high school level were sixteen or seventeen years old, and that at that age were probably on the varsity; therefore, most of the injuries would fall into those groupings.

Here, we found ourselves falling into the same trap that many previous investigators had fallen into (131, 34, 169). We had failed to consider the numbers of youths participating in football in the same racial or age groups who remained injury-free. Therefore, the first modification brought about by the pilot or pretest effort of the study was the redesigning of the project to include collection of demographic data on <u>all</u> of the student athletes. Rates could then be computed and a comparison could be made between the injured and non-injured students.

As Table III indicates the number of participants injured in practice exceeded those in game situations by a small margin. In addition, the month

TABLE II.--FREQUENCY DISTRIBUTION OF INJURY TO STUDY PARTICIPANTS BY RACE, AGE, AND PLAYER STATUS, DURING PILOT PHASE OF STUDY

Race	Number of Injuries	Percent of Injuries
White	758	87.4
Negro	107	12.3
Other	2	.3
Total	867	99.9
Age		
13 Years	4	.4
14 Years	37	4.2
15 Years	173	19.9
16 Years	272	31.3
17 Years	318	36.6
18 Years	54	6.2
19+ Years	5	.5
Unknown	4	.4
Total	867	99.8
Player Status		
Varsity	719	82.9
Junior Varsity	126	14.5
Unknown	22	2.5
Total	867	99.9

in which the greatest number of injuries occurred was September; 41.5 per cent of all injuries occurred during that month. August and October each

TABLE III.--FREQUENCY DISTRIBUTION OF INJURIES TO STUDY PARTICIPANTS BY MAJOR ACTIVITY AND MONTH OF INJURY, DURING PILOT PHASE OF STUDY

Major Activity	Number of Injuries	Percent of Injuries
Practice Activity	461	53.0
Interschool Game	406	47.0
Total	867	100.0
Month of Injury		
August	232	26.7
September	360	41.5
October	226	26.1
November	46	5.3
Unknown Month	3	.4
Total	867	100.0

accounted for about 26 per cent. These results, both with regard to the ratio of practice injuries to game injuries and to the month of greatest injury frequency, are contrary to earlier findings present in the literature. Dalzell (56) reported 63 per cent of injuries in his study as occurring in games and only 37 per cent in practice. In the opposite direction, Lloyd (141) and Henry (115) reported that only 40 per cent of all injuries occurred during interscholastic games, and that from 16 to 18 per cent occurred during preliminary work. Scrimmage periods accounted for approximately 39 per cent of the injuries reported by the two investigators.

With respect to the month in which the greatest number of injuries were reported to have occurred in other studies, Van Brocklin (262), reporting on injuries in Oregon high schools in 1951, cited October as the month with the highest incidence of injuries. Krause (132) supported that data with similar results--indicating October as the most hazardous month for football play; 42.8 per cent of the injuries in his investigation occurred during that time.

The divergence of our data from previously reported results, forced us to consider other factors which might have been working to produce the inconsistencies between our findings and those of previous investigators. The degree of effort put forth in practice by a player, the duration of the practice itself, and the type of practice activities all suggested themselves as possibilities for explaining the differences between game and practice frequencies. The same factors might have had a similar effect on the month exhibiting the highest injury frequency, since practice injuries are a substantial portion of the injuries occurring in any month. This assumption seems warranted in view of the frequency of injuries occurring in the month of August--a month during which no games at all were played: the month's injury rate equaled that of October, whose injuries would be incurred primarily in game play and only secondarily, if at all, in practice.

Study and analysis of tabulations of this nature led to additional types of modifications of the data collection interview form and technique. These changes permitted inclusion of more detailed information on the amount of time boys were actually practicing during practice sessions, the types of drills and group work they engaged in, and the length of active practice sessions.

Table IV shows the incidence of injuries by type for the four most frequently occurring injuries. The most common types of injury were: sprains, 23 per cent; contusions, 18 per cent; fractures, 12 per cent; and, concussions, six per cent. The table also displays the most frequently injured parts of the body. The five most injured parts were: the knee, followed by the ankle, head and neck, shoulder, and hand.

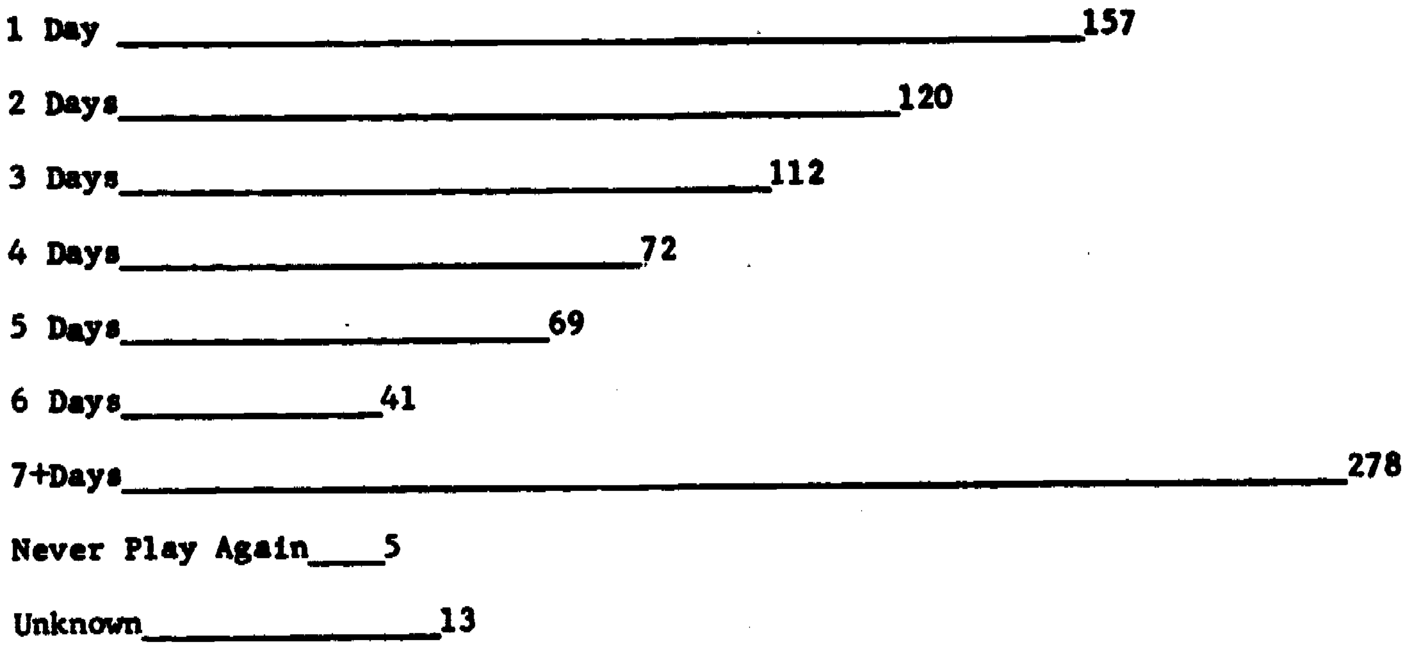
TABLE IV.--FREQUENCY DISTRIBUTION OF INJURIES TO STUDY PARTICIPANTS BY TYPE OF INJURY* AND PART OF THE BODY INJURED*, DURING PILOT PHASE OF THE STUDY

Type of Injury	Number of Injuries	Percent of Injuries
Sprain	203	23.0
Contusion	159	18.0
Fracture	104	12.0
Concussion	55	6.0
Part of Body Injured		
Knee	187	21.6
Ankle	153	17.6
Head and Neck	106	12.2
Hand	32	3.6

*Data presented for only the four most frequent items in each classification.

Figure 1 shows the number of days lost to activity beyond the day of injury by players injured during the pilot study. It can be noted here that the greatest number of boys injured lost at least a full week from activity. While a considerable proportion, almost 20 per cent, lost only one day from action. Over half the youths were inactive for four days or longer. Injured players classified as "never play again" numbered three for medical reasons, two from parental prohibition. Injuries incurred ranged from moderate to severe injury.

FIGURE 1.--NUMBER OF DAYS LOST PER INJURY DURING PILOT STUDY



Information from Table IV differs greatly from other reported studies of football morbidity in that fractures and concussions have never accounted for such a high percentage of the total number of injuries. Although the Carnegie Study (38) in 1929 reported 382 fractures and 132 concussions among only 525 major injuries in college football, since that time these more severe types of injury have not been ranked as high in frequency. Stevens (243), in his study of football injuries, reported the knee, foot, hip, and thigh as the most frequently injured body parts. He reported sprains, strains, bruises, and dislocations as the most frequently reported types of injury. Henry (115) also reported sprains, bruises, strains, and cuts and abrasions as the most frequently occuring types of injuries.

It was felt that the degree of severity of the injury might account for the larger number of head and neck injuries as well as the extensive numbers of fractures and injuries of a concussive nature. The number of serious injuries, at least as judged serious by the number of days lost to activity, seemed to confirm this. The early pilot data displayed in Figure 1 on time lost due to injury suggested that our interviewers were obtaining information on a disprpportionate number of the more serious injuries. This indicated to the investigator that the members of the staff were not communicating to the cooperating coaches and their assistants a definitive description of the type of injury we wished to include in the study as defined by our working definition. It seemed that the following factors were worthy of looking into:

(a) the possibility that some coaches did not understand the working definition of injury that we were using.

(b) That some injuries by their very nature defied the strict semantics of our working definition. For example, a laceration might not limit the activity of a student athlete's activity except for bandaging or padding of the injured part; yet, if the doctor sutured this injury, he would fit the classification of "injured".

(c) That a youth mildly concussed in the first quarter of a game might play later in the game and thereby not fulfill our requirement, in the trainer's estimate, as an injury we would wish to pursue.

(d) That a boy who was injured who usually played both ways (offense and defense) might be used on a limited basis in a one-way capacity as a result of a minor injury. It may have been unclear that such an injury would fit our terminology of "modified" activity.

(e) That often the coach or trainer would forget several minor injuries during the time interval between interviewer visits.

(f) That, in some cases, injured boys were seen by professionals other than medical doctors (chiropractors) and did not fit our definition.

In order to pursue our intuitions about our collected data, and, in so doing, both tighten-up the data collection procedures and more adequately define an injury occurrence for the purposes of the study, a special meeting of consultants to the project was called for the spring of 1969. Twenty of the study school coaches, the project staff, and several, selected, outside consultants met to go over these matters. Outside professional help consisted of the president of the North Carolina State Medical Society, the executive director of the National Federation of State High School Athletic Associations, and the executive secretary of the American Football Coaches' Association. Representatives of the State Department of Public Instruction and the North Carolina High School Athletic Association also contributed their time and knowledge to this meeting.

As a result of the guidance and counsel received during these deliberations, the decision was made to redesign to some degree the study for 1969. The following modifications in the study protocol were made:

1. Demographic data would be collected on all sample school student athletes rather than on only the injured subjects.

2. A daily roster was designed and provided to each study school coach upon which a record of the names of each boy injured each day could be entered for later abstraction by the visiting interviewer.
3. An attempt was made to increase the frequency of interviewer visitations to more than once a week to each study school.
4. The working definition of an injury was refined to "one occurring as a result of participation in an organized football program at the high school level, _for which professional treatment_ was received, _and/or_ which resulted in restriction or modification of the boy's usual activity for one day beyond the day of the injury."

In addition to both alleviating these expressed data deficiencies, and clearing up interviewing difficulties due to misunderstanding on the part of both coaches and investigators with respect to the definition of an injury, the staff gained practical field experience in interviewing by conducting 867 injury interviews. In addition, staffing patterns were proven adequate to fulfill the requirements of the study's operation in the ensuing 1969-1972 football seasons.

CHAPTER V

EPIDEMIOLOGIC ANALYSIS AND DISCUSSION OF THE INCIDENCE OF INJURIES IN HIGH SCHOOL FOOTBALL

A logical query into the nature and character of a relatively unknown quantity such as accidental football injury must begin with very general descriptive observations. Along this line, the first step in the data analysis of this study was to determine the crude incidence rate of injury to participants among the study population during the 1969-1972 football seasons.

There were 4,287 injuries reported and interviewed from among the 8,776 study participants in 43 schools in the study. This represents an incidence rate of 488 per thousand, or some 48 injuries for each hundred participants.

The distribution of the dependent variable, in this case, football trauma, was then examined within the sample population. This is reported in some detail in this chapter with respect to the types of injury sustained, the parts of the body injured, and an estimate of the severity of the injury. Comparisons were then made with reported frequencies in other populations. These comparisons are on the overall crude rates where applicable, and on differences in frequencies within populations where data sources and definitions are comparable. Some liberty has been taken in making these comparisons with other related studies and in suggesting provisional hypotheses based on subjective and intuitive judgment. The remainder of the chapter will deal with the examination of the frequency of injury of certain segments, or within certain segments, of the population according to selected variables felt to be descriptive of the environment and/or the host. These variables are two of the generally accepted epidemiologic classifications. The third classification, that of the agent of the injury, will be considered separately in Chapter VI.

Comparison of Crude Incidence Rates With Those of Other Populations

The present study and those of a number of other investigators of high school football morbidity are displayed in Table V. This comparison suggests several problems which have been discussed earlier with respect to comparability of research results in the area of athletic injury research. As shown, most of the studies have involved only one year of research attack. In addition, there is a distinct, observable difference in rates between those studies that have utilized insurance claims and mail-in questionnaires as data sources and those that have utilized existing medical records on defined student populations. The rates are much lower for those studies using insurance claims.

This is probably attributable to the difference in their usual definition of an injury. For example, in the insurance claim type study, an injury is simply defined as "an injury of a given severity or particular type that results in a claim." These injuries are very select types requiring a physician's attention and/or hospital care and treatment. On the other hand, the questionnaire effort, for its definition of an injury, often must depend on the judgment of the many cooperating coaches or trainers as to what constitutes an injury for that study.

Existing medical records of entire team or groups of teams, as in "Atlanta High Schools," "Andover Academy," or "U.S. Air Force Teams," seem to provide the most descriptive injury incidence data. Their data compare very favorably with the current study, which used a direct interview approach and a stipulated injury definition which was stringently controlled by the project staff. The current study findings of one injury for every two young

TABLE V

COMPARISON OF CRUDE INCIDENCE RATES OF HIGH SCHOOL FOOTBALL INJURY BETWEEN SELECTED MORBIDITY STUDIES SINCE 1933

Investigator	Schools or Area of Country	Source of Data	Number of Study Years	Number of Players	Number of Injuries	Injury Rate
Blyth Mueller	North Carolina High Schools	Direct Interview	1969	2,269	1,209	.532
			1970	2,305	1,096	.475
			1971	2,107	1,024	.485
			1972	2,095	958	.457
			Combined Four Years (1969-72)	8,776	4,287	.488
Neilson, N.	California High Schools	Insurance Claims	One (1933)	13,559	3,003	.221
Henry, N.	North Carolina High Schools	Questionnaire	One (1948)	2,800	1,009	.360
Krause, M.	Oregon High Schools	Insurance Claims	One (1955)	4,854	1,761	.363
Clark, D.	Andover Academy Massachusetts	Medical Records	Eight (1956-63)	2,120	1,062	.510
Alley, R.	California High Schools	Insurance Claims	One (1961)	19,413	4,829	.249
Wisconsin Athletic Assn.	Wisconsin High Schools	Insurance Claims	One (1962)	30,357	6,012	.198
Allman, F.	Atlanta City High Schools	Medical Records	One (1962)	1,200	657	.547
Allen, M.	U.S. Air Force Teams in Asia	Medical Records	One (1965)	406	268	.660

man exposed in high school football should represent an accurate statement of the extent of the problem of injuries at the high school level of play.

Distribution of Injuries to Study Participants 1969-1972

Type of Injury-- Table VI shows the relative incidence of injury by type of injury. Distributed in order of frequency are 4,278 injuries (which includes multiple injuries) categorized into 18 types; 13 additional types, involving only 124 injuries, were classified as "other or unknown." As shown, the seven most common types of injury to high school level players in this study were sprains, contusions, fractures, pulled muscles, strains, lacerations, and concussions. These seven injury types accounted for over 70 per cent of all injuries observed during 1969-1972.

These data also compare favorably with information reported by Neilson (169), Krause (132), and Van Brocklin (262) who found the same injury types accounting for from 70 to 84 per cent of all football injuries to high school players. They did not include muscle pulls and this type injury will not be included in the comparison. Henry (115), reporting on types of injuries occurring to North Carolina high school footballers in 1948, indicated that 94 per cent of the injuries during that year were of the six types mentioned above, not including muscle pulls.

However, with respect to the relative rank order of these six most frequently occurring injuries, there is considerable difference in that data reported here and that from earlier studies of high school football injury. Table VII shows these differences particularly with regard to the percentage of fractures, concussions, and lacerations. It can be seen that no single study in the past has ever reported a greater frequency of fractures than the current study with one exception. Krause (132) reported 10.8 per cent

TABLE VI

FREQUENCY DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO THE TYPE OF INJURY SUSTAINED 1969 - 1972

TYPE INJURY	FREQUENCY	PERCENTAGE
Sprain	874	20.4
Contusion	759	17.7
Fracture	456	10.6
Pulled Muscle	378	8.8
Strain	316	7.4
Laceration	249	5.8
Concussion	231	5.4
Torn Ligament	219	5.1
Muscle Contusion	138	3.2
Joint Contusion	138	3.2
Dislocation	92	2.1
Nerve Injury	65	1.5
Torn Cartilage	60	1.4
Separation	47	1.1
Infection	47	1.1
Heat Exhaustion	30	0.7
Ruptured Blood Vessel	28	0.7
Torn Tendon	27	0.6
Other and Unknown	124	3.1
Total	4,278	99.9

TABLE VII

COMPARISON OF THE SIX MOST FREQUENTLY APPEARING INJURY TYPES BETWEEN SELECTED STUDIES OF HIGH SCHOOL FOOTBALL INJURIES

	- Percentages -				
Type of Injury	Blyth Mueller	Henry	Krause	Tabrah	Allen
SPRAIN	20.4	22.7	34.6*	38.5	28.0
CONTUSION	17.7	31.5	31.3	5.4	30.0
FRACTURE	10.6	5.0	10.8**	8.5	6.0
STRAIN	7.4	14.1	*	26.7	14.0
LACERATION	5.8	13.6***	2.7	2.2	2.5
CONCUSSION	5.4	4.0	2.2	3.3	3.0

* Sprains and Strains classified under one heading

** Includes fractured teeth

*** Includes abrasions

of all injuries as fractures; however, this frequency included the dental injuries which certainly magnified the fracture problem considerably.

As shown, the percentage of concussions in the current study is more than twice that of all previous reports of similar data--with again one exception: Henry's (115) rate. Again, with respect to the lacerations sustained in the present study, a higher percentage is shown when compared to other work in every case except that of Henry (115), where abrasions were included with lacerations making direct comparison impossible.

Many hypotheses might be put forth to account for the different frequencies in injury types. Certainly, the fact that the game has changed over the past several years could account for the differences. The advent of the hard-shelled helmet and the many changes in techniques of blocking and tackling are important considerations with regard to these same factors and warrant further study.

<u>Part of the Body Injured</u>-- The distribution by body location is given in Table VIII. The most frequently injured body part was the knee (19.3 per cent), and the ankle (15.3 per cent). The head and neck received 8.8 per cent of all the injuries, followed by the shoulder (7.3 per cent), and the upper leg (5.4 per cent), in descending order of frequency.

That the knee and ankle rank as the two most commonly injured body parts in football activity is consistent with all previous high school level studies using even remotely comparable data sources (5, 34, 115, 116). As the 1968 pilot data demonstrated, the head and neck again accounted for a greater proportion of the total number of injuries than did the shoulder. This can possibly be accounted for by the differences in definition or classification (e.g., in the current study collar bone damages were separated

TABLE VIII

FREQUENCY DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCOUDING TO THE PART OF THE BODY INJURED

PART CF BODY INJURED	FREQUENCY	PERCENTAGE
Knee	827	19.3
Ankle	657	15.3
Shoulder	315	7.3
Head	265	6.2
Upper Leg	232	5.4
Back	203	4.7
Lower Leg	145	3.4
Fingers	137	3.2
Hand	134	3.1
Neck	111	2.6
Ribs	111	2.6
Elbow	102	2.4
Lower Arm	101	2.4
Hips	97	2.3
Foot	94	2.2
Groin	86	2.0
Wrist	80	1.9
Thumb	72	1.7
Nose	65	1.5
Upper Arm	61	1.4
Eye	52	1.2
Chin	49	1.1
Collar Bone	41	1.0
Other and Unknown	250	5.8
Total	4,287	100.0

from other shoulder injuries) and changes in techniques of skill execution as indicated earlier.

Another interesting finding, identifiable from the data in Table VIII, is the high proportion of back injuries to the total number of injuries sustained. The back has never appeared in other morbidity studies as a significant area of involvement with respect to football injuries.

Table IX shows the distribution of injury to body parts by more generalized, and perhaps more game-related classifications. The lower extremity classification reflects 46.3 per cent of the total injuries when looked at in this manner. The upper extremity received almost one-fourth of all injuries; the trunk was next in order of frequency with 12.9 per cent. The head and neck had the lowest frequency of the generalized categories, accounting for only 12.9 per cent of the total. Table X shows the distribution of the seven most prevalent types of injury as categorized by part of the body injured. The seven major classifications of type of injury accounted for a total of 2,711 of the total injuries sustained by participants in the study. The lower extremity received 1,447, and the most frequently injured location on the lower extremity was the knee and ankle. The upper extremity received 603 of the seven most frequent type injuries. The finger-hand (266) and shoulder (145) were the most frequently injured sites. The head and neck received 393, almost all concussions, while the site most often injured was the brain itself.

The hand or fingers were fractured most often, followed by the lower arm-elbow, ankle, nose, and ribs. The most frequent sites of laceration were the face, hand, and fingers. Interestingly enough, the knee received the greatest number of contusions. Most reports of knee injuries in football have indicated

TABLE IX

FREQUENCY DISTRIBUTION OF INJURIES ACCORDING TO GENERALIZED BODY AREAS

BODY AREA	FREQUENCY	PERCENTAGE
LOWER EXTREMITY	1986	46.3
Upper Leg	232	5.4
Knee	827	19.3
Lower Leg	145	3.4
Ankle	657	15.3
Foot	94	2.2
Toes	31	0.7
TRUNK	658	13.2
Hips- Pelvis	113	2.7
Chest - Ribs	132	3.1
Back	203	4.7
Groin	86	2.0
Internal Injury	34	0.7
HEAD AND NECK	554	12.9
Head	265	6.2
Eye(s)	52	1.2
Mouth	21	0.5
Face	27	0.6
Nose	65	1.5

Table IX continued on page 82

(Table IX continued)

BODY AREA	FREQUENCY	PERCENTAGE
Neck	111	2.6
Teeth	13	0.3
UPPER EXTREMITY	1,043	24.4
Shoulder	356	8.3
Upper Arm	61	1.4
Elbow	102	2.4
Lower Arm	101	2.4
Wrist	80	1.9
Hand - Finger(s)	271	6.3
Thumb	72	1.7
OTHER	136	3.1
TOTAL	4,287	99.9

TABLE X

DISTRIBUTION OF SELECTED INJURY TYPES ACCORDING TO THE PART OF THE BODY INJURED

Part of Body Injured	Type of Injury							
	Contusion	Sprain	Fracture	Strain	Laceration	Concussion	Torn Ligament	Total
Total	655	811	361	305	138	231	210	2711
Lower Extremity	250	693	77	217	27	0	183	1447
Upper Leg	61	1	3	1	2	0	1	69
Knee	120	188	5	183	10	0	146	652
Lower Leg	44	6	32	3	13	0	0	98
Ankle	25	498	37	30	2	0	36	628
Trunk	185	9	37	34	0	0	3	268
Hips-Pelvis	71	3	2	2	0	0	1	79
Chest-Ribs	72	0	31	3	0	0	0	106
Back	42	6	4	22	0	0	2	76
Groin	0	0	0	7	0	0	0	7
Head and Neck	33	12	38	22	56	231	1	393
Head	4	0	0	0	18	231	0	253
Face	2	0	0	0	22	0	0	24
Nose	14	0	35	0	14	0	0	63
Neck	13	12	3	22	2	0	1	53
Upper Extremity	187	97	209	32	55	0	23	603
Shoulder	68	35	12	20	0	0	10	145
Upper Arm	28	0	6	2	3	0	0	39
Lower Arm-Elbow	48	21	54	7	15	0	8	153
Hand-Finger(s)	43	41	137	3	37	0	5	266

sprains, strains, and other torsion type injuries to the joint itself. In addition, the ligamentous and cartilage injuries usually are predominant. For example, Thorndike (249) reported only six contusions out of 483 knee injuries over a seven year period at Harvard. After the knee, the shoulder, upper leg, hip, and back areas were most often contused.

Time Lost From Activity Due To Injury-- As this project, from its inception, was concerned principally with the gathering and analysis of data related to the cause or causes of the injury, or to factors which might later prove to be associated with such cause or causes, diagnostic or other medical evaluative information was not given a very high priority with regard to data acquisition. Because interview data was restricted to the knowledge available to the injured youth, his coach, and his fellow players, little confidence can be placed in the medical classification of the injury. An index of the severity of the injury, however, was felt to be moderately important to the general analysis of results. Data were obtained, therefore, on the length of time the student athlete was disabled by his injury and on the type of medical or other treatment he received for his injury. Both of these factors were considered to be indicators of the severity of the injury, particularly the measure of disability days.

Table XI indicates that the highest percentage of injured had their activity restricted for seven days or more (34.7 per cent). The next largest category of disabilities was the boys injured to the extent that they had to modify their activity for only one day beyond the day of the injury (18.1 per cent). The same extremes were observed during the pilot phase of the study, and at that time were considered to be related to problems involved in the data collection system. However, when compared with the pilot data,

TABLE XI

FREQUENCY DISTRIBUTION OF DAYS LOST FROM PARTICIPATION BY INJURED PARTICIPANTS

NUMBER OF DAYS LOST	FREQUENCY	PERCENTAGE
LESS THAN ONE DAY	112	2.6
ONE DAY	777	18.1
TWO DAYS	519	12.1
THREE DAYS	498	11.7
FOUR DAYS	402	9.4
FIVE DAYS	194	4.6
SIX DAYS	152	3.5
SEVEN OR MORE DAYS	1,488	34.7
NEVER PLAY AGAIN*	27	0.6
UNKNOWN	118	2.7
TOTAL	4,287	100.0

*Includes Parental and Medical Prohibition the data confirms that the findings are consistent from year to year. Injuries seem to fall into two extreme categories: either one is injured quite severely, or barely injured at all. It is interesting to speculate on why over one-half of the injured athletes were restricted for fewer than five days. Several interesting possibilities suggest themselves as reasons for this. If a young man is injured in a game on Friday, he has Saturday and Sunday to recover. In addition, Mondays are often "light" practice days for some teams particularly following a victory. Hence, the boy injured on Friday may be able to go "full" on Monday without discomfort. He may, at any rate, be given a "light" practice. On the other hand, the coach may choose to rest the injured boy for an additional day. So the large number of injuries in the one to three day restricted category is not surprising.

On the other side of the coin, for those coaches who go "heavy" on Monday and Tuesday, the injured may be held out an additional day (particularly front-line ball players) to miss the heavy work but still get back to work on the fifth day to perfect their timing and pick up any changes in plays or formations introduced for the forthcoming Friday evening encounter.

Practice injuries could conceivably follow a pattern as well. A youth injured in heavy work on Monday or Tuesday would likely be held out until the Friday game, resulting in an average loss of activity of from one to three days. Another boy, injured moderately on Thursday, would probably miss the game but be available on the following Monday again resulting in a three to four day loss.

The small number of injuries producing disabilities of from five to six days could be attributable to cases of players who, rather severely injured on Friday, (this was frequently observed with regard to recurring knee and ankle injuries), were held out until light work on the following Wednesday or Thursday. This would enable the player to get ready for the Friday ball game.

The frequency of "never play again" classifications were only slightly less than one per cent. This included one case in which decision to prohibit participation was parental rather than medical: the youth had sustained a rather severe nose injury. The other 26 boys sustained injuries severe enough, on the medical basis, to prevent their further participation in contact sports.

A comparison of current study results (using disability days as an index of severity of injury) with studies of high school football morbidity is impossible. Studies of morbidity, to date, either do not include an index of severity or disability (6, 115, 116, 132, 246, 262), or they use diagnostic information from professional sources dissimilar to those of the current study, such dissimilarity making comparison difficult.

The Incidence of Injury By Certain Environmental Factors

School Classification--An examination of Table XII reveals that football injuries were most frequent among players from the 1A-2A schools. The players from the larger 3A schools had the next highest injury rate and the lowest rate occurred in the large 4A schools.

The data agrees with other reports of injury rate by school size, such as Henry (115), and Krause (132), where both investigations indicated a greater injury rate among players participating on teams from schools with the smallest enrollments.

TABLE XII

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INCIDENCE RATES OF INJURIES TO PARTICIPANTS BY SCHOOL CLASSIFICATION 1969-1972

Class of School	Injured	Not Injured	Total	Rate	Percent of Population
1A - 2A	936	832	1,768	.529	20.1
3A	1,494	1,565	3,059	.488	34.9
4A	1,857	2,092	3,949	.470	45.0
Total	4,287	4,489	8,776	.488	100.0

Table significant at .01

Month of the Injury--The frequency distribution of injuries by month of activity is revealed in Table XIII. It indicates that September is the

TABLE XIII

FREQUENCY DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO THE MONTH OF ACTIVITY 1969- 1972

MONTH	FREQUENCY	PERCENTAGE
AUGUST	1,177	27.5
SEPTEMBER	1,543	36.0
OCTOBER	1,323	30.8
NOVEMBER	196	4.6
DECEMBER	3	0.1
UNKNOWN	44	1.0
TOTAL	4,286	100.0

most hazardous month of football participation, with 36.0 per cent of the total number of injuries. October had the next highest frequency with 30.8 per cent. While these distributions were consistent with that found during the pilot phase of the study they again disagree with previously reported work by Henry (115) and Van Brocklin (262). Perhaps of more interest than the high frequency of injury during the months of September and October, is the frequency of injury for the month of August (27.5 per cent). In North Carolina, football practice cannot begin until the 8th of August. For a period of seven days, only light drills without equipment or conditioning programs are permitted. Therefore, this injury rate is principally for the period of one-half month, which magnifies the proportion of injuries occurring in August considerably. The very low frequency of injury in the month of November is easily explained. In this area of the country, football season starts in the late summer and has been completed, with the exception of play-off championship games, by the first week in November. Therefore, the frequency for November reflects the injuries of only one week of scheduled game activity, plus a small number of championship games. For example, in 1969 only six of the 43 study schools succeeded in making it to the play-off games in their respective divisions.

This earlier starting time in the South is another possible explanation for the disagreement with results reported in other studies with regard to the month exhibiting the greatest frequency of football injuries. In some northern and mid-western states, football does not begin until September, and traditionally ends on Thanksgiving Day or during the last week of November. Practice seems inconsistent with what common sense would seem to dictate when the prevailing weather conditions in the two areas of the country are considered.

Practice Versus Game Activity-- Of the 4,287 injuries recorded, 2,192 or 51.1 per cent occurred in practice. Table XIV indicates the consistency of this observation with the pilot year of 1968. The differing percentages of game versus practice injuries are very similar. This is certainly not consistent with the amount of effort invested in the two activities by the teams during the year. It is suggested that, if equal time were involved, game activity would vastly outstrip the practice routines in so far as injury

TABLE XIV

FREQUENCY DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO GAME OR PRACTICE ACTIVITY - 1969 - 1972

PLAY SITUATION	FREQUENCY	PERCENTAGE
GAME	2,079	48.5
PRACTICE	2,192	51.1
UNKNOWN	16	0.3
TOTAL	4,287	99.9

experience is concerned. This contention is supported rather well by data which indicates that the highest number of injuries were incurred on Friday--game day.

Quarter of Game-- Table XV shows the distributi of the injuries that occurred in games during 1969-1972 by the quarter of the game in which the injury took place. The second period accounted for the highest proportion of injuries with 567, or 27.2 per cent. Interestingly, the data also reveal that the first half accounted for over one-half of the total game injuries.

Earlier studies reveal dissimilar and similar findings. Both Hibbert (116) and Krause (132) reported the third quarter as the most dangerous with regard to injury and the second half as accounting for more than three-fourths of total game injuries. Their findings were used to suggest either that fatigue in the second half, or that highly motivated play in close games or less highly motivated play in games with lop-sided scores, would account for more second half injuries. One earlier investigator, Van Brocklin (262) reported findings similar to those of the current study. His report indicated the same second quarter rank with regard to injury frequency. The reason for the disparity in data is not understood. Any comment would be purely conjectural and based on no observed behavior, either objective or subjective during the investigation.

TABLE XV

FREQUENCY DISTRIBUTION OF INJURIES TO PARTICIPANTS
BY QUARTER OF GAME - 1969 - 1972

QUARTER OF GAME	FREQUENCY	PERCENTAGE
FIRST	475	22.8
SECOND	567	27.2
THIRD	487	23.4
FOURTH	402	19.3
UNKNOWN	128	6.1
TOTAL	2,059	98.8

<u>Interval Between Injury Occurrence and Treatment</u>-- It is very likely that the time between injury and treatment should be considered as a host factor rather than as a variable related to the environment. It is felt though, that the immediate availability of medical resources to the student athlete, and the degree of injury awareness of the youngster as reflected by the attitude of his coaches, might also be considered as environmental in

nature in that they are part of the overall football activity milieu. In any event, Table XVI shows the distribution of injuries by the time interval between the receipt of the injury and the provision of medical treatment. Of the 4,287 boys injured during the study, 2,393 or 55.8 per cent, were treated within one day of the injury. However, almost five per cent of the students who received treatment, did not receive it until at least four days after the injury occurred.

TABLE XVI

FREQUENCY DISTRIBUTION OF INJURIES TO PARTICIPANTS BY THE INTERVAL BETWEEN INJURY AND RECEIPT OF MEDICAL TREATMENT 1969 - 1972

INTERVAL BETWEEN INJURY AND Rx	FREQUENCY	PERCENTAGE
SAME DAY	1,437	33.5
ONE DAY	956	22.3
2-3 DAYS	413	9.6
4-7 DAYS	189	4.4
8 plus DAYS	63	1.5
DID NOT VISIT M.D.	1,137	26.5
UNKNOWN	92	2.1
TOTAL	4,287	99.9

The Incidence of Injury By Certain Host Factors

Age-- Information concerning incidence rates by age are presented in Table XVII.

TABLE XVII

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATES OF PARTICIPANTS ACCORDING TO AGE

Age in Years	Injured	Not Injured	Total	Injury Rate	Percent of Population
13 yrs.	2	6	8	.250	0.1
14 yrs.	133	346	479	.278	5.6
15 yrs.	767	1,498	2,265	.339	26.2
16 yrs.	1,300	1,542	2,842	.457	32.9
17 yrs.	1,625	993	2,618	.621	30.3
18 yrs.	263	124	387	.680	4.5
19 yrs.	12	22	34	.353	0.4
Total	4,102*	4,531	8,633*	.475	100.0

*Unknowns deleted from population
Entire table significant at .01

Players 18 years of age had the highest injury rate. As shown, the 16 year-olds were the largest group of participants, one-third of the total; yet this group had a significantly lower injury rate. In fact, the rate of injury increased consistently with age, except for the lower rate for 19 year-old youths. These data indicate a correlation between age and injury rate. One explanation for this relationship, which has been extended frequently, is that older players are exposed to greater risk, greater activity, and hence have more injuries. However, given this correlation and the above explanation for it, age itself may be a satisfactory exposure-to-risk variable. Additional data presented with respect to estimated time played, or exposure to the risk of football injury, will indicate that this is the case. It is necessary to look at the phenomenon of increased injury rate and age in a somewhat different aspect which includes how much time played has been accrued by the members of the various age groups.

While the data presented is in sharp contrast with the hypotheses suggested by most investigators for this phenomenon, it is not so divergent from the hypothesis of Shaffer (227) and others who have attempted to relate injury experience with lack of physical maturity. Even controlling for exposure-to-risk, it is still very possible that the greater injury experience by age is a function of physical immaturity rather than age per se. The substantial number of 17 and 18 year-olds that were injured in the current study were 17 and 18 by chronological measurement only. It is conceivable that a good portion of the youths were retarded in their sexual or physical development.

Exposure to Risk-- Table XVIII provides information on the exposure-to-risk item which is then translated throughout the later evaluation of host variables such as race, grade, player status, and other variables. The data on exposure were based on the estimated amount of time, in minutes, that each study member was actively exposed to injury in game situations.

The lowest rate of injury was for those youths exposed to 31-35 minutes of play, and the boys who played an average of 11-15 minutes had the highest injury rate. One would think that the players exposed longest would have the highest injury rate, but the data does not show this to be true.

Race-- Table XIX shows the frequency and probability of difference between rates of injury and race of participants. The deviation from a uniform distribution of injuries by race is not significant as indicated by a chi-

TABLE XVIII

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATES OF PARTICIPANTS ACCORDING TO TIME EXPOSED TO RISK

Time in Minutes	Injured	Not Injured	Total	Injury Rate	Percent of Population
1 - 5	168	981	1,149	.146	16.4
6 - 10	164	328	492	.333	7.0
11 - 15	199	197	396	.503	5.7
16 - 20	281	483	764	.368	10.9
21 - 25	478	968	1,446	.331	20.7
26 - 30	145	682	827	.175	11.8
31 - 35	61	450	511	.119	7.3
36 - 40	108	449	557	.194	8.0
41 - 45	133	396	529	.251	7.6
46 +	122	198	320	.381	4.6
Total	1,859*	5,132	6,991	.266	100.0

*Unknowns deleted from population
Table significant at .01

square value of .00418 (1 d.f.). There is no identifiable difference in observed injury rate between the races.

Grade.-- Table XX indicates a clear relationship between grade in school and injury among the participants of the study. With no differential rate on an exposure-to-risk measure, the increased rate of injury at higher grade levels was felt to be a function of age. Differences between observed and

TABLE XIX

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATES OF PARTICIPANTS ACCORDING TO RACE

Race	Injured	Not Injured	Total	Injury Rate	Percent of Population
White	3,133	3,469	6,602	.475	76.2
Black	967	1,071	2,038	.474	23.5
Indian	10	3	13	.769	0.2
Oriental	2	4	6	.333	0.1
Total	4,112*	4,547	8,659*	.474	100.0

*Unknowns deleted from population

White vs Black - Not significant $X^2 = .00418$ (1.d.f.)

TABLE XX

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATES OF PARTICIPANTS ACCORDING TO GRADE IN SCHOOL

Grade	Injured	Not Injured	Total	Injury Rate	Percent of Population
9th	103	196	299	.344	3.7
10th	819	1,502	2,321	.353	29.1
11th	1,237	1,444	2,681	.461	33.6
12th	1,703	981	2,684	.635	33.6
Total	3,862*	4,123	7,985*	.484	100.0

*Unknowns deleted from population
Entire table significant at .01

expected frequencies were significant at a probability level of .001 for all grades.

Weight-- Data pertaining to weight interval injury rates are given in Table XXI. Players who weighed between 180-199 pounds had the highest injury rate. There seems to be a relationship between weight and injury as injury rate increases with the increase in weight. Since football is a contact sport, it would seem logical that smaller or lighter players would be more apt to sustain injury than bigger or heavier players. Evidently, this is

TABLE XXI

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATES OF PARTICIPANTS ACCORDING TO WEIGHT

Pounds	Injured	Not Injured	Total	Injury Rate	Percent of Population
100 - 119	24	78	102	.235	1.2
120 - 139	310	772	1,082	.287	12.7
140 - 159	1,112	1,784	2,896	.384	33.9
160 - 179	1,441	1,100	2,541	.567	29.7
180 - 199	763	420	1,183	.645	13.8
200 - 219	291	183	474	.614	5.5
220 - 239	97	88	185	.524	2.2
240 - 259	34	51	85	.400	1.0
Total	4,072*	4,476	8,548*	.476	100.0

*Unknowns deleted from population
Entire table significant at .01

not the case.

Generally, earlier reports of injury occurrence and weight of participants have indicated that the smaller players had the worst of it with respect to injury rates. Tabrah (246) reported that average weights of players sustaining severe or multiple injury did not differ from the mean weights of their fellow participants. Dalzell (56) presented data indicating that the lighter weight youths sustained the more serious injuries, and in fact, were injured more frequently. These findings are not consistent with the present study results.

Height.-- Table XXII shows the frequency distribution and probability of

TABLE XXII

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATES OF PARTICIPANTS ACCORDING TO HEIGHT

Height in Inches	Injured	Not Injured	Total	Injury Rate	Percent of Population
60 - 61	17	29	46	.369	0.5
62 - 63	31	64	95	.326	1.1
64 - 65	75	175	250	.300	2.9
66 - 67	379	647	1,026	.369	11.9
68 - 69	947	1,240	2,187	.433	25.3
70 - 71	1,184	1,263	2,447	.484	28.3
72 - 73	1,046	748	1,794	.583	20.7
74 - 75	367	307	674	.544	7.8
76 - 77	63	49	112	.562	1.3
78 - 79	11	4	15	.733	0.2
Total	4,120*	4,526	8,646*	.476	100.0

*Unknowns deleted from population
Entire table significant at .01

difference between injury rate and the players' height. Again, as with weight, there is a relationship between injury and the height of players. The rate increases with height. The two factors, height and weight, considered together, reinforce the earlier hypothesis that larger boys, less agile and flexible, are probably injured more frequently than their smaller, more agile counterparts, whose lower injury rate is due to their ability to "get out of harm's way."

Player Status.-- Table XXIII reveals the relationship between injury rate for players of varsity teams versus players of junior varsity teams. The frequencies differ from a uniform distribution by a significant margin. The results here are straightforward. Varsity players risk a significantly greater chance of injury than do junior varsity players.

TABLE XXIII

FREQUENCIES AND PROBABILITY OF DIFFERENCE BETWEEN INJURY RATES OF PARTICIPANTS ACCORDING TO PLAYER STATUS 1969 - 1972

Status	Injured	Not Injured	Total	Injury Rate	Percent of Population
Varsity	3,240	2,654	5,894	.550	71.2
J. V.	759	1,621	2,380	.319	28.8
Total	3,999*	4,275	8,274	.483	100.0

Table significant at .01

The rate for varsity participants is significantly greater. Differences such as these have never been reported in the literature. Either investigators have failed to differentiate between the levels of play in this regard, or the junior varsity level teams have not been studied and reported on with respect to injury experience.

The results shown here may well be a function of age. The younger boys are very likely playing on the junior varsity teams unless they are big, strong youths. In either event, the two items act as limiting factors on the injury incidence of junior varsity players. They are younger and smaller-both of which are related to smaller rates of injury occurrence. A few of these players in the younger age groups are bigger and stronger, and play therefore, at the varsity level and contribute to the greater injury rate at that level. It is also possible that a "harder" game of ball is played at the varsity level. Each, and perhaps all, of these factors combine to contribute to the higher injury rate among varsity players.

Football Playing Experience.-- Table XXIV presents the frequency distribution and probability of difference between injury rates according to the number of years of football playing experience of participants. That the incidence of injury to participants increases with the number of years of playing experience is quite evident. The injury rate rises from its lowest point at 266 per thousand (no previous experience) to a height of 915 (nine or more years of playing experience). The results are quite clear. Players with greater experience risk a significantly greater chance of injury than do players with less experience. One conceivable reason for the higher rate among experienced players is that there are a disproportionate number of recurring injuries to parts injured earlier. In support of this, the next factor considered is reinjury rates for participants.

History of Prior Injury at Football-- Table XXV presents clear evidence

TABLE XXIV

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATES OF PARTICIPANTS ACCORDING TO AMOUNT OF PREVIOUS EXPERIENCE PLAYING FOOTBALL 1969 - 1972

Number of Years	Injured	Not Injured	Total	Injury Rate	Percent of Population
None	147	405	552	.266	6.4
One	394	754	1,148	.343	13.2
Two	707	1,020	1,727	.409	19.9
Three	891	880	1,771	.503	20.4
Four	719	641	1,360	.529	15.7
Five	593	404	997	.595	11.5
Six	256	250	506	.506	5.8
Seven	185	130	315	.587	3.6
Eight	121	44	165	.733	1.9
Nine	118	11	129	.915	1.5
Total	4,131	4,539	8,670	.476	99.9

Table Significant at

that players with a history of football injury sustain re-injury at a much higher rate than their associates with no history of prior football trauma. This relationship is emphasized by a chi-square value of 220.55 (1.d.f.) which exceeds chance at the .001 level of probability. Twenty-eight per cent of the participants had a history of prior injury. Of these 2,200 youths, 1,372 were re-injured. Allen (5) in his study of young airmen football players reported that a significant number of injuries in his study had had recurring injuries of some consequence.

TABLE XXV

FREQUENCIES AND PROBABILITY OF DIFFERENCE BETWEEN INJURY RATES TO PARTICIPANTS ACCORDING TO HISTORY OF PRIOR FOOTBALL INJURY 1969 - 1972

Prior Injury	Injured	Not Injured	Total	Injury Rate	Percent of Population
Yes	1,372	828	2,200	.624	28.1
No	2,456	3,165	5,621	.437	71.9
Total	3,828	3,993	7,821	.489	100.0

Probability of difference between groups significant at .01

$x^2 = 220.55$ (1 d.f.)

It could not be expected that players would remember all of the injuries that they had sustained during their participation in high school athletics. Therefore, only data with respect to previous football injuries requiring medical treatment which disabled the boy for seven days or more were solicited.

Position played when injured.-- Table XXVI presents information on the distribution of injuries by the position played when injured. Some clarification is necessary before this table can be evaluated. First most previous studies have considered the relative risk involved by the position played. In Hibbert (116) stated:

TABLE XXVI

FREQUENCY DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO POSITION PLAYED 1969 - 1972

POSITION PLAYED	FREQUENCY	PERCENT	A DENOMINATOR	RANK ORDER
End, Defense	394	9.2	2	6
End, Tight	201	4.7	1	5
End, Split	118	2.8	1	11
Tackle, Defense	444	10.4	2	3
Tackle, Offense	243	5.7	2	11
Guard, Defense	231	5.4	2	12
Guard, Offense	305	7.1	2	9
Center	155	3.6	1	8
Linebacker	489	11.4	2.5	7
Quarterback	260	6.1	1	2
Halfback Defense	340	7.9	2.5	10
Halfback Offense	432	10.1	2	4
Flanker	21	0.5	1	16
Wingback	81	1.9	1	14
Safety	116	2.7	1	12
Fullback	277	6.5	1	1
Tailback	97	2.3	1	13
Middleguard	38	0.9	1	15
Blocking Back	7	0.2	1	17
Slotback	6	0.1	1	18
Unknown Position	13	0.2	-	17
TOTAL	4,268	99.7		

> Before football took to the air, fullbacks and guards traditionally bore the brunt of most injury. This has changed and injuries are very evenly divided, although the quarterback position is still the safest.

Dalzell (56) also reported on the most frequent position sustaining injury in football. His data ranked the defensive end, defensive tackle, linebacker, and offensive halfback, in descending order of frequency.

In looking at the table, it should be kept in mind that there are two halfbacks, two guards, two tackles and two ends for each fullback, quarterback and center. In addition, in several defensive formations there are as many as four linebackers, and anywhere from two to five defensive backs. In Table XXVI, column A indicates the denominator assigned for each position. The frequency of injury is then presented for the number of positions played. The fullback position is inherently the most hazardous on the field. It is followed closely by the quarterback and the defensive tackle and offensive halfback.

CHAPTER VI

DISCUSSION OF THE ACTIVITY ENGAGED IN WHEN INJURED AND THE AGENTS OF FOOTBALL INJURY

As the principal aim of the study was to determine causes of high school football injury, it was necessary to develop a taxonomy for classifying football accidents for causal analysis. The criteria established for the taxonomy were: (1) that it be designed to include all of the events, objects, and circumstances related to the cause of the accident, (2) that it classify all types of football injuries and accidents, (3) that it be adaptable to unusual situations that might arise during interviews, and (4) that it be amenable, to the extent possible, to pre-coding of its categories to facilitate data processing.

Football accidents which result in injury do not occur within clearly defined categories. A classification had to be developed into which the collected data could be assembled by some predetermined rules. Accidents in football have some common causal factors: the activity of the injured; his emotional state; the initiating action; the resulting injury; the object or agent involved, if any, and its condition. A classification scheme was developed for three of these factors: (1) the activity of the injured, (2) the agent or agents of the injury, and (3) the injury occurrence itself. The classification specifications appear in Appendix E.

The analysis of the injury data related to cause will be separated into a consideration of the activity of the injured at the time of injury, the object or agent that caused the injury, and the interrelationship of the two.

Activity Engaged in at the Time of the Injury

Table XXVII shows the distribution of injuries to participants by the

TABLE XXVII

DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO PRACTICE ACTIVITY EXCLUSIVE OF SCRIMMAGE

ACTIVITY	FREQUENCY	PERCENT PRACTICE INJURIES	PERCENT TOTAL INJURIES
CONDITIONING ACTIVITY	(130)	15.3	3.0
Wind Sprints	67		
Reaction Drills	14		
Exercises	21		
Other Conditioning	28		
ABILITY DRILLS	(89)	10.5	2.1
Monkey Roll	16		
Coffce Grinder	3		
Other Ability	70		
TACKLING DRILLS	(287)	33.8	6.7
One-On-One	158		
Alabama Drill	153		
Form Tackling	10		
Other Tackling	66		
BLOCKING DRILLS	(147)	17.3	3.4
One-On-One	68		
Two-On-Two	24		
Blocking on End	11		
Two-On-One	4		
Other Blocking	40		

(Table XXVII continued on page 108)

TABLE XXVII Continued

ACTIVITY	FREQUENCY	PERCENT PRACTICE INJURIES	PERCENT TOTAL INJURIES
EQUIPMENT WORK	(129)	15.2	3.0
7 - Man Sled	30		
2 - Man Sled	9		
Buckaroo Machine	3		
Holding Dummy	24		
Hitting Dummy	44		
Other Equipment	19		
OTHER	(58)	6.8	1.4
Kick Off Drill	3		
Passing Drill	32		
Half Speed Scrimmage	23		
UNKNOWN	(8)	.94	.1
TOTAL	848	99.8	19.7

players' activity during practice situations exclusive of scrimmage activity. Tackling drills were by far the most hazardous activities, accounting for 33.8 per cent of the injuries. Youths were injured most frequently in one-on-one type drills. In these drills, the tackler was injured more frequently than the ballcarrier. This was also the case with the players exposed in the "Alabama" drill. In this particular drill there is a ballcarrier, permitted to run only within a prescribed area, a blocker, and a tackler. The tackler was injured more often than either the blocker or the ballcarrier. However, when exposed to the sideline tackling drill (one-on-one tackling from a 45 degree angle), it was the ballcarrier who was injured most often.

An unusual finding is indicated by the frequency of injury headed "equipment work". This activity was the fourth most hazardous drill or practice activity. The use of hand-held and stand-up dummies, sleds, and other field equipment purports to provide for less contact between players during instruction for and practicing of fundamental skills of the game--thereby minimizing the risk of injury. However, from the data one could conclude that an athlete is almost as safe when blocking "live" as on equipment or dummies.

Another item of interest extractable from Table XXVII is the unusually high frequency of injury while participating in wind sprints and reaction drills. These activities involve no deliberate contact and are used primarily for conditioning purposes. That such activities result in injury must be due either to poor conditioning of the student athlete himself, or, to the condition of the surface upon which he is performing. In either case, all of these injuries should be considered preventable.

Information on Table XXVIII indicates the distribution of injuries to players by selected general activities which were being performed when players incurred injuries during games and scrimmages. It is clear that defensive work was responsible for the greatest proportion of the injuries (44.4 per cent) in games and scrimmages, and (31.8 per cent) of all injuries. Offensive play was next in order of frequency, accounting for 42.7 per cent of the game and scrimmage activity injuries and 30.6 per cent of the total.

While the results, indicating a greater propensity for injury among defensive ballplayers than offensive players, were not surprising, the other item disclosed by data from this table is worthy of note. The high incidence of injury during speciality play activity (8.1 per cent of all injuries) must be considered important. The very small amount of time exposed in kickoff, punt, and point-after-touchdown situations relative to total game and scrimmage time indicate a disproportionate incidence during these activities. This apparently high incidence is very likely due to contact in the open between runner and tackler, blocker and tackler, and others moving at a high rate of speed. Such contact could conceivably result both in a greater

TABLE XXVIII

DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO SELECTED GAME AND SCRIMMAGE ACTIVITY

ACTIVITY	FREQUENCY	PERCENT OF GAME AND SCRIMMAGE INJURY	PERCENT OF TOTAL INJURIES
<u>Offensive Play</u>	(1311)	(42.7)	(30.6)
Ballcarriers	784	25.5	18.3
Blocking	527	17.2	12.3
<u>Defensive Play</u>	(1364)	(44.4)	(31.8)
Tackling	664	21.6	15.5
Other Defense	700	22.8	16.3
<u>Specialty Play</u>	(349)	(11.4)	(8.1)
Kickoffs	150	4.9	3.5
Punts	177	5.8	4.1
Point after Touchdown	22	0.7	0.5
<u>Unknown</u>	(48)	(1.5)	(1.1)
Total	3072	100.0	71.6

number of injuries and in more injuries of a disabling nature. Further discussion of this phenomenon will be forthcoming from data presented on injuries incurred during selected activities and their relation to time lost due to disability. For example, Table XXIX shows the percentage of disability days over seven resulting from injury while performing certain activities on offense during games and scrimmages. There appears to be an as-

TABLE XXIX

FREQUENCY DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO OFFENSIVE PLAY ACTIVITIES AND PERCENTAGE OF DISABILITY DAYS OF SEVEN OR MORE 1969 - 1972

Offensive Activity	Frequency	Percent	Disability days of Seven or More
QB Tackled Moving Laterally	25	1.9	44.0
QB Tackled on Drop Back Pass	44	3.4	40.9
Ball Carrier Tackled:			
Head-on	9	0.7	44.4
Line of Scrimmage	174	13.2	36.2
Downfield	172	13.1	36.6
Sideline	212	16.1	44.8
N.E.C.*	84	6.4	29.8
Running Ball N.E.C.	66	5.0	31.8
Blocking:			
Line of Scrimmage	388	29.5	33.8
Downfield	86	6.5	40.7
Sideline	14	1.1	35.7
Pass Blocking	40	3.0	30.0
Total	1,314	99.9	36.8

* N.E.C. - Not Elsewhere Classified

sociation between the severity of injury incurred and the activity engaged in at the time of the injury.

One might expect that the greatest number of injuries would occur at the line of scrimmage. This is not the case on offense. More than half of the injuries occurred at the sideline, downfield, or were incurred by the quarterback while moving laterally or dropping back to pass.

Very similar associations are shown in Table XXX for injuries incurred

TABLE XXX

FREQUENCY DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO DEFENSIVE PLAY ACTIVITY AND PERCENTAGE OF DISABILITY DAYS OF SEVEN OR MORE 1969 - 1972

Defensive Activity	Frequency	Percent	Percentage of Disability Days of Seven of More
Tackling:			
Line of Scrimmage	257	18.8	25.7
Downfield	106	7.8	42.5
Sideline	73	5.3	39.7
Head-on	15	1.1	33.0
As Blocked	46	3.4	43.5
N.E.C.*	167	12.2	29.9
Lateral Pursuit	102	7.5	43.1
Defensive Charge	63	4.6	33.3
Fighting Off Block	90	6.6	34.4
Being Blocked Line of Scrimmage	226	16.6	34.5
Trapped	14	1.0	42.9
Blocked Downfield	100	7.3	40.0
Cutting to Intercept Pass	42	3.1	38.1
Positioning for Tackle	30	2.2	30.0
Recover Fumble	34	2.5	47.1
Total	1,365	100.0	34.9

*N.E.C. - Not Elsewhere Classified

in defensive play during games and scrimmages. Downfield tackling, lateral pursuit of the ball carrier, and being blocked downfield result in more severe injuries. Although a rather small number of cases are represented, cutting to intercept a pass is another defensive activity that seems to be related to more severe injury occurrence. Table XXXI presents additional data related to the average number of disability days according to selected football activity. In this case, the frequency of injury incurred during participation in speciality play is considered. As shown, the greatest number of injuries on speciality plays occur when the athlete is blocked under a punt (17.2 per cent), blocked on kickoffs (12.9 per cent), or is blocking on a punt (10.3 per cent).

It seems clear that the activities associated with contact between players in the open field are inherently more dangerous to the health of the athlete as far as disability is concerned.

Over the years, the game of football has opened up. It has been said that the old, crushing, bruising types of body contact have been eleiminated by the so-called open game. But, perhaps we have traded the bruises of close, in-line play of the "three yards and a cloud of dust" era, for the more severe injuries which are resulting from a greater frequency of impact between youths traveling at high rates of speed over greater distances prior to collision. Add the element of inadequate plastic armor plate and you have the necessity ingredients to explain the relative high degree of severity connected with downfield, sideline, and open field injury occurrences during games and scrimmages.

The Agent of the Injury

The injuries reported in this study have resulted from accidents on the

TABLE XXXI

FREQUENCY DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO SPECIALTY PLAY ACTIVITY AND PERCENTAGE OF DISABILITY DAYS OF SEVEN OR MORE 1969-1972

Speciality Play	Frequency	Percent	Percentage of Disability Days of Seven or More
Punt:			
Tackling	32	9.2	46.9
Being Blocked	60	17.2	55.0
Blocking	36	10.3	30.6
Blocking Punt	8	2.3	37.5
Return	26	7.4	26.9
N. E. C.*	15	4.3	26.7
Kickoff:			
Being Blocked	45	12.9	48.9
Tackling	33	9.5	33.3
Blocking	29	8.3	41.4
Return	29	8.3	38.0
N. E. C.*	14	4.0	28.6
Point After Touchdown:			
Blocking P. A. T.	10	2.9	20.0
Kicking	12	3.4	33.3
Total	349	100.0	39.8

*N. E. C. - Not Elsewhere Classified

football field or practice area. Accidents are considered in terms of a related series of events, objects, and happenings leading to an injury. These factors include the activity of the injured, which has been discussed earlier in this chapter, the object involved, and the action directly causing the injury. For the most part, the two latter items have been combined in the classification of agent. For example, "blow from object" is related to the actual object which caused the injury itself but was not necessarily a precipitating factor with regard to the accident in which the injury occurred. However, the category of falls combines the activity (fall, catching a pass) and the object of the injury (collision with the ground or another person) and is the precipitating factor itself--the fall. All of the categories have been designed to deal with and must be evaluated in light of, the particular phenomenon under study, that is, football trauma.

The analysis of cause is begun in Table XXXII which presents, in broad categories suggestive of cause based on the components discussed above, relationships quite divergent from long standing hypotheses as to the factors involved when persons are injured while playing football. Part of the differences are due to the classification itself. For instance, a very large number of the persons injured by a "blow from object" might very well have been categorized under "collision with another person". Here certain arbitrary assignments had to be made. If the injury itself, that is--the laceration or contusion--were directly attributable to a blow being delivered to the victim by the helmet of his opponent, the item was coded to "blow from object - helmet of opponent." If it could not be ascertained just what object caused the laceration or contusion, but the respondent could report that the injury was incurred while being struck by an opponent during a tackle,

TABLE XXXII

FREQUENCY DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO GENERAL CLASSIFICATION OF CAUSE

CAUSE OF INJURY	FREQUENCY	PERCENTAGE
Blow from Object	1,337	31.2
Collision with Object	369	8.6
Contact with Sharp, Hard, or Rough Object	170	4.0
Ill-Fitting, Broken or Defective Equipment	75	1.7
Caught in or Between Objects	62	1.4
Torsion or Twisting	463	10.8
Stepped in or on Object	112	2.6
Illegal Act	159	3.7
Improper Technique	81	1.9
Inadequate Care of Minor Wound or Blister	68	1.6
Heat	33	0.8
Collision with Another Person	860	20.1
Other	274	6.4
Unknown	224	5.2
Total	4,287	100.0

the injury would have been coded to "collision with another person - tackler." One would expect that the majority of injuries would be caused by collisions of this nature--between the ballcarrier and the tackler; blocker and tackler;

or, blocker and blocker. That these are important considerations is shown by the high percentage of injuries in the category (20.1 per cent). However, the frequency of injuries due to blow from object is larger, at 31.2 per cent of the total. Falls, torsion or twisting type causes were next in order of frequency. Interestingly, illegal acts (3.7 per cent) and improper techniques (1.9 per cent), both activities over which responsible leadership in athletics could exert some control, are responsible for a significant proportion of the injuries. This is true also with respect to the number of persons who lost time from activity due to improper or inadequate care of a minor wound or blister. Perhaps the most significant finding in this table, although not unexpected, related to the 33 cases of heat involvement. Of the 23 cases reported in 1969, 12, or more than half, also experienced a heat episode during the 1968 season. Youths who once suffer a heat problem should be watched very carefully for further involvement. The responsibility of coaches and other athletic officials for the prevention of heat trauma should not be underrated.

Table XXXIII provides a more detailed look a the number of youths injured by a blow from an object. The data clearly indicts helmets as the one piece of equipment most often responsible for the injuries in this category. The helmet not only caused 38.8 per cent of the injuries delivered by a blow, but were responsible for 12.1 per cent of the total injuries sustained by study participants. The helmet of the tackler was most often the agent of the injury, accounting for over one-third of the helmet-related injuries. The practice of "spearing"--using the helmet as a destructive weapon--has been indicted in the literature as the cause of many injuries. Concern has generally been directed towards the neck of the person doing the

TABLE XXXIII

DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO AGENT OF INJURY - BLOW FROM OBJECT

AGENT	FREQUENCY	PERCENT	PERCENT OF TOTAL INJURIES
HELMET:	(519)	(38.8)	(12.1)
Ballcarrier	65	12.5	
Blocker	153	29.5	
Tackler	222	42.8	
Opponent, N.E.C.*	79	15.2	
SHOULDER PADS:	(203)	(15.2)	(4.7)
Ballcarrier	16	7.9	
Tackler	53	26.1	
Blocker	117	57.6	
Opponent, N.E.C.*	17	8.4	
SHOES:	(309)	(23.1)	(7.2)
Kicked	139	45.0	
Stepped on	170	55.0	
KNEES	(159)	(11.9)	(3.7)
ELBOW	(27)	(2.0)	(0.6)
FOREARM	(50)	(3.7)	(1.2)
FIST-FINGER	(44)	(3.3)	(1.0)
BALL	(18)	(1.3)	(0.4)
UNKNOWN	(8)	(0.6)	(0.2)
TOTAL	1,337	99.9	31.1

*N.E.C. - Not Elsewhere Classified

spearing (6, 223, 238). However, several authors, including Rose (212) and Miller (158), have reported increased risk to the recipient of these blows. While the present data does not indicate spearing as a cause, reviewing game films of study schools disclosed that the practice was prevalent among study participants.

Players' shoes were indicated by respondents as the cause of injury in seven per cent of the cases. These injuries amounted to 23.1 per cent of the blow from object causes. Shoulder-pads and knee-pads were the next most frequent cause of injury. It is obvious that the hard plastic protective gear contributes greatly to the accident trauma sustained by high school athletes.

Tables XXXIV, XXXV, AND XXXVI presents information on other equipment-

TABLE XXXIV

DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO SELECTED AGENTS OF INJURY - ILL-FITTING, BROKEN OR DEFECTIVE EQUIPMENT

AGENT	FREQUENCY	PERCENT	PERCENT OF TOTAL INJURIES
IMPROPER FIT:	(37)	(49.3)	(0.9)
Helmet	22	59.5	
Shoes	3	8.1	
Shoulder Pad	12	32.4	
BROKEN EQUIPMENT:	(33)	(44.0)	(0.8)
Webbing of Helmet	6	18.2	
Screw on Helmet	4	12.1	
Broken Face Mask	23	69.7	
NO HELMET WORN	(5)	(6.7)	(0.1)
TOTAL	75	100.0	1.8

TABLE XXXV

DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO SELECTED AGENTS OF INJURY - CONTACT WITH HARD, SHARP OR ROUGH OBJECT

AGENT	FREQUENCY	PERCENT	PERCENT OF TOTAL INJURIES
FENCE POST	20	11.8	0.5
OVERLAPPING FACE MASK	24	14.1	0.6
DUMMY	16	9.4	0.4
HELMET	41	24.1	1.0
EXPOSED PAD	5	2.9	0.1
SHOULDER PAD	13	7.6	0.3
ROCK	24	14.1	0.6
GLASS	12	7.1	0.3
METAL ON SLED	10	5.9	0.2
BENCH	5	2.9	0.1
TOTAL	170	99.9	4.1

-involved injury causes. In these tables the categories of "ill-fitting, broken, or defective equipment," "Contact with sharp, hard, or rough object," and "Caught in or between object" are combined. As shown, 0.8 per cent of the total injuries incurred in the study were due to broken or defective equipment. An additional 1.0 per cent of the total was due to contact with the helmet, and 0.6 per cent to the overlapping of helmet faceguards. In the "Caught in or between" category, 0.7 per cent of the total injuries was incurred when a player caught part of his body in a helmet or other piece of

TABLE XXXVI

DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO SELECTED AGENTS OF INJURY - CAUGHT IN OR BETWEEN OBJECTS

AGENT	FREQUENCY	PERCENT	PERCENT OF TOTAL INJURIES
Caught Between:	(32)	(51.6)	(0.7)
Helmets	7	21.8	
Knee and Ground	3	9.4	
Shoulder Pads	3	9.4	
Face Masks	19	59.4	
Caught In:	(30)	(48.4)	(0.7)
Shoulder Pad	14	46.7	
Jersey	15	50.0	
Unknown	1	3.3	
TOTAL	62	100.0	1.4

equipment. The total production of injuries related to equipment, indicated by the three categories of this table, exceed seven per cent of all injuries.

Tables XXXVII and XXXVIII show the frequency of injury and percentage of total injuries contributed by the categories of "torsion" and "stepped on or in object." Of the injuries sustained and classified as due to torsion or twisting, the greatest percentage were not related to contact at all. Two-point -eight per cent of the torsion injuries occurred when the player "cut" or changed direction with no contact involved. An additional 1.0 per

TABLE XXXVII

DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO SELECTED AGENTS OF INJURY - TORSION OR TWISTING

AGENT	FREQUENCY	PERCENT	PERCENT OF TOTAL INJURIES
TWISTED BY:			
Two Men Tackling	37	8.0	0.9
Being Tackled, Hung in Turf	32	6.9	0.7
Cutting - No Contact	122	26.3	2.8
Landing - No Contact	40	8.6	0.9
Being Tackled	77	16.6	1.8
Avoiding Block - No Contact	10	2.2	0.2
Being Blocked - Foot Imbedded	57	12.3	1.3
Block	37	8.0	0.9
Going for Underthrown Ball	9	1.9	0.2
Hung in Turf - No Contact	42	9.1	1.0
TOTAL	463	99.9	10.7

cent occurred when a player hung his cleat or shoe in the turf, again, with no contact involved.

In the category of "stepped on or in object," the results clearly call for better administration of the football program. Two point-seven per cent of all injuries were due to either inadequate facilities, inadequate main-

TABLE XXXVIII

DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO SELECTED AGENTS OF INJURY - STEPPED ON OR IN OBJECT

AGENT	FREQUENCY	PERCENT	PERCENT OF TOTAL INJURIES
Hole	50	44.6	1.2
Uneven Surface	16	14.3	0.4
Rock	7	6.3	0.2
Mud Hole	16	14.3	0.4
Equipment on Field	14	12.5	0.3
Another Player's Helmet	9	8.0	0.2
TOTAL	112	100.0	2.7

tenance of facilities, or carelessness. Holes and rocks should not be present on playing surfaces and uneven surfaces and mud-holes should be filled in. Stepping on a piece of equipment is evidence of carelessness in operation of the program.

Table XXXIX presents data related to injuries classified as being caused by "collision with an object." In most cases, the object or agent was the ground. Three hundred-forty such injuries (7.9 per cent of all injuries) were due to contact with the ground. These have been assigned to a category other than to "falls" because the fall category identified the fall as the precipitating factor, but some other factor as the agent. In the cases assigned to this tabulation, the cause or agent of the injury is the collision with the ground after being tackled, being blocked, or after landing from a jump.

TABLE XXXIX

DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO THE AGENT OF THE INJURY - COLLISION WITH OBJECT

AGENT	FREQUENCY	PERCENT	PERCENT OF TOTAL
GROUND:	(340)	(92.1)	(7.9)
After Block	40	11.7	0.9
After Tackling	60	17.6	1.4
After Being Tackled	136	40.0	3.2
After Being Blocked	46	13.5	1.1
After Hitting Dummy	17	5.0	0.4
After Undercut*	15	444	0.3
After Jumplanding	16	4.7	0.4
N.E.C.**	10	2.9	0.2
SLED	10	2.7	0.2
DUMMY	10	2.7	0.2
COLLISION, N.E.C.	9	2.4	0.2
TOTAL	369	99.9	8.5

* Tackled while in air, taking legs out from under player, not permitting him to land on his feet.
** Not elsewhere classified

With the possible exception of the small number of injuries (10) related to collision with equipment, the majority of the injuries in this category are those expected in football participation. Being tackled and blocked resulting in a collision with the ground which causes an injury is part of the risk assumed by the athlete when he decides to play football. There may be a modest reduction in such injuries if greater emphasis is placed on agility and "learning how to fall" when one is tackled, but this is highly problematical.

Table XL presents additional data oncollision type injuries. In this case, injuries sustained as a result of colliding with another player--an opponent or a teammate. It could be expected that, since football is a contact sport, the lion's share of the injuries would be sustained in the manner described by this category heading. However, the classification scheme dictated that if the injury was the result of a blow from the hard shelled helmet or another piece of identifiable equipment or object, the assignment of classification was made to the agent most directly related to causing the injury. As shown in this table, only 20.1 per cent of all injuries sustained by study participants were of the general "collision" type between players. Of these 860 injuries, 542 were between the ball-carrier and the tackler. Of these 542 injuries the tackler was injured 338 times as opposed to 204 injuries for the ballcarrier. Of some interest with respect to the earlier described elevated rate of injury in blocking on offense, is the number of injuries classified as collision with another player (225 or 52 per cent of the total injuries) which involve injury sustained while being blocked. The downfield--the open-field nature of this problem--is again pointed out by the large number receiving the injurious block from the side or the rear.

The prospects for prevention of injury are great in the area of officiating. Most penalties of more than five yards are designed to protect the athlete from injury. Any study of athletic injuries must take into consider-

TABLE XL

DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO THE AGENT OF THE INJURY - COLLISION WITH PERSON

AGENT	FREQUENCY	PERCENT	PERCENT OF TOTAL
COLLISION			
BALLCARRIER WITH TACKLER:	(204)	(23.7)	(4.8)
Head on	29	14.2	
From Side	19	9.3	
From Behind	14	6.9	
From Blindside	7	3.4	
With Gang Tacklers	67	32.8	
From Both Sides	15	7.4	
While Held by Tackler	24	11.8	
N.E.C.*	29	14.2	
TACKLER WITH BALLCARRIER:	(338)	(39.3)	(7.9)
From Side	10	3.0	
Head On	29	8.6	
Man Fell on Him	243	71.9	
N.E.C.	56	16.5	
RECEIVING BLOCK:	(225)	(26.2)	(5.2)
From Front	48	21.3	
Cross Body	20	8.9	
Roll Block	16	7.1	
From Side	89	39.6	
Behind	21	9.3	
N.E.C.	31	13.8	
COLLISION WITH ANOTHER N.E.C.	93	(10.8)	(2.2)
TOTAL	860	100.0	20.1

*N.E.C. - Not Elsewhere Classified

ation the conduct of officiating. Table XVI presents data on the number of injuries sustained due to the commission of some illegal act or rule infraction. In each case the respondent testified that the injury <u>was a direct result</u> of the personal foul involved. As shown, 159 injuries (3.8 per cent of all injuries sustained in the study) were incurred as a result of an illegal act. Clipping was the violation involving the greatest number of injuries 74 or 46.5 per cent. Spearing contributed 28 or 17.6 per cent, followed by piling-on 21 or 13.2 per cent. The crackback block accounted for another 10 injuries, or 6.3 per cent of the illegal acts. This violation, however, is in reality only another form of clipping. In this regard, the number of crackback blocks could just as well have been coded as clipping violations. There is a fine line of judgment involved in interpreting the crackback as a clip. This should be emphasized by officiating clinics or training sessions. The issue at stake usually is whether or not the man came from a split-out position in relation to the line of scrimmage, whether he made the block within the scrimmage area, or finally, if not in the scrimmage area, whether his head was in front of the recipient of the block at the time the block was thrown. In looking at the problems of injuries, related to situations in which a violation of the rules might have been involved, the study design called for the review of game films in order to determine to some extent the relative frequency of personal foul violations and the extent to which they were observed and called by game officials. These data are in no way related to the information on frequency of injury to participants due to illegal acts as identified on the preceding page. Over 400 game films of participating study schools were reviewed and analyzed for the number of violations called. Often, these films involved play with

TABLE XLI

DISTRIBUTION OF INJURIES TO PARTICIPANTS ACCORDING TO THE AGENT OF THE INJURY - ILLEGAL ACTS

AGENT	FREQUENCY	PERCENT	PERCENT OF TOTAL
Clipping	74	46.5	1.7
Crack Back	10	6.3	0.2
Hit While Down	13	8.2	0.3
Pile On	21	13.2	0.5
Face Mask	2	1.3	0.1
Spear	28	17.6	0.7
Hit While Out of Bounds	3	1.9	0.1
Personal Foul	8	5.0	0.2
TOTAL	159	100.0	3.8

teams other than study schools, therefore, data is not directly comparable to injury data from study schools alone.

Excluding the very small number of crackback and roughing-the-passer violations observed, the greatest disparity in the "observed-called" and "observed-not-called" violations are with respect to "spearing", piling-on, clipping, and unnecessary roughness. The more obvious fouls, those that generally involve an official directly--faceguard grabbing, unsportsmanlike play, and so forth--were more frequently called. It was the opinion of staff film observers that generally the uncalled violations were away from the ball, indicating a propensity on the part of the officials to place more emphasis on the administrative control of the game (e.g., placement of the ball) than on the safety of the participants. This seems to be upheld by the over-all percentage of non-called violations (74.7 per cent).

CHAPTER VII

THE RELATIONSHIP BETWEEN THE TRAINING AND EXPERIENCE OF THE COACHES AND THE INCIDENCE OF INJURIES TO THEIR HIGH SCHOOL FOOTBALL PLAYERS

Introduction

Lloyd, Deaver, and Eastwood (141) stated that a large number of football injuries could be eliminated by proper leadership and that the coach should be the number one preventer of injuries. It is the purpose of this chapter to investigate the type of training and experience of coaches whose teams are associated with different injury rates. At the present time there are no definite requirements needed to be employed as a high school football coach in North Carolina.

The high school coach is not required to have a degree in physical education, to have any prior experience in football coaching, to have college credit in any specific courses, or to have any previous football playing experience. At the present time, in fact, the most valuable kinds of training and experience for football coaches are not definitely known. In a study completed by Conrad (48), he concluded that a majority of football coaches in the Pittsburgh, Pennsylvania, area were using training techniques detrimental to the physical well-being of their athletes. A study in Nassau County, New York, by Plesent, recommended that contact sport coaches be certified to teach physical education, be experienced physical education teachers, and be experienced in coaching contact sports.

The North Carolina Study was mainly concerned with the training and experience of head football coaches. Information is available concerning the assistant coaches, but the staff considered the head coach the single most important member of the high school football staff. The head coach usually makes the decisions, and the assistant coaches carry out these decisions. Data concerned with the coaches was collected only during the 1969 football season, as was additional information in this chapter.

Age

Table XLII clearly indicates that the age of the head coach was important when considering injury prevention. High school football teams with coaches under thirty years of age were associated with the highest injury rate, while teams with coaches forty-five years of age and over had the lowest injury rate. As the age of the coach increased, the injury rate of their teams steadily decreased. In looking at the probability of difference between the observed and expected injuries, a chi-square value of 19.9254 (2 d.f.) clearly

TABLE XLII

FREQUENCIES AND PROBABILITY OF DIFFERENCES
BETWEEN INJURY RATES TO PARTICIPANTS
AND THE AGE OF THE COACH

Age of Coach	Players Injured	Not Injured	Total Players	Rate	Per cent of Population
A. -30 Years	424	256	680	.623	30.2
B. 30-44 Years	609	551	1,160	.525	51.5
C. 45+ Years	174	238	412	.422	18.3
Total	1,207	1,045	2,252	.535	100.0

Probability of differences between groups:

Entire table X^2 = 19.9254 (2 d.f.) Significant indicates that the difference between groups is significant. There seems to be a trend in the college coaching profession to hire younger coaches for their enthusiasm and recruiting ability. It may well be that a high school coach should be an older and more mature person if prevention of injuries is considered important.

Playing Experience

Plesent in his study in New York, found that contact sport coaches who had a greater number of seasons of playing experience in a contact sport also had teams with a greater rate of injury. The North Carolina Study investigated the playing experience of the coaches in three different categories. These categories are as follows: (1) playing experience of coach by total number of years, (2) playing experience of coach by high school or college, and (3) position played by coach.

The data is Table XLIII state there is no significant difference in

TABLE XLIII

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATES TO PARTICIPANTS AND THE YEARS OF PLAYING EXPERIENCE OF THE COACH

No. of Years	Injured	Not Injured	Total	Rate	Per Cent of Population
A. 1-5	487	427	914	.533	42.9
B. 6-10	667	550	1,217	.548	57.1
Total	1,154	977	2,131	.542	100.0

Probability of differences between groups:

Entire table X^2 = .2320 (1 d.f.) Not Significant injury rate between football teams coached by men who had played football from one to five years and those who had played from six to ten years. The injury rates of both groups were similar, and the difference between the observed and expected number of injuries was not significant.

Table XLIV states that the coaches who had a background of only high school playing experience were associated with teams who had high injury rates, and teams with a coach who had a background of both high school and college playing experience had low injury rates. The data also show that teams coached by men with only college playing experience had the lowest injury rate. The difference between groups, when looking at the observed and expected injuries, was significant, as indicated by a chi-square value of

TABLE XLIV

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATE TO PARTICIPANTS AND THE HIGH SCHOOL OR COLLEGE PLAYING EXPERIENCE OF THE COACH

Experience	Injured	Not Injured	Total	Rate	Per Cent of Population
A. High School Only	242	158	400	.605	18.8
B. College Only	76	115	191	.398	9.0
C. High School and College	836	704	1,540	.543	72.2
Total	1,154	977	2,131	.542	100.0

Probability of differences between groups:

Entire table X^2 = .2320 (1 d.f.) Not Significant

10.4059 (2 d.f.).

The data in Table XLIV indicate that college playing experience was an asset in high school coaching when considering injury prevention. It may be that the coach with college playing experience has more knowledge in the fundamental skills of football. Added emphasis is the fact that the group with only college playing experience had teams with the lowest injury rate and was the only group that had a significant chi-square value in the difference between the observed and expected number of injuries. It is also true that the three coaches in the college-only group were three of the oldest coaches. The three of them had a combined total of seventy-six years of coaching experience. Data from Table XLII indicated that age was an important factor in relating coaches' background to injury data.

It was interesting to note that there was no difference in injury rate between teams whose coaches were linemen and those who played in the backfield. Table XLV also indicates that probability of difference between groups

TABLE XLV

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATES TO PARTICIPANTS AND THE POSITION PLAYED BY THE COACH

Position Played By Coach	Players Injured	Not Injured	Total	Rate	Per Cent of Population
A. Backfield	667	539	1,206	.553	56.6
B. Lineman	487	438	925	.526	43.4
Total	1,154	977	2,131	.541	100.0

Probability of differences between groups:

A vs. B X^2 = .6717 (1 d.f.) Not Significant is not significant (chi-square value of .6717 with one degree of freedom). The information did point out the fact that, in the group of forty-one coaches who completed the questionnaire, eighteen played halfback and ten played tackle. The remainder of the coaches were distributed evenly among the other football playing positions.

Coaching Experience

It would seem logical that the number of years a football coach had in coaching football would be an important part of his background and training. The North Carolina Study investigated the area of coaching experience by the total number of years of coaching football. The number of years in coaching varied from one to thirty-six.

Table XLVI indicates that football coaches with the least amount of

TABLE XLVI

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATES TO PARTICIPANTS AND THE COACHING EXPERIENCE OF THE COACH

No. of Years	Injured	Not Injured	Total	Rate	Per Cent of Population
A. 1-4	236	103	339	.696	15.9
B. 5-9	370	303	673	.549	31.6
C. 10-14	211	134	345	.611	16.2
D. 15-19	210	269	479	.438	22.5
E. 20+	127	168	295	.431	13.8
Total	1,154	977	2,131	.542	100.0

Probability of differences between groups:
Entire table $X^2 = 34.2381$ (4 d.f.) Significant

coaching experience (1-4 years) were associated with teams that had the highest injury rate, when compared to teams whose coaches had more experience. In group B (5-9 years) the rate drops, goes back up slightly in group C (10-14 years), and drops back down in group D (15-19 years). Group E (20+ years) was associated with teams that had the lowest injury rate. There was a steady decline in injury rate as the number of years of coaching experience increased, except for a slight rise in group C.

The probability of the difference between the observed and expected number of injuries is significant for groups A, D, and E and would happen by chance less than five times in one hundred. A chi-square value of 34.2381 (4 d.f.) indicates that the difference between groups is also significant.

The data clearly state that the more coaching experience a man had, the less chance there was that his players would receive an injury. The injury rate of teams whose coaches had only one to four years of experience was extremely high, as indicated by the fact that seventy boys out of one hundred probably will be injured. Coaching experience was an important factor in a coach's background when related to injury data.

Education

The training and background of coaches would have to include their major and minor area of study in college. The researchers investigated the following three areas in regard to the education of the coach:

1. Compared the coaches who had a physical education major or minor with those who had no physical education training.
2. Compared the coaches who had a master's degree with those who had no master's degree.

3. Compared the coaches with a master's degree in physical education with coaches with master's degrees in other areas.

Table XLVII compared coaches with a major in physical education, coaches with a minor in physical education, and coaches with no training in physical education. Teams with coaches who had a major in physical education had a similar rate of injury, when compared to teams whose coaches majored in other academic areas. The interesting finding here was that the coaches with a minor in physical education coached teams with the lowest injury rate.

TABLE XLVII

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATES TO PARTICIPANTS AND THE EDUCATION OF THE COACH

Discipline	Injured	Not Injured	Total	Rate	Per Cent of Population
A. Physical Education Major	812	574	1,386	.585	65.0
B. Physical Education Minor	114	243	357	.319	16.7
C. No Physical Education	228	160	388	.587	18.2
Total	1,154	977	2,131	.541	99.0

Probability of differences between groups:

Entire table $X^2 = 38.7925$ (2 d.f.) Significant

The data within groups indicate that the difference between observed and expected injuries is significant for physical education majors and minors, but not for coaches with majors in other areas. That the probability of the difference between groups is significant is shown by a chi-square value of 38.7925 (2 d.f.).

Why a football team coached by a man with a minor in physical education should have a significantly lower injury rate than one coached by a man with a major in physical education is unknown to the invertigator. Perhaps the universities and colleges preparing physical education teachers and coaches should evaluate their curriculum. The data in the North Carolina Study failed to establish a significant relationship between a coach's possession of a degree with a major in physical education and a concomitant lower rate of incurred injury among his players.

In comparing injury rates of football teams coached by men with master's degrees and those with no master's degrees, the teams with coaches who had the master's degree also had the lower injury rate, as shown in Table XLVIII.

TABLE XLVIII

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATES TO PARTICIPANTS HAVING COACHES WITH MASTER'S DEGREES AND THOSE HAVING COACHES WITH NO MASTER'S DEGREE

Discipline	Injured	Not Injured	Total	Rate	Per Cent of Population
A. No Master	749	557	1,306	.573	58.0
B. Master	458	488	946	.484	42.0
Total	1,207	1,045	2,252	.536	100.0

Probability of differences between groups:

A vs. B X^2 = 8.1328 (1 d.f.) Significant

The probability of difference between the number of observed and expected injuries is significant for the group with master's degrees. The probability of difference between groups A and B is significant with a chi-square value of 8.1328 (1 d.f.).

The data presented in Table XLIX state that coaches with master's degrees in physical education are associated with teams that have higher injury rates than those coached by men with master's degrees in other areas. There is not any doubt that continued education is an asset to a football coach. It is not known why a team coached by a man having a master's degree in physical education should have a higher rate of injury than a team coached by

TABLE XLIX

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATES TO PARTICIPANTS AND COACHES WITH A MASTER'S DEGREE IN PHYSICAL EDUCATION VERSUS COACHES WITH A MASTER'S DEGREE IN OTHER AREAS

Discipline	Injured	Not Injured	Total	Rate	Per Cent of Population
A. Master's Physical Education	283	262	545	.519	24.2
B. Master's Other	175	226	401	.436	17.8
C. Non Master's	749	557	1,306	.573	58.0
Total	1,207	1,045	2,252	.536	100.0

Probability of differences between groups:

A vs. B X^2 = 7.6578 (1 d.f.) Significant a man with a master's degree in another area. Further research is needed in this area to find out why this is true.

Specific College Courses

After much discussion, the investigators agreed that there are a limited number of college courses that, if taken by a future high school football coach, should have some type of beneficial effect on injury rate in his school. The first course should be one in football coaching, where the future coach would receive important information about fundamental football skills, drills for teaching fundamentals, practice organization, field equipment, game organization, selection of staff, and purchasing of equipment. The second course should be one in sports training which is usually taught by the college or university athletic team doctor or trainer. This course would deal mainly in injury prevention and health problems associated with a high school football program. An example would be the proper method of administering liquid and salt during the early weeks of practice. A course in first aid was selected as the third course. Of course, first aid is administered after an injury is incurred; however, the staff felt that the proper administration of first aid after an injury might (1) prevent the serious complication of a minor injury and (2) play some role in decreasing the probability of a first injury being incurred a second time. Coaches were asked if they had had courses similar to the three named; they were not asked to describe actual course content.

The data in Table L state, in all three cases, that teams whose coaches had completed the courses also had had higher injury rates. In the football coaching class and the sports training class, the probability of difference between the observed and expected number of injuries was not significant within

TABLE L

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATES TO PARTICIPANTS AND THE COACHES' CREDIT IN SPECIFIC COLLEGE COURSES

Class	Injured	Not Injured	Total	Rate	Per Cent of Population
FOOTBALL COACHING					
A. Yes	848	679	1,527	.555	71.7
B. No	306	298	604	.507	28.3
Total	1,154	977	2,131	.542	100.0
SPORTS TRAINING					
A. Yes	996	824	1,820	.547	85.4
B. No	158	153	311	.508	14.6
Total	1,154	977	2,131	.542	100.0
FIRST AID					
A. Yes	1,020	811	1,831	.557	86.0
B. No	134	166	300	.446	14.0
Total	1,154	977	2,131	.542	100.0

Probability of differences between groups:

Football Coaching: A vs. B X^2 = 1.8121 (1 d.f.) N/S
Sports Training: A vs. B X^2 = .6654 (1 d.f.) N/S
First Aid: A vs. B X^2 = 5.4501 (1 d.f.) Significant

or between groups. The difference between the observed and expected for the first aid class was not significant for group A, but was significant for group B. The probability of difference between group A and group B was also significant, as indicated by a chi-square value of 5.4501.

The data in Table L fail to establish a relationship between a lower rate of injury and a coach's having had courses in football coaching, in athletic training, or in first aid. The data suggest, in fact, that it may be advantageous for a coach not to take the courses. It must be realized that this course work is only one consideration in the background and training of coaches as related to injury data.

Investigation and research into the material presented in these courses should be an area of concern for the educators responsible for the training of high school football coaches.

Assistant Coaches

Table LI clearly shows that the more assistant coaches a school hires, the lower the injury rate. The injury rates for schools with one assistant coach and two assistant coaches are very high. The majority of the schools were classified in the groups which had three, four, or five assistant coaches, and the injury rates of these schools were about the same. There is a tremendous decrease in injury rate with the schools which had seven assistant coaches. The injury rate of the schools with only one assistant coach was almost double that of those with seven assistant coaches.

Groups A and B had more observed injuries than would be expected by chance, and both were significant. The probability of the difference between observed and expected injuries was not significant in groups C, D, and E, but in group F, where there were fewer injuries than expected, it was significant. A chi-square value of 25.9103 (5 d.f.) indicates that the probability of

TABLE LI

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATES TO PARTICIPANTS AND THE NUMBER OF ASSISTANT COACHES

Number of Assistant Coaches	Injured	Not Injured	Total	Rate	Per Cent of Population
A. One	87	34	121	.719	5.6
B. Two	204	111	315	.648	14.8
C. Three	270	275	545	.495	25.6
D. Four	286	218	504	.567	23.7
E. Five	240	232	472	.508	22.1
F. Seven	67	107	174	.385	8.2
Total	1,154	997	2,131	.542	100.0

Probability of differences between groups:

Entire table X^2 = 25.9103 (5 d.f.) Significant

difference between groups was also significant and would happen by chance less than five times in one hundred.

It would seem logical that a greater number of assistant coaches would do a better job in the total football program, which includes injury prevention. It is almost impossible for a head coach and one assistant to handle the numerous duties involved in running a football program. The data in Table LI support this theory.

Contact Work

The forty-one coaches who completed the questionnaires were asked the amount of contact work they had used in preparing their teams during the season. Since football is a contact sport, it would seem that the coaches who had had the most days of live contact practice would have had more injuries. Table LII indicates that the teams who had had live contact work on Monday and Tuesday had the highest injury rate, and the teams who had had contact on Tuesday and Wednesday had the lowest injury rate. The group of teams who had had contact on Monday, Tuesday, and Wednesday also had a high injury rate.

TABLE LII

FREQUENCIES AND PROBABILITY OF DIFFERENCES BETWEEN INJURY RATE TO PARTICIPANTS AND THE AMOUNT OF CONTACT WORK DURING THE SEASON

Days	Injured	Not Injured	Total	Rate	Per Cent of Population
A. Monday Tuesday Wednesday	259	221	480	.539	22.5
B. Monday Tuesday	225	117	342	.657	16.0
C. Tuesday Wednesday	293	389	682	.429	32.0
D. Unknown	377	250	627	.601	29.4
Total	1,154	977	2,131	.542	99.0

Probability of differences between groups:

Entire table X^2 = 28.7822 (3 d.f.) Significant
C vs. B X^2 = 24.5686 (1 d.f.) Significant
C vs. A X^2 = 15.7283 (1 d.f.) Significant

When comparing the probability of difference between the observed and expected number of injuries, group C (Tuesday-Wednesday) had a significant difference from both group A (Monday-Tuesday-Wednesday) and group B (Monday-Tuesday). One theory as to why this difference does exist, is that the coaches who had had contact on Monday did not give their players the opportunity to recover from the games that had been played on Friday or Saturday. Another theory would be that, if a team had lost the previous game, the coach would have had a tough scrimmage on Monday. A number of the study coaches did say that contact work on Monday was decided by the outcome of the game on Friday night. It is evident that additional research is needed in this area.

Administering Liquids

High school football practice in North Carolina begins the second week in August. The first week of practice is limited to a period of acclimatizing the players to the intense heat. During this first week players are prohibited by the North Carolina High School Athletic Association from wearing football protective equipment. These precautions are taken to prevent heat stroke and possible death. With all the present knowledge in the area of preventing heat stroke in football players, the investigators were interested in evaluating the study school coaches in regard to the following:

1. If the coaches give their players water during practice, when is the the water administered?
2. If the coaches give their players a salt additive, when is the salt administered?
3. How many coaches use commercial drinks and what brand?

Table LIII shows the policies of administering liquids of the forty-one

TABLE LIII

FREQUENCY DISTRIBUTION OF ADMINISTERING LIQUIDS

Administering Liquids	Frequency	Per Cent
A. Every 20 Minutes	1	2.4
B. Every 30 Minutes	3	7.3
C. Every 45 Minutes	12	29.3
D. Every Hour	2	4.9
E. Half-Way Through Practice	14	34.1
F. Anytime	3	7.3
G. No Water	1	2.4
H. Unknown	5	12.2
Total	41	99.0

coaches. The literature in this area (53, 94, 46, 78, 116) suggests giving water to players both during practice and during games. A time interval of thirty to forty-five minutes is suggested. Table LIII indicates that less than 50 per cent of the coaches are giving water to their squads as recommended. It is most interesting that 34.1 per cent of the coaches give water only one time during practice, and that is when practice is half over. It is hard to believe, but one coach does not give water to his players during practice.

In regard to giving liquids in practice, it is appropriate to point out that the North Carolina high school football coaches have a coaching clinic every year, one week before the football season begins. The main auditorium is filled to capacity, whenever a leading college coach is talking about the offense and defense that took his team to the Orange Bowl. During the lecture on the medical aspects of preventing injuries, two-thirds of the coaches in the auditorium get up and leave. It is during this portion of the clinic that the coaches are given the proper methods of administering liquids and salt to their football players--as well as other similar information. This information is given by leading experts in the field of sports medicine. It is during this medical section that the coaches are given directions on making a special drink which will replace the water and body salts that have been lost. The drink is very inexpensive and can be made by the coach. It is possible that the coaches who get up and leave the auditorium have already heard the information or are already using correct methods of administering liquids to their players. It is possible, but Table LIII indicates that it is not probable.

Table LIV shows how the study coaches administer the salt additives. It should be stated here that the proper time of intake of salt for football players taking part in preseason practice should be after practice and during meals. Salt taken right before going on the field does not get into the system fast enough to take effect. If the salt were taken two hours before practice, it would be of much greater value. The salt taken after practice would replace that which was lost in the practice session. Table LIV indicates that a major portion of the coaches are not administering salt additives at the proper times. This type of information should be fundamental knowledge to a high school football coach.

The data in Table LV are another indication that the coaches are not receiving needed information. Eighteen of the forty-one coaches are buying

TABLE LIV

FREQUENCY DISTRIBUTION OF SALT ADDITIVE CONSUMPTION

Administering Salt Additive	Frequency	Per Cent
A. Before Practice	1	2.4
B. During Practice	8	19.5
C. After Practice	3	7.3
D. Before and After Practice	2	4.9
E. Before and During Practice	7	17.1
F. None Given	1	2.4
G. Unknown	19	46.3
Total	41	99.9

TABLE LV

FREQUENCY DISTRIBUTION OF SPECIAL DRINKS

Type Drink	Frequency	Per Cent
A. Half Time	4	9.7
B. Take 5	10	24.4
C. Sportade	2	4.9
D. Gatorade	2	4.9
E. Kool-Aid and Salt	5	12.2
F. Ice Water and Salt	5	12.2
G. None	7	17.1
H. Unknown	6	14.6
Total	41	100.0

commercial drinks to give their squads. There is nothing wrong with this practice if the school has an overabundance of money, and if funds are not needed to buy first-rate equipment or to grade the practice field. When it is realized that a drink (which will serve the same purpose) can be made for a fraction of the cost, the fact that coaches spend money on commercial drinks is difficult to understand.

The data presented in Tables LIII, LIV and LV illustrate the need for the certification of coaches. The head coach of a high school football team should be thoroughly schooled in the area of sports medicine and should realize its contribution to the total football program.

Fundamental Football Skills

A unique study, completed in 1961 by McKain, made reference to the disagreement among football experts on the proper execution of fundamental football skills. The North Carolina Study attempted to study the relationship between football injuries and the use of special drills and football skills. The first two years of baseline data have produced basic information on the types of drill which are associated with a high injury rate and the number of concussions which are associated with improper tackling and blocking techniques.

Football practice sessions are usually broken down into periods of time in which football related drills are used to prepare the players for game-type situations. Table LVI shows a selection of football drills used by the forty-three study schools and the incidence of injury associated with each drill. The total number of injuries received in drills make up 21.4 per cent of the total injuries. Table LVI distributes the drills into the following categories:

TABLE LVI

DISTRIBUTION OF INJURIES BY PRACTICE ACTIVITY EXCLUSIVE OF SCRIMMAGE

ACTIVITY	Frequency	Per Cent	Per Cent of Total Injuries
Wind Sprints	21		
Reaction Drills	15		
Other Conditioning	6		
Total Conditioning	(42)	16.2	3.5
Monkey Rolls	11		
Coffee Grinder	4		
Total Agility	(15)	5.8	1.2
Alabama Drill	16		
One-On-One	52		
Sideline Drill	15		
Form Tackling	6		
Total Tackling	(89)	34.4	7.4
One-On-One Blocking	19		
Two-On-One Blocking	11		
Two-On-Two Blocking	4		
Blocking On End	3		
Half Speed	3		
Total Blocking	(40)	15.4	3.3
Blocking on 7-Man Sled	12		
Blocking on 2-Man Sled	2		
Holding Dummies	9		
Hitting Dummies	13		
Buckaroo Machine	9		
Total Equipment	(45)	17.4	3.7
Total	259		21.4

1. Conditioning

2. Agility

3. Tackling

4. Blocking

5. Equipment work (sleds-dummies)

The data state that 3.5 per cent of the total number of injuries were received in conditioning drills and that an additional 1.2 per cent were received in agility drills. This type drill is associated with no contact and is designed to get the player into condition for contact. A large percentage of the injuries in these drills were pulled muscles, which may be an indication of improper warm-up methods or too rapid and severe conditioning programs.

Special attention should be given to the drills using sleds and dummies. These drills are used to teach proper techniques, and in many cases are used to avoid live contact work. Equipment work was associated with 17.4 per cent of the injuries and 3.7 per cent of the total injuries. This may not seem important until compared with the live contact blocking drills, which had a lower percentage of injuries in both categories. This data suggest it is safer to have live blocking drills than dummy blocking drills. A possible explanation here would be that the players are not being taught the proper techniques of blocking the sleds or dummies, and possibly more important, are not being taught the correct methods of holding the blocking dummies.

As would be expected, the full-speed tackling drills are associated with the largest percentage of injuries. The one-on-one tackling drill was credited with fifty-two injuries. The investigator observed this tackling drill while visiting the study schools, and in many cases observed the distance between the tackler and the ball carrier to be too great. Additional investigation into live tackling drills is needed; it is obvious that some type of change would be appropriate.

A total of one hundred and three football players, who received concussions, were asked about the position of their head at the time their injuries were incurred. A large proportion of the concussion injuries were associated with the tackler and the blocker. The accepted head position when tackling or blocking is with the chin extended and head straight. Table LVII indicates that only eighteen players, of the total one-hundred and three who received concussions, were following the accepted technique. More than one-half of the total concussions were associated with players who were

TABLE LVII

CONCUSSIONS BY POSITION OF VICTIM'S HEAD

Position of Head	Frequency	Per Cent
Chin Tucked, Head Straight	34	33.0
Chin Tucked, Head to Right	21	20.0
Chin Tucked, Head to Left	8	7.8
Chin Extended, Head Straight	18	17.4
Chin Extended, Head to Right	7	6.8
Chin Extended, Heat to Left	5	5.1
Chin Extended Slightly, Normal Eyes Front Position	10	9.8
Total	103	99.9

blocking or tackling with their chins tucked. There is a definite indication in Table LVII that improper techniques are being taught. This is one area of football which has been totally neglected and is in dire need of additional research as to the best methods of executing the fundamentals of football.

The information in this chapter presents a strong case for additional research in this area. The data clearly suggest that coaches with a specific type of background and training are associated with a low injury rate. The variables in a coach's background and training which have been shown to be important when related to injury data are as follows:

1. Age
2. College playing experience
3. Coaching experience
4. Advanced degrees
5. Number of assistant coaches

The information also indicates that coaches need more training in sports medicine and in teaching the basic fundamental skills of football.

School administrators and university educators should evaluate the present status of high school football coaches. These men have the responsibility for the health and welfare of thousands of teenage boys, and there are no specified requirements for the position. At present, every certified teacher in the state of North Carolina has the qualifications to be a high school head football coach. It is time for change. The certification of high school football coaches in North Carolina is recommended.

CHAPTER VIII

COMPARISON OF FOOTBALL PROTECTIVE EQUIPMENT WITH INJURY DATA AND LIMITED CONTACT WITH INJURY DATA

As stated in the review of the literature, there is a definite difference of opinion among researchers concerning football protective equipment. Since the principal aim of this study was to determine causes of high school football injury, protective equipment was considered an important area of investigation. None of the past research has related the type, fit, and condition of protective equipment to injury data. Several researchers concluded that certain types of protective equipment were better than others; however, their conclusions were reached on the basis of data obtained in controlled laboratory settings. Such research, while important in evaluating protective equipment, needs to be complemented and substantiated by data generated on the playing field itself.

Rachun and Kavanagh (199) realized this when they suggested a large-scale study to evaluate football protective equipment in the field. The North Carolina Study, whose intent is to gather field data on the relationship between protective equipment and high school football injuries, is the first such investigation to be conducted.

The analysis of the data will be concerned with the helmet, shoulder pads, and shoes. The number of hip and thigh injuries were too small to warrant closer investigation.

HELMET DATA

TABLE LVIII

In analyzing the data pertaining to the helmet, head injury will refer to concussion. There were other types of head injuries in the study but they

TABLE LVIII

HEAD INJURIES (CONCUSSIONS) BY MAKE OF HELMET 1969-1972

Helmet Make	Injured	Not Injured	Total	Injury Rate	Percent of Population
Wilson F2000	16	310	326	.049	5.2
Wilson F2002	4	88	92	.043	1.5
Rawlings HND	10	403	413	.024	6.6
Rawlings HC	10	553	563	.018	9.0
Riddell TK2	75	3,099	3,174	.024	50.8
McGregor 100MH	20	729	749	.027	12.0
McGregor Leather	10	229	239	.044	3.8
Southern Athletic	9	163	172	.052	2.8
Gladiator	4	148	152	.026	2.4
Riddell TK	13	358	371	.035	5.9
Total	171	6,080	6,251	.027	100.0

Probability of Differences Between Groups Significant at .05

could not be atributed to the helmet. A concussion could be attributed solely to the helmet whereas a combination of variables could have caused a laceration or neck injury. Table LVIII shows the concussion injuries by make of helmet for years 1969 - 1972. Players wearing the Southern Athletic and the Wilson F2000 helmets had the highest injury rate; those wearing the Rawlings HND, Rawlings HC and the Riddell TK2 had the lowest injury rate. When you compare the pooled injury rates of the Wilson and Southern Athletic helmets with those of the Rawlings and Riddell helmets, the difference is significant at the .01 level with a chi-square value of 13.61731 (1 d.f.).

TABLE LIX AND LX

The final two years of the study involved placing three additional helmet makes into a random sample of the study schools. Four schools were wearing the new Riddell air padded helmet, four schools the Bell Toptex helmet and four schools the Rawlings JRC Helmet. All players in these study schools were measured for head size and each boy was fitted by our staff. Helmets were supplied to the schools by the study grant. Table LIX shows the concussion injuries associated with the above helmets for the years 1971 and 1972. The Rawlings JRC was associated with the lowest concussion rate and the Bell Toptex the highest. There was no significant difference between helmets when observing each year, but when you combine both years as in Table LX, the probability of difference between groups is significant at the .05 level of probability.

TABLE LIX

HEAD INJURIES (CONCUSSIONS) BY MAKE OF HELMET
1971

Make of Helmet	Injured	Not Injured	Total	Injury Rate	Percent of Population
Bell Toptex	6	142	148	.041	40.4
Riddell Microfit	3	141	144	.021	39.3
Rawlings JRC	1	73	74	.014	20.2
Total	10	356	366	.027	99.9

Table Shows No Significant Difference

Table LIX continued on page 157

(TABLE LIX continued) 1972

Make of Helmet	Injured	Not Injured	Total	Injury Rate	Percent of Population
Bell Toptex	5	98	103	.049	27.9
Riddell Microfit	7	153	160	.044	43.4
Rawlings JRC	0	106	106	0	28.7
Total	12	357	369	.033	100.0

Table Shows No Significant Difference

TABLE LX

HEAD INJURIES (CONCUSSIONS) BY MAKE OF HELMET
1971 - 1972

Make of Helmet	Injured	Not Injured	Total	Injury Rate	Percent of Population
Bell Toptex	11	240	251	.044	7.6
Riddell Microfit	10	294	304	.033	9.2
Rawlings JRC	1	179	180	.006	5.4
Total	22	713	735	.029	22.2

Probability of difference between groups significant at .05

TABLE LXI

Table LXI compares the injury rate of the Bell Toptex, Riddell Microfit and the Rawlings JRC with other helmets being used in the study schools in 1971 and 1972. The Southern Athletic helmet is again associated with the highest injury rate and the Rawlings JRC the lowest injury rate.

TABLE LXI

HEAD INJURIES (CONCUSSIONS) BY MAKE OF HELMET 1971-1972

Helmet Make	Injured	Not Injured	Total	Injury Rate	Percent of Population
Wilson F2000	1	109	110	.009	3.3
Rawlings HND	7	176	183	.038	5.5
Riddell TK2	33	1,511	1,544	.021	46.6
McGregor 100 MH	6	362	368	.016	11.1
Southern Athletic	4	28	32	.125	1.0
Gladiator	2	102	104	.019	3.1
Riddell TK	7	227	234	.030	7.1
Bell Toptex*	11	240	251	.044	7.6
Riddell Microfit*	10	294	304	.033	9.2
Rawlings JRC*	1	179	180	.006	5.4
Total	82	3,228	3,310	.025	99.9

*Helmets Supplied by Study to Selected Schools

Entire Table is Significant at .01

TABLE LXII

Table LXII refers to concussion rate associated with different types of helmet mounts - suspension, suspension padded, padded and non-resilient liner. No significant difference between the injury rates of the above type helmet mounts is indicated by the data collected in this study. Other studies have stated that one type mount is superior to another, but the North Carolina data does not indicate this difference to be significant.

TABLE LXII

HEAD INJURIES (CONCUSSION) BY TYPE OF MOUNT
1969 - 1972

Mount	Injured	Not Injured	Total	Injury Rate	Percent of Population
Suspension	109	4,620	4,729	.023	57.5
Suspension-Padded	9	514	523	.018	6.4
Padded	79	2,645	2,724	.029	33.1
Non-Resilient Liner (Bell Toptex)	10	241	251	.040	3.0
Total	207	8,020	8,227	.025	100.0

Table Shows No Significant Difference Between Groups

TABLE LXIII

There are numerous theories existing today that are concerned with the make and type of football helmet, but an area that has been completely overlooked in the research is the fit of the helmet. A study by Alley on serious head and neck injuries noted that only 4.7 percent of the boys receiving head injuries were wearing properly fitted helmets. Alley does not state what a properly fitted helmet is or how the boys who were not injured were wearing their helmets. The data collected in the North Carolina Study shows no significant difference in injury rate between players' helmets that fit as recommended by the manufacturer and those that are too small, too large or have some other type of poor fit.

TABLE LXIII

HEAD INJURIES (CONCUSSIONS) BY FIT OF HELMET

Helmet Fit	Injured	Not Injured	Total	Injury Rate	Percent of Population
Good	95	3,868	3,963	.024	48.9
Too Large	48	1,876	1,924	.025	23.7
Too Small	4	155	159	.025	2.0
Suspension-Up	9	502	511	.018	6.3
Shims Thin	39	1,148	1,187	.033	14.6
Suspension-Up and Too Small	6	215	221	.027	2.7
Other Ill-Fit	4	140	144	.028	1,8
Total	205	7,904	8,109	.025	100.0

Entire Table Shows No Significant Difference

TABLE LXIV

One would expect football players wearing new helmets to have a lower injury rate than those players wearing helmets in very bad condition. Ironically, as shown in Table LXIV, the rate for very bad helmets is lower than the rate for new helmets. There is no significant difference between the four categories and this is difficult to analyze. This could be attributed to the possibility that the most active players receive the newer equipment. This question could be answered with exposure time data.

TABLE LXIV

HEAD INJURIES (CONCUSSIONS) BY CONDITION OF HELMET

Helmet Condition	Injured	Not Injured	Total	Injury Rate	Percent of Population
New	44	1,525	1,569	.028	19.5
Used But Good Condition	148	5,873	6,021	.025	75.0
Visable Signs of Wear	5	240	245	.020	3.1
Unsafe	4	188	192	.021	2.4
Total	201	7,826	8,027	.025	100.0

Table Shows No Significant Difference

SHOULDER PAD DATA

TABLE LXV

Injury data concerned with the shoulder girdle area included all types of shoulder injuries. It is possible that a small percentage of the injuries could not be prevented by the shoulder pads but due to the problem of interviewing team doctors concerning each injury, all shoulder injuries were included.

Table LXV reveals shoulder pad make and the injury rates associated with each pad. The two pads associated with the highest injury rate are Rawlings Quarterback pad and the Southern Athletic. The Rawlings pad had an injury rate of .167 or 167 injuries per 1000 participants and the Southern Athletic has a rate of .154 or 154 injuries per 1000 participants. Wilson,

TABLE LXV

INJURY RATES (SHOULDER-GIRDLE) BY MAKE OF SHOULDER PAD 1969 - 1972

Shoulder Pad Make	Injured	Not Injured	Total	Injury Rate	Percent of Population
Wilson	26	248	274	.095	4.6
Nokona	4	47	51	.078	0.9
Riddell	17	370	387	.044	6.5
Rawlings:					
CP	72	2,194	2,266	.032	37.8
HPO	9	296	305	.030	5.1
UP2	28	1,346	1,374	.020	22.9
FP14	5	255	260	.019	4.3
QBP	4	20	24	.167	0.4
ER	60	823	883	.068	14.7
Southern Athletic	26	143	169	.154	2.8
Total	251	5,742	5,993	.042	100.0

Table Significant at .01

Nokona and the Rawlings ER shoulder pads were associated with the next highest injury rates. The remainder of the Rawlings shoulder pads were associated with the lowest injury rates.

TABLE LXVI

During the final two years of the study the Gladiator G-25 shoulder pad was placed in three of the study schools. As shown in Table LXVI the Gladiator

TABLE LXVI

INJURY RATES (SHOULDER-GIRDLE) BY MAKE OF SHOULDER PAD
1971 - 1972

Shoulder Pad Make	Injured	Not Injured	Total	Injury Rate	Percent of Population
Wilson	10	77	87	.115	3.3
Riddell	7	90	97	.072	3.6
Southern Athletic	7	32	39	.179	1.5
Rawlings:					
CP	26	926	952	.027	35.7
UP2	15	613	628	.024	23.6
ER	46	625	671	.069	25.2
Gladiator G-25	7	182	189	.037	7.1
Total	118	2,545	2,663	.044	100.0

Table Significant at .01

pad was associated with one of the lower injury rates when compared to other shoulder pads being used in the study schools in 1971-1972. Southern Athletic was again associated with the highest injury rate.

TABLE LXVII

The data collected in the North Carolina Study does not support past research that states properly fitted shoulder pads would protect the wearer. Table LXVII indicates there is no significant difference between the six categories of shoulder pad fit when considering shoulder girdle injury. These

TABLE LXVII

INJURY RATES (SHOULDER-GIRDLE) BY FIT OF SHOULDER PAD
1969 - 1972

Fit	Injured	Not Injured	Total	Injury Rate	Percent of Population
Good	222	5,468	5,690	.039	69.7
Too Large	29	958	987	.029	12.1
Too Small	26	486	512	.051	6.3
Distance Between Neck and Pad Too Little	14	263	277	.051	3.4
Distance Between Neck and Pad Too Much	5	172	177	.028	2.2
Epaulets Not Over Shoulder	14	497	511	.027	6.3
Total	310	7,844	8,154	.038	100.0

Table Shows No Significant Difference

results are surprising and will be mentioned again in this chapter.

TABLE LXVIII

Data comparing the condition of shoulder pads with the rate of injury are presented in Table LXVIII. The table indicates that players wearing pads classified as new have a higher injury rate than those wearing pads classified as used or showing signs of wear, and a similar rate with those pads classified as unsafe. A possible explanation for this data might be that the football

TABLE LXVIII

INJURY RATES (SHOULDER GIRDLE) BY CONDITION OF SHOULDER PAD
1969 - 1972

Condition	Injured	Not Injured	Total	Injury Rate	Percent of Population
New	61	1,170	1,231	.050	15.6
Used but Good Condition	232	6,066	6,298	.037	79.7
Visable Signs of Wear	6	275	281	.021	3.6
Unsafe	5	82	87	.057	1.1
Total	304	7,593	7,897	.038	100.0

Table Shows No Significant Difference

players wearing new shoulder pads are also exposed to more contact in practice and games. It is a known fact that starters receive the best equipment and the older equipment is handed down to the substitutes and younger players.

FOOTBALL CLEAT

TABLES LXIX, LXX, LXXI, LXXII

The type of cleats on the football shoe is an area of great controversy among researchers concerned with football injuries. Because a large number of knee injuries are incurred in noncontact situations, the football cleat has become suspect. The theory stated is that the cleat gets caught in the turf and when the player turns the foot, stays stationary. There has been a mass move to the soccer shoe due to the shortness of the cleats. The theory now is that players wearing soccer shoes will not get their cleats caught in the turf. However, our early results did not substantiate this theory as is indicated in the above mentioned tables. All categories show the soccer shoe to be associated with higher injury rates than the regular football cleat. In Table LXX, the data indicates that the bar and disc on the heel of the football shoe is associated with the highest injury rate and for years this was believed to reduce knee and ankle injuries.

It was the feeling of the study investigation team that we were not getting a true picture of knee and ankle injury cause due to the poor condition of the game and practice fields. It was not possible to say whether knee and ankle injuries were caused by cleat type or the rough condition of the field. If a player stepped in a hole and sprained his ankle, it was not fair to associate his injury with a cleat type. To alleviate this problem, nine schools were picked by random and their game and practice fields were completely resurfaced and maintained in good condition for the final two years of the study, 1971-1972. Three of the schools were supplied with soccer shoes and the other schools were in the conventional football cleat.

TABLE LXIX

KNEE AND ANKLE INJURIES BY CLEAT TYPE
1969 - 1972

Cleat Type	Injured	Not Injured	Total	Injury Rate	Percent of Population
Short	618	3,647	4,265	.145	53.5
Long	277	1,554	1,831	.151	23.0
Soccer	174	763	937	.186	11.7

(Table LXIX continued on page 167)

(Table LXIX Continued - Knee and Ankle Injuries by Cleat Type 1969-1972)

Cleat Type	Injured	Not Injured	Total	Injury Rate	Percent of Population
Swivel	50	198	248	.202	3.1
Astro	109	589	698	.156	8.7
Total	1,228	6,751	7,979	.154	100.0

Probability of Difference Between Groups Significant at .01

TABLE LXX

KNEE AND ANKLE INJURIES BY HEEL CLEAT 1969 - 1972

Cleat Type	Injured	Not Injured	Total	Injury Rate	Percent of Population
Short	599	3,598	4,197	.143	52.5
Long	264	1,482	1,746	.151	21.8
Soccer	174	759	933	.186	11.7
Astro Turf	110	614	724	.152	9.1
BAR	51	204	255	.200	3.2
Disc	30	108	138	.217	1.7
Total	1,228	6,765	7,993	.154	100.0

Table Significant at .01

TABLE LXXI

ANKLE INJURIES BY CLEAT TYPE
1969 - 1972

Cleat Type	Injured	Not Injured	Total	Injury Rate	Percent of Population
Short	279	3,986	4,265	.065	53.5
Long	112	1,719	1,831	.061	23.0
Soccer	75	862	937	.080	11.7
Swivel	27	221	248	.109	3.1
Astro	50	648	698	.072	8.7
Total	543	7,436	7,979	.068	100.0

Table Significant at .05

TABLE LXXII

KNEE INJURIES BY CLEAT TYPE
1969 - 1972

Cleat Type	Injured	Not Injured	Total	Injury Rate	Percent of Population
Short	339	3,926	4,265	.079	53.5
Long	165	1,666	1,831	.090	23.0
Soccer	99	838	937	.106	11.7
Swivel	23	225	248	.093	3.1
Astro	59	639	698	.085	8.7
Total	685	7,294	7,979	.086	100.0

Short Cleat vs. Soccer Shoe Significant at .01

TABLE LXXIII

It is evident from Table LXXIII that there is a reduction in the rate of

TABLE LXXIII

SELECTED SCHOOLS BY KNEE AND ANKLE INJURIES
1971 - 1972

Schools	Injured	Not Injured	Total	Injury Rate	Percent of Population
Schools with Fields Surfaced Soccer Shoes	17	131	148	.115	3.5
Schools with Fields Surfaced Regular Cleats	97	558	655	.148	15.6
Schools with No Changes	725	2,674	3,399	.213	80.9
Total	839	3,363	4,202	.199	100.0

Probability of Difference Between Groups Significant at .01

knee and ankle injuries to players wearing soccer shoes when performing on well maintained fields. Schools with fields surfaced and players wearing soccer shoes had the lowest injury rate, while schools with no changes to fields or cleat type were associated with a much higher knee and ankle injury rate. The probability of this difference being due to chance is less than one in one hundred.

TABLE LXXIV

Table LXXIV shows a dramatic reduction of knee and ankle injuries in the schools that had their fields resurfaced and wore soccer shoes in

TABLE LXXIV

KNEE AND ANKLE INJURIES OF SCHOOLS WEARING SOCCER SHOES AND FIELDS RESURFACED 1971-1972 VS. KNEE AND ANKLE INJURIES OF SAME SCHOOLS IN 1969-1970

Schools	Injured	Not Injured	Total	Injury Rate	Percent of Population
Schools 1969-1970 Regular Fields and Cleats	55	133	188	.293	56.0
Schools 1971-1972 Fields Resurfaced Soccer Shoes	17	131	148	.115	44.0
Total	72	264	336	.214	100.0

Probability of Difference Between Groups Significant at .01

1971-1972 when compared to the injury rate in 1969-1970, before any changes were initiated.

TABLE LXXV

Table LXXV shows the injury rates for the schools that had their fields resurfaced and wore regular football cleats during the 1971-1972 football seasons. Their knee and ankle injury rate was lower in 1971-1972 when compared to 1969-1970, before any changes were made, but the difference was not significant.

TABLE LXXV

KNEE AND ANKLE INJURIES OF SCHOOLS WEARING REGULAR CLEATS AND FIELDS RESURFACED 1971-1972 VS. KNEE AND ANKLE INJURIES OF SAME SCHOOLS IN 1969-1970

Schools	Injured	Not Injured	Total	Injury Rate	Percent of Population
Schools 1969-1970 Regular Cleats and Fields	109	497	606	.180	48.1
Schools 1971-1972 Regular Cleats Fields Resurfaced	97	558	655	.148	51.9
Total	206	1,055	1,261	.163	100.0

Table Shows No Significant Difference

TABLE LXXVI AND LXXVII

Table LXXVI compares the schools with soccer shoes and fields resurfaced,

TABLE LXXVI

SELECTED SCHOOLS BY ANKLE INJURIES 1971 - 1972

Schools	Injured	Not Injured	Total	Injury Rate	Percent of Population
Schools with Fields Surfaced Soccer Shoes	9	139	148	.061	3.5
Schools with Fields Surfaced Regular Cleats	44	611	655	.067	15.6
Schools with No Change	312	3,087	3,399	.092	80.9
Total	365	3,837	4,202	.087	100.0

Table Shows No Significant Difference

TABLE LXXVII

SELECTED SCHOOLS BY KNEE INJURIES
1971 - 1972

Schools	Injured	Not Injured	Total	Injury Rate	Percent of Population
Schools with Fields Surfaced Soccer Shoes	8	140	148	.054	3.5
Schools with Fields Surfaced Regular Cleats	53	602	655	.081	15.6
Schools with No Changes	413	2,986	3,399	.122	80.9
Total	474	3,728	4,202	.113	100.0

Table Significant at .01

the schools with regular cleats and fields resurfaced, and the schools with no changes. The comparison is for ankle injury rate only. There was a slight decrease in injury rate in the schools with the resurfaced fields but the difference was not significant. When comparing the same groups of schools and looking only at knee injury rate, Table LXXVII indicates that there is a significant decrease in injury rate with the schools that had their fields resurfaced. The difference was significant at the .01 level of probability and the schools with fields resurfaced and wearing soccer shoes were associated with the lowest rate.

LIMITED CONTACT

Practice activity accounted for 51.1 per cent of all injuries from 1969-

1972 and live contact tackling and blocking drills accounted for 10 per cent. There is no doubt that live contact during football practice is a necessity, but it is also true that the basic fundamentals of football can be taught properly with the use of adequate field equipment and that live contact during practice can be reduced. Six study schools consented to follow a limited contact program during 1971 and 1972. These schools were supplied with field equipment which they felt necessary to carry out this program. This program is outline in Figure I.

TABLE LXXVIII

The result of this program.is displayed in Table LXXVIII which compares

TABLE LXXVIII

INJURY RATES OF SCHOOLS IN LIMITED CONTACT PROGRAM 1971-1972
VS. SCHOOLS IN REGULAR CONTACT PROGRAMS 1971-1972

Schools	Injured	Not Injured	Total	Injury Rate	Percent of Population
Limited Contact 1971-1972	237	332	569	.417	13.5
Regular Contact 1971-1972	1,745	1,888	3,633	.480	86.5
Total	1,982	2,220	4,202	.472	100.0

Probability of Difference Betweem Group Significant at .01

the frequency of injury to participants in the limited contact program with the rest of the study population where no changes were instituted in their contact program. The schools in the limited contact program were associated with a low injury rate and this difference was significant at the .01 level of probability.

TABLE LXXIX

The schools that followed the limited contact program in 1971-1972 also had a significantly reduced injury rate when compared to their injury rate when following their normal contact program in 1969-1970, as shown in Table LXXIX.

TABLE LXXIX

INJURY RATES OF SCHOOLS IN LIMITED CONTACT PROGRAM 1971-1972
VS. SAME SCHOOLS IN REGULAR CONTACT PROGRAM 1969-1970

Schools	Injured	Not Injured	Total	Injury Rate	Percent of Population
Six Schools in Limited Contact Program 1971-1972	237	332	569	.417	48.7
Identical Schools in Regular Contact Program 1969-1970	293	307	600	.488	51.3
Total	530	639	1,169	.453	100.0

Probability ‹ Difference Between Groups Significant at .05

TABLE LXXX AND LXXXI

The first question that is asked in regard to a limited contact program concerns the won-lost record of the teams involved. Table LXXX indicates that

TABLE LXXX

WON-LOST RECORD OF TEAMS PARTICIPATING IN LIMITED CONTACT PROGRAM 1971-1972 VS. TEAMS IN REGULAR CONTACT PROGRAM 1971-1972

Schools	Won -	Lost -	Tie	Percent of Games Won
Limited Contact 1971-1972	74	48	6	57.8
Regular Contact 1971-1972	381	335	35	50.7

The limited contact programs did not affect the won-lost record of the participating teams and in fact, these schools had a better winning percentage than the schools in a normal contact program. Table LXXXI compares the won-lost record of the schools participating in the limited contact program with their won-lost record while following a normal contact program in 1969-1970.

TABLE LXXXI

WON-LOST RECORDS OF TEAMS PARTICIPATING IN LIMITED CONTACT PROGRAM 1971-1972 VS. SAME TEAMS IN REGULAR CONTACT PROGRAM 1969-1970

Schools	Won -	Lost -	Tie	Percent of Games Won
Limited Contact 1971-1972	74	48	6	57.8
Same Schools Regular Contact 1969-1970	62	54	8	50.0

The schools again had a better winning percentage while following the limited contact program. A winning record is not being associated with a limited contact program but it does refute the theory that hard contact in practice is a necessity in order to have a successful football team.

It is recommended by the investigators that in order to collect additional data on condition and fit of equipment that a study be carried out on a smaller scale. It would be the main objective in this study to collect exposure to contact data and severity of injury. In order to accomplish this it would be necessary to have one investigator assigned to each school and to be at the school during every practice and game. The number of study schools could be reduced to five. This type of study would help clear up the data on condition and fit up equipment, and would also make it possible for the investigator to follow up on the more serious injuries.

CHAPTER IX

SUMMARY AND RECOMMENDATIONS

Summary

It was the purpose of this study to demonstrate the effectiveness of applying epidemiologic methods in determining the extent of the problem of high school football injuries in North Carolina. An attempt was also made to interrelate certain variables associated with the problem of risk in athletics, and to provide a descriptive baseline of data on high school football injuries upon which to design and evaluate further analytic and experimental study.

The study was of a prospective nature in that each student athlete participating in football in any of 45 sample schools was included in the collection of data on demographic items related to the host and environment. The data source was direct interview of the injured players from this population. The interview forms, which were completed prior to the first football season covered--1968, provided information of two types. Information on the host (the student athlete) was obtained during the first two weeks of the summer practice session. Most information on the event, including game and injury data, was obtained by a staff of field investigators using direct interview techniques.

During the football season of 1968, a pilot study was performed. It had three purposes: (1) to determine if the interview items were yielding the desired information, (2) to provide a training opportunity for interviewers, and (3) to establish a workable schedule for interview visits to participating schools.

During the study years 1969-1972, data were obtained from 8,776 student athletes at 43 schools. Of this number, 4,287 were injured, representing a crude incidence rate of 488 per thousand participants.

At the close of the season, and after relevant information had been collected, the raw data were classified, coded, and placed in computer-acceptable form for analysis. Following a description by tabulation of the players (both injured and non-injured), game situations, and injuries, selected statistical evaluation techniques were employed to look at certain relationships between selected groups. The analytic method used most often consisted of testing the significance of differences in proportions using the chi-square test. It was decided, a priori, to employ a significance level of .05 for statistical tests applied to comparisons involving specified groups of the population.

The principal findings are summarized as follows:

Distribution of Injuries

1. The most common types of injury to high school players are sprains, contusions, fractures, pulled muscles, strains, lacerations, and concussions.
2. A greater frequency of fractures, concussions, and lacerations were found than ever reported in the past.
3. The most frequent injured part of the body was the knee (19.3 per cent), and the ankle (15.3 per cent).
4. The head and neck received slightly less than 9 per cent of all injuries sustained.
5. The knee received the greatest number of contusions.
6. Almost 35 per cent of the student athletes injured were disabled for seven days or more.

Environmental Variables

1. Injuries were most frequent in the 1A and 2A classification schools (population of 0-500 students).
2. September was the month in which the most injuries occurred (36.0 per cent).
3. Fifty-one per cent of all injuries occurred in practice.
4. The second quarter of the game accounted for the highest percentage of game injuries (27.2 per cent).
5. Of the total number of youths injured, who received treatment, 4.4 per cent did not receive it until at least four days after the injury occurred.

Host Variables

1. Players eighteen years of age had the highest injury rate.
2. There is a distinct correlation between age and injury, in that injury risk increases with increased age.
3. No differences were found between the black and white youths' injury experience at football.
4. Varsity level players risk a significantly greater chance of injury than do junior varsity players.
5. Players with greater experience at football risk a significantly greater chance of injury than do players with less experience.
6. Student athletes with a history of football injury sustain injury at a significantly higher rate than their associates with no history of prior football trauma.

Activity at Time of Injury

1. During practice activities, exclusive of scrimmage, the various tackling drills were the most hazardous activities accounting for 33.8 per cent of the injuries.

2. The one-on-one tackling drills were the type where youths were injured most frequently.
3. Defensive play was responsible for the greatest proportion of game and scrimmage injuries (44.4 per cent).
4. Athletes sustained more serious injuries when blocking, tackling, and receiving blocks and tackles in the open field.

The Agent of the Injury

1. Injuries caused by a blow from an object accounted for 31.2 per cent of all injuries sustained.
2. The helmet was the object causing the most injuries to players (12.1 per cent).
3. Almost 5 per cent of the injuries sustained were of a type related to torsion or twisting and involved no contact at all.
4. Only 20.1 per cent of the injuries sustained in the study were of a type caused by collision between players classified to no other injurious agent.

Coaches' Background and Experience

1. The age of the head coach was important when considering injury prevention. As the age of the coach increased, the injury rate of his team steadily decreased.
2. The number of years a coach had played football did not seem to affect his team's injury rate, but a coach who had college playing experience in his background was associated with teams that had lower injury rates.
3. Football coaches with the least amount of coaching experience were associated with teams that had the highest injury rate when compared to teams whose coaches had more experience.

4. Advanced degrees were an asset to football coaches when injury rates were considered.
5. A large percentage of football coaches in this study were not aware of the proper methods of administering liquids and salt during preseason practice.
6. The full speed tackling drills were the most hazardous in producing injuries.
7. More than half of the total concussions were associated with players who were using improper blocking or tackling techniques.

Injury Data Related to Type, Condition, and Fit of Protective Equipment

1. The Southern Athletic helmet and shoulder pads were associated with the highest rate of injury.
2. The condition and fit of the football helmet did not seem to affect the risk of injury.
3. The Bell Toptex helmet was associated with a high injury rate.
4. There was no significant difference in injury rates of different type helmet mounts.
5. It is evident that there is a reduction in the rate of knee and ankle injuries to players wearing soccer shoes when performing on well maintained fields.
6. Schools following a limited contact practice program were associated with lower injury rates.

Recommendations

Organized interscholastic athletics are an integral part of the educational program at almost every school level. As an extracurricular function, interscholastic athletic activities have had a phenomenal development in number and diversity during the last twenty-five years. They have had their greatest development in the secondary school; but have also become prominent at the junior high and elementary levels, especially in the upper grades. There is general agreement among educators today on the potential value of such activities to the total educational program.

With this growing interest in sports, particularly football, and their inclusion in the programs of more and more schools, it becomes increasingly apparent that additional consideration must be given to the inherent danger to participants in these activities. Athletics are hazardous. In sports requiring vigorous activity injuries are certain to occur. However, persons responsible for medical supervision of all co-curricular athletic activities should exert every effort to assure that the potential for injury is kept to the absolute minimum commensurate with the value and benefit of participation. The potential for injury prevention in high school football is great. There is currently available adequate hard data upon which to implement sound countermeasures to protect the student athlete from harm. Some of these include, but are not limited to:

(1) Physicians limiting drastically the number of boys who are participating at "marginal" levels of physical well-being.

(2) Physicians, coaches, and others responsible for athletic programs and as consumers of athletic protective equipment, must take a firm stand in demanding safer equipment. This would include re-

quire manuracturers to provide soft external padding of all helmets and shoulder pads to limit the injuries from blows delivered by these items.

(3) Those responsible for the conduct of interscholastic football must initiate action to insure that the game is played only on well-maintained turf surfaces in quality soccer shoes.

(4) Game officials must give appropriate emphasis to and accept their responsibility for the protection of the student athlete. No new rules are needed. What <u>is</u> needed is more stringent enforcement of those rules currently "on the books."

(5) Limiting "live contact," particularly tackling and blocking drills, to the extent consistent with the instruction of youths in fundamental game skills.

During the last decade, an increased awareness of the problem of football injuries has been evident. Injuries to stellar professional performers have highlighted this awareness.

Interest in research into the prevention of these injuries has had a parallel growth (168). Much of this interest, however, has been restricted to many small fragmented attempts to consider the extent of the problem. Unfortunately, these research efforts have suffered from lack of comparable populations, sample designs, injury definitions, classifications, and many other factors. The greatest need to be fulfilled before the prospects for football injury prevention are to be realized to the fullest without detrimental effects on a great many athletic activities is the establishment of a "Sports Trauma Institute" through which efforts could be made to coordinate research ventures, provide adequate medical specialist consultation, and disseminate research findings to the athletic community. This "Institute," with adequate support, could provide opportunities to stimulate research application to learn a great deal more about the extent, character, and nature of injuries resulting from participation in many sports activities other than football alone. Gymnastics, ice hockey, trampolining, diving, lacrosse, and wrestling are examples of just a few areas where the potential for prevention of injuries is even more ill-defined than that of football a decade ago.

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APPENDIX A

DEMOGRAPHIC INTERVIEW FORM

EPIDEMIOLOGY OF HIGH SCHOOL FOOTBALL INJURIES

University of North Carolina
Population Data - Section 1

Study Number ______

School Code ______

PART I. GENERAL INFORMATION:

A. NAME ____
Last First Middle

B. AGE (circle) 14 15 16 17 18 19 20+ C. GRADE 8 9 10 11 12 pg ______

D. RACE
1 White
2 Black
3 Indian
4 Other

E. HEIGHT ______feet ______inches

F. WEIGHT __________pounds ______

G. FOR HOW MANY YEARS HAVE YOU PARTICIPATED IN ORGANIZED FOOTBALL?

______
______

1 High school, one year
2 High school, two years
3 High school, three years
4 Junior High, one year
5 Junior High, two years
6 Junior High, three years
7 This is first year of football
Other organized football, specify
____________________ # years______

H. DO YOU PLAY ANY OTHER VARSITY OR J.V. SPORTS? 1 Yes 2 No

if yes:
01 Basketball
02 Baseball
03 Swimming
04 Track
05 Wrestling
06 Soccer
07 Golf
08 Tennis
09 Basketball + Track
10 Baseball + Track
11 Basketball + Baseball
12 Basketball + Baseball and Track
13 Baseball + Wrestling
14 Track + Wrestling
15 Baseball + Golf
16 Wrestling + Tennis
17 Basketball + Golf
18 Basketball + Tennis
19 Basketball, Golf and Wrestling

any other combination:______________________________

I. IN YOUR SCHOOL PHYSICAL EDUCATION CLASSES DID YOU EVER HAVE A UNIT, OR BEEN TAUGHT FUNDAMENTALS OF:

Tumbling	1 yes	2 no
Gymnastics	1 yes	2 no
Weights	1 yes	2 no

J. ARE YOU A VARSITY OR J. V. PLAYER THIS YEAR? J.V. Var.

If you played football last year - how much time do you feel you averaged playing in each game? ________________minutes

PART II. PHYSICAL EXAMINATION

A. DID YOU HAVE A PHYSICAL EXAMINATION PRIOR TO THE CURRENT FOOTBALL SEASON?
1 yes 2 no

if yes,
1 Physician(s) examined entire team at one schedule time
2 Your family physician examined you
3 Your family physician filled out appropriate medical form from prior knowledge of your health
4 Team physician performed individual examination
5 Friendly doctor in town
6 Examined by school physician
7 My father is a physician he certified my health
8 Examined by a physician in the Upward-Bound program
9 Examined by physician of the Health Department
0 Other,________________________________

Where was the examination held?
1 Doctor's office 2 At School
3 Health Department 4 At home
5 Other,______________________

Were joints and extremeties examined at the time of your physical exam?

1 Yes 2 No

How did the doctor check your blood pressure?

1 With blood pressure cuff around upper arm
2 Listened with stethoscope
3 Other,________________________ 4 Did not take it

How did the doctor check your heart?

1 Listened to it with stethoscope to bare chest
2 Listened to it with stethoscope over shirt or other clothing
3 EKG
4 As far as I know, he didn't check it.
5 Other, ________________________

When the doctor checked you for a hernia or rupture, did he have you cough or strain as though you were trying to move your bowels?

1 Cough
2 Strain
3 Neither (if something else explain ______________________)
4 He did not check

PART III. MISCELLANEOUS INFORMATION

A. HAVE YOU HAD A PREVIOUS INJURY IN FOOTBALL WHICH REQUIRED MEDICAL CARE AND WHICH CAUSED YOU TO MISS AT LEAST A WEEK OF PARTICIPATION 1 Yes 2 No

if yes: What body part was injured______________________

What type of injury was it______________________

How long do you think you were unable to play _____days

B. DO YOU WRAP YOUR ANKLES OR KNEES?

ANKLE(S)	1	Yes	2	No
KNEE(S)	1	Yes	2	No

if yes:
1 Before both games and practices
2 Before games only
3 Before practices only
4 Other, ______________________

C. DO YOU TAPE YOUR ANKLES OR KNEES?

ANKLE(S)	1	Yes	2	No
KNEE(S)	1	Yes	2	No

if yes:
1 Before both games and practices
2 Before games only
3 Before practices only
4 Other, ______________________

D. WHAT DID YOU DO DURING THE SUMMER TO STAY (or get) IN PHYSICAL CONDITION FOR FOOTBALL?

E. WHY ARE YOU PLAYING FOOTBALL?

APPENDIX B

INJURY INTERVIEW FORM

EPIDEMIOLOGY OF HIGH SCHOOL FOOTBALL INJURIES

Revised 7/1/69

University of North Carolina

Study Number ________

SECTION II - Injury Data

School Code ________

NAME OF INJURED: ________ Last ________ First ________ Middle

A. WHERE DID INJURY OCCUR? 1 Game Field 2 Practice Field 3 Locker Room 4 Training Room Other ________

B. DID INJURY OCCUR DURING: 1 Game? 2 Practice? 3 Other? ________

If injury occurred during a game:

Who was the opponent? ________

Was the game at home or away: ________

What quarter of the game did injury occur: 1st 2nd 3rd 4th DK

What was your game jersey number ________

How much time do you think you actually played in this game?

________ minutes Are you a starter? 1 Yes 2 No

C. WHAT POSITION DO YOU PLAY? (If more than one apply, check them all and place an asterick beside the one you were playing when injured?)

01 End, Defense
02 End, Offense (Tight)
03 End, Offense (Split)
04 Tackle, Defense
05 Tackle, Offense
06 Guard, Defense
07 Guard, Offense
08 Center
09 Linebacker
10 Quarterback
11 Halfback, Defense
12 Halfback, Offense
13 Flanker
14 Wingback
15 Safety
16 Fullback
17 Blocking Back
18 Slotback
19 Kicker
20 Middle Guard
21 Tailback
Other, ________

D. WHAT WAS THE TYPE OF INJURY (Check and number all that apply)

01 Abrasion
02 Contusion
03 Laceration
04 Puncture wound
05 Sprain
06 Fracture
07 Strain
08 Internal Injury
09 Heat Exhaustion
10 Muscle Contusion
11 Heat Stroke
12 Joint Contusion
13 Burn
14 Dislocation
15 Separation
16 Inflammation
17 Infection
18 Nerve Injury
19 Hemmorrage
20 Concussion
21 Foreigh object in body orifice
22 Ruptured blood vessel
23 Torn Ligament
24 Pulled Muscle
25 Torn Tendon
26 Boil(s)
27 Torn Cartilage
28 Blister(s)
29 Hernia
Other, ________

____

E. WHAT PART OF THE BODY WAS INJURED

01 Head
02 Eye(s)
03 Mouth
04 Teeth
05 Ear
06 Face
07 Neck
08 Throat
09 Nose
10 Shoulder
11 Collar Bone
12 Upper Arm
13 Lower Arm
14 Elbow
15 Hand
16 Spine
17 Back
18 Pelvis, Hips
19 Buttocks
20 Upper Leg
21 Knee
22 Lower Leg
23 Ankle
24 Foot
25 Ribs
26 Viscera
27 Finger(s)
28 Toe(s)
29 Spleen
30 Chin
31 Groin
32 Testicles
33 Stomach
34 Heel
35 Thumb
36 Chest
37 Sternum
38 Kidney
39 Coccyx
Other, ________

____

F. DATE OF INJURY

________ day ________ month

G. WAS THIS A NEW INJURY TO BODY PART?

1 Yes 2 No

if no, give approximate date of earlier injury

____

H. DID YOU SEE A DOCTOR ABOUT YOUR INJURY? 1 Yes 2 No

if yes, why: 1 Pain 2 Swelling 3 Bleeding 4 Coach Suggeste
5 Parent Advised 6 Recurring injury 7 Doctor Suggested
8 Team doctors orders 9 Unconsciousness Other________

I. WHEN DID YOU SEE THE DOCTOR: 1 Same day 2 Next day 3 2-3 days later
4 4-7 days later 5 Longer

J. WHAT TREATMENT WAS RECEIVED FOR THIS INJURY?

01 Sutures
02 Wrap (Ace)
03 Bandage
04 X-Ray
05 Surgery
06 Oral Medication
07 Injection
08 Physical Therapy
09 Examination
10 EEG
11 Ice/or cold
12 Aspiration of joint
13 Whirlpool
14 Aspiration, oral medication and X-Ray
15 X-Ray and Cast
16 Sling
17 X-Ray and physical therapy
18 X-Ray and Wrap
19 X-Ray and Sutures
20 X-Ray and Injection
21 X-Ray and Hospitalization
22 X-Ray and Traction
23 X-Ray and Aspiration
24 Hospitalization
25 Cast
26 Aspiration, Traction and Cast
27 X-Ray and Sligh
Other,____________________

____

K. DID YOU RESUME PRACTICE OR GAME ACTIVITY AFTER THE INJURY? 1 Yes 2 No

If no, what did you do during the remainder of the game or practice?

1 Went to hospital
2 Sat on Bench
3 Dressed and went home
4 Sat out with ice on it
5 Went to doctor's office
6 Put it in whirlpool
7 Walked it off
8 Went to locker room to apply heat
Other,____________________

If yes, How soon did you return to game/practice?

1 Stayed in
2 Next play
3 First off or def play series following injury
4 Beginning of next period
5 After half-time
6 1-5 minutes
7 6-9 minutes
8 10-15 minutes
9 16-30 minutes
0 30+ minutes
Other,____________________

Who made decision that you should continue to participate?

1 Physician
2 Trainer
3 Student Trainer
4 Coach
5 Parent
Other,____________________

L. HOW LONG DID THIS INJURY KEEP YOU FROM PARTICIPATING IN FOOTBALL (full)?

1 1 day
2 2 days
3 3 days
4 4 days
5 5 days
6 6 days
7 7+ days
8 Never play again (parental)
9 Never play again (medical)

M. WHAT WAS THE CONDITION OF THE FIELD ON WHICH INJURY OCCURRED?

01 Turf or Grass - Dry
02 Turf or Grass - Wet
03 Sparce grass - rough
04 Sparce grass - rocky
05 Dusty
06 Hard packed clay
07 Hard earth
08 Mud
09 Turf n.e.c.
10 Dry hard surface n.e.c.
11 Dry n.e.c.
12 Rough, dry turf
Other, ____________________

N. DESCRIBE IN YOUR OWN WORDS HOW THE INJURY OCCURRED.

EQUIPMENT AND OTHER FACTORS RELATED TO INJURIES

A. HEAD INJURY (HELMET)

1. Type ______________________ and Make ____________________

2. Model Number ________________

3. Shell 1 Hard Outside 2 Soft Outside

4. Condition 1 Old 2 New 3 Reconditioned

5. Fit 1 Big 2 Small 3 Other, specify______________

6. Face Mask

   Make_____________________

   Type 1 Cage 2 One bar 3 Two bar 4 Other, specify_________

   Condition 1 Good 2 Poor 3 Broken 4 Improperly mounted

7. Neck Protection
   Rear insert in helmet? 1 Yes 2 No

8. Mouth Piece worn? 1 Yes 2 No 1 Dentist Fitted 2 Self-Fitted

9. Chin Strap worn? 1 Yes 2 No

   If yes, how was fit? 1 Equal distance from each side 2 Poor

10. Ask for demonstration of head position when injury was sustained.

    1 Chin tucked down, head straight
    2 Chin tucked, head turned to right
    3 Chin tucked, head turned to left
    4 Chin extended, head straight
    5 Chin extended, head turned to right
    6 Chin extended, head turned to left
    7 Normal eyes front position
    Other, specify________________________

11. Did you notice any of the following symptoms after head injury was sustained?

1 Yes	2 No	Headache
1 Yes	2 No	Visual disturbance
1 Yes	2 No	Memory loss
1 Yes	2 No	Unconsciousness (knocked-out)

B. SHOULDER INJURY (SHOULDER PADS)

1. Type ______________________ and Make ________________

   Model Number __________________

2. Position (construction) 1 Lineman 2 Back 3 Quarterback
   4 Linebacker Other, specify__________

3. Condition 1 Old 2 New 3 Reconditioned

4. Fit 1 Large 2 Small Other, specify_____________

   Distance between neck and edge of pad ________ inches

   How are laces worn? 1 Snug 2 Loose

   Condition of laces:
   1 Old, worn shoelaces
   2 Good shoelaces
   3 Old, worn nylon cords
   4 Good nylon cord
   Other, specify___________________

C. HIP INJURY (HIP PADS)

1. Type__________________2. and Make________________

   Model Number ___________________

3. Condition 1 Old 2 New 3 Reconditioned

4. Fit 1 Worn high on hips 2 Worn low on hips
   1 Large 2 Small Other, specify _______________

D. RIB INJURY (RIB PADS)

1. Type________________Make__________Model Number__________

2. Condition 1 Old 2 New 3 Reconditioned

3. Fit 1 Large 2 Small Other, specify____________

E. THIGH INJURY (THIGH PADS)

Make____________ Type___________.

CONDITION 1 Old 2 New 3 Reconditioned

Fit 1 Worn High 2 Worn Low
1 Small 2 Large 3 Correct size

F. KNEE AND ANKLE INJURIES (SHOES)

Make_______________ 1 Highs 2 Lows 3 3/4

Game and Practice shoes same type 1 Yes 2 No

If no, what are other type:

Make________________________ 1 Highs 2 Lows 3 3/4

(TYPE OF CLEATS) 1 Short 2 Long (HEEL) 1 Cleats 2 Soccer Type
3 Heel plate

Were ankles <u>wrapped</u> 1 Yes 2 No <u>taped</u>, 1 Yes 2 No

Other Notes:

Interviewer__________________________ Date of Interview _______________

APPENDIX C

FOOTBALL COACHES INTERFORM FORM

COACHES'S INTERVIEW FORM

Age__________ Marital Status____________

I. Playing Experience:

Level	Years	Sub or Starter	Position (Major)	School and Location
High School				
Jr. College				
College				
Professional				

II. Coaching Experience:

Level	Years	Duty or Assignment	School or Location	Head Coach
High School				
Jr. High				
Jr. College				
College				

III. Education:

College	Major Field	Minor Field	Degree Received	Year

1. Did you have a football coaching class in your college training?
__________ yes _____ no

A sports training class? _____ yes _____ no

A first aid course? _____ yes _____ no

2. During the fall, do you have responsibilities other than football coaching?
______ yes ______ no

If yes, what other responsibilities?

________ Assistant Principal ________ Principal

________ Teach ________________________ Subject

________ Other, explain ____________________________________

3. How many assistant football coaches do you have?

_________(Please complete Part Two for each)

Organization of Practice

How do you organize your orverall practice or team preparation efforts from the first legal practice date until your first game, with respect to the following three areas? (Some indication of the amount of time allocated to each is desired.)

Conditioning of players:

Instruction and work on fundamentals:

Team play:

During the season, (after your first game) what is your usual pattern of practice organization from Monday to Friday, with respect to the same three areas:

Conditioning:

Instruction and fundamentals:

Team play:

What is your practice with regard to contact from Monday to Thursday?

Miscellaneous:

Does your team use a special drink or salt additive during the summer months?

Drink: _______yes ______ no

Salt additive: _______yes _______ no

If yes, what drink: ____________________

If yes to salt item, how is salt administered?

If you give liquids, on what interval basis are they administered to your players?

Do you have all your players wrap ankles for practice or games? (Check one or more that apply).

Games, all players ______

Practice, all players _______

Games, selected players _______

Practice, selected players ________

None _______

What is your philosophy of football? (Why are you in coaching? The game's contribution to youth. Its relationship to other school programs, and so forth.)

PART TWO - ASSISTANTS

1. **Playing Experience**:

Level	Years	Starter or Sub	Position (Major)	School or Location
High School				
Jr. High School				
College				
Professional				

2. **Coaching Experience**:

Level	Years	Duty or Assignment	School	Head Coach
Jr. High School				
High School				
Jr. College				
College				
Professional				

3. **Education**:

College	Major Field	Minor Field	Years	Degree

a. Did you have a course in football coaching?

_________ yes _________ no

b. A course in first aid? ______yes ______ no

c. A course in athletic training? ______ yes ______ no

APPENDIX D

EQUIPMENT DATA FORM

EQUIPMENT DATA FORM

EPIDEMIOLOGY OF HIGH SCHOOL FOOTBALL INJURIES

The University of North Carolina

Section III - Equipment Data

Study Number

5354

School Number

NAME: ______________________________
Last First Middle

A. HELMET

__________ Make
__________ Model Number
__________ Condition

1. Shell
   - (1) Hard Shell
   - (2) Soft Shell
   - (3) Soft Strip
   - (4) Other ______

2. Type
   - (1) Suspension (full)
   - (2) Suspension/padded
   - (3) Padded
   - (4) Other __________

3. Face Mask
   - (1) Cage
   - (2) One-bar
   - (3) Two-bar
   - (4) QB
   - (5) Other ________

4. Neck Protection
   - (1) Yes (2) No Rear Insert
   - (1) Yes (2) No Neck Roll

5. Mouth Piece
   - (1) Dentist fitted
   - (2) Self fitted
   - (3) Don't use one
   - (4) Other ________

6. Helmet Fit
   - (1) Good
   - (2) Too Large
   - (3) Too Small
   - (4) Suspension Up
   - (5) Shims Thin
   - (6) Chin Strap Off-Center
   - (7) Other ______________

B. SHOES (Game)

__________	__________	__________
Make	Model	Condition

1. <u>Style</u> (1) Highs (2) Lows (3) 3/4 (4) Other __________

2. <u>Cleats</u>

(1) Short Metal
(2) Short Nylon
(3) Long Metal
(4) Long Nylon
(5) Soccer Type
(6) Other __________

3. <u>Heels</u>

(1) Short Metal
(2) Short Nylon
(3) Long Metal
(4) Long Nylon
(5) Soccer Type
(6) Other __________

If practice shoes are not same as game shoes, use second code to right of item and encircle it.

C. SHOULDER PADS

__________	__________	__________
Make	Model Number	Condition

1. <u>Position Construction</u>

(1) Lineman
(2) Back
(3) QB
(4) Linebacker
(5) Utility
(6) Other__________

2. <u>Fit</u>

(1) Good
(2) Too Large
(3) Too Small
(4) Too Little Distance Between Neck and Pad
(5) Too Much Distance Between Neck and Pad
(6) Epaulets Not Over Point of Shoulder
(7) Other __________

D. HIP PADS

__________	__________	__________
Make	Model Number	Condition

1. Fit

(1) Good
(2) Worn High
(3) Worn Low
(4) Trimmed
(5) Other __________

E. THIGH PADS

______	______	______
Make	Model Number	Condition

1. Placement

(1) Good
(2) High
(3) Low
(4) Too Small
(5) Other ______

2. Size

Approximately ______X ______inches

3. Material

(1) Hard Shell
(2) Soft Shell

F. KNEE PADS

______	______	______
Make	Model Number	Condition

1. Placement

(1) Good
(2) High
(3) Low
(4) Too Small
(5) Other ______

2. Size

Approximately ______X ______inches

3. Material

(1) Hard Shell
(2) Soft Shell

APPENDIX E

CODING AND CLASSIFICATION SPECIFICATIONS

EPIDEMIOLOGY OF HIGH SCHOOL FOOTBALL INJURIES

SECTION I POPULATION DATA

CODING SPECIFICATIONS

Column	Item	Classification	Code
1-4	Study Number		3000-5999
5-7	School Number	See attched list of code assignments	700-999
8	Age	13 years	3
		14 years	4
		15 years	5
		16 years	6
		17 years	7
		18 years	8
		19 years	9
		20+ years	0
		Unknown age	X
9	Grade	7th grade	7
		8th grade	8
		9th grade	9
		10th grade	0
		11th grade	1
		12th grade	2
		Post graduate	3
		Unknown grade	X
10	Race	White	1
		Negro	2
		Indian	3
		Unknown Race	X
11-12	Height	(in inches)	00-99
		Unknown Height	XX
13-15	Weight	(in pounds)	000-999
		Unknown Weight	XX
16	Football Experience	Total years	00-99
		Unknown	XX

Column	Item	Classification	Code
17	High School Experience	1 year	1
		2 years	2
		3 years	3
		None	0
		Unknown	X
18	Junior High School Experience	1 year	1
		2 years	2
		3 years	3
		None	0
		Unknown	X
19	Experience below the Junior High level	1 year	1
		2 years	2
		3 years	3
		4 years	4
		5 years	5
		6 years	6
		7 years	7
		8 years	8
		9 years	9
		None	0
		Unknown	X
20	Does athlete play other Sport?	Yes	1
		No	2
		Unknown	X
21-22	If yes, what other sport or sports?	Basketball	01
		Baseball	02
		Swimming	03
		Track	04
		Wrestling	05
		Soccer	06
		Golf	07
		Tennis	08
		Basketball and Track	09
		Baseball and Track	10
		Basketball and Baseball	11
		Basketball, Baseball and Track	12
		Baseball and Wrestling	13
		Track and Wrestling	14
		Baseball and Golf	15
		Wrestling and Tennis	16
		Basketball and Golf	17
		Basketball and Tennis	18
		Basketball, Golf, and Wrestling	19
		Soccer and Baseball	20
		Track and Golf	21

Column	Item	Classification	Code
		Track and Soccer	22
		Track and Tennis	23
		Wrestling, Golf, and Baseball	24
		Baseball, Track and Wrestling	25
		Swimming and Track	26
		Soccer and Wrestling	27
		Basketball, Baseball, and Wrestling	28
		Basketball, Baseball, and Golf	29
		Wrestling and Golf	30
		Unknown	XX
		No in Column 20	--
23	Did athlete ever have formal instruction in tumbling in Physical Education program?	Yes	1
		No	2
		Unknown	X
24	Did athlete ever have formal instruction in gymnastics in Physical Education program?	Yes	1
		No	2
		Unknown	X
25	Did athlete ever have formal instruction in weight training in Physical Education program?	Yes	1
		No	2
		Unknown	X
26	Was athlete a varsity or junior varsity level player?	Varsity	1
		Junior Varsity	2
		Unknown	X
27-28	Estimated time played in each game by athlete last season	Number of minutes	00-99
		Unknown	XX
29	Did athlete have a physical examination prior to this season?	Yes	1
		No	2
		Unknown	X
30	Circumstances of the physical examination	Physician(s) examined entire team, or a large number of boys at one specified time	1

Column	Item	Classification	Code
		Family physician examined boy privately	2
		Family physician certified boy's health from prior knowledge of boy, not from physical examination	3
		Team physician examined boy privately	4
		Doctor reputed to be "easy" on pre-sport physicals did examining or certified health	5
		School physician provided the examination	6
		Father was physician and he certified son's health	7
		Examined by physician in the Upward Bound program	8
		Examined by physician at the Health Department	9
		Other, specify	0
		Unknown	X
		No response in Column 29	-
31	Place physical exam too place	Physician's office	1
		School gymnasium	2
		Health Department	3
		Boy's home	4
		Hospital	5
		Unknown	X
		No in Column 29	-
32	Were joints and extremities examined?	Yes	1
		No	2
		Unknown	X
		No. in Column 29	-
33	In what manner was blood pressure checked?	With cuff around upper arm	1
		Listened with stethescope	2
		Other, specify	3
		Did not take it	4
		Unknown	X
		No in Column 29	-
34	How was athletes heart checked?	Listened to it with stethescope to bare chest	1
		Listened to it with stethescope over shirt or other clothing	2
		EKG	3
		Was not checked	4
		Unknown	X
		No in Column 29	-

Column	Item	Classification	Code
35	Was athlete checked for hernia or rupture? (Method)	Cough	1
		Strain	2
		Breathe deeply	3
		Unknown	X
		Did not check	4
		No in Column 29	-
36	Has athlete had an injury previously which caused him to miss at least a week of football play?	Yes	1
		No	2
		Unknown	X
37-38	If yes, what part of the body was injured?	Head	01
		Eye(s)	02
		Mouth	03
		Teeth	04
		Ear	05
		Face	06
		Neck	07
		Throat	08
		Nose	09
		Shoulder	10
		Collar Bone	11
		Upper Arm	12
		Lower Arm	13
		Elbow	14
		Hand	15
		Spine	16
		Back	17
		Pelvis, Hip(s)	18
		Buttocks	19
		Upper Leg	20
		Knee	21
		Lower Leg	22
		Ankle	23
		Foot	24
		Ribs	25
		Viscera	26
		Finger(s)	27
		Toe(s)	28
		Spleen	29
		Chin	30
		Groin	31
		Testicles	32
		Stomach	33
		Heel	34
		Thumb	35

Column	Item	Classification	Code
		Chest	36
		Sternum	37
		Kidney	38
		Coccyx	39
		Lung	41
		Wrist	42
		Achilles Tendon	43
		Jaw	44
		Navel	45
		Side	46
		Unknown	XX
39-40	What type of injury sustained	Abrasion	01
		Contusion	02
		Laceration	03
		Puncture Wound	04
		Sprain	05
		Fracture	06
		Strain	07
		Internal Injury	08
		Heat Exhaustion	09
		Muscle Contusion	10
		Heat Stroke	11
		Joint Contusion	12
		Burn	13
		Dislocation	14
		Separation	15
		Inflammation	16
		Infection	17
		Nerve Injury	18
		Hemorrhage	19
		Concussion	20
		Foreign Body	21
		Ruptured Blood Vessel	22
		Torn Ligament	23
		Pulled Muscle	24
		Torn Tendon	25
		Boil(s)	26
		Torn Cartilage	27
		Blister(s)	28
		Hernia	29
		Chipped Bone	31
		Slipped Disc	32
		Pinched Nerve	33
		Unknown	XX
		No in Column 36	--
41-42	How many days beyond the seven mentioned were	Number in days	07-99
		Unknown	XX
		No in Column 36	--

Column	Item	Classification	Code
	missed because of this previous football injury?		
43	Do you wrap ankles?	Yes	1
		No	2
		Unknown	X
44	When are they wrapped?	Before both games and practices	1
		Before games only	2
		Before practices only	3
		Only post-injury	4
		Unknown	X
		No in Column 43	-
45	Do you wrap knee(s)?	Yes	1
		No	2
		Unknown	X
46	When are they wrapped?	Before both games and practices	1
		Before practices only	2
		Before games only	3
		Only post-injury	4
		Unknown	X
		No in Column 45	-
47	Do you tape ankle(s)?	Yes	1
		No	2
		Unknown	X
48	When are they taped?	Before both games and practices	1
		Before games only	2
		Before practices only	3
		Only post-injury	4
		Unknown	X
		No in Column 47	-
49	Do you tape knee(s)?	Yes	1
		No	2
		Unknown	X
50	When do you tape knee(s)?	Before both games and practices	1
		Before games only	2
		Before practices only	3
		Only post-injury	4
		Unknown	X
		No in Column 49	-

Column	Item	Classification	Code
51-52	What did boy do during summer to get or stay in proper physical condition for football?	Did some running, n.e.c.	01
		Worked with weights	02
		Weights and running	03
		Weights and ran one mile per day	04
		Weights and heavy work	05
		Heavy work (construction)	06
		Weights, distance running and wind sprints	07
		Weights, ran and exergenie	08
		Weights, running, heavy work and football camp	09
		Weights, distance running and sprints daily	10
		Weights, running and football camp	11
		Running and tennis	12
		Swimming, running and weights	13
		Farm work and running	14
		Baseball	15
		Swimming and summer basketball	16
		Basketball	17
		Weights and sprints three times weekly	18
		Worked Saturdays	19
		Swimming and hiking	20
		Weights, running and baseball	21
		Worked, n.e.c.	22
		Worked and basketball	23
		Weights and basketball	24
		Heavy work and running	25
		Sprints and "worked-out"	26
		"Worked-out"	27
		Ran, weights and basketball	28
		Nothing	29
		Swimming and golf	30
		Water skiing	32
		Running and baseball	33
		Swimming	34
		Sprints and agility work	35
		Coach's prescribed program	36
		Weights and swimming	37
		Touch football	38
		One week football camp	39
		Swimming and running	40
		Softball, tennis and heavy work	41
		Tennis	42
		Jogging	43
		Softball and "worked-out"	44
		Running and basketball	45
		Farm work and baseball	46
		Swimming and baseball	47

Column	Item	Classification	Code
		Swimming, running and boxing	48
		Swimming, running and baseball	49
		Baseball and basketball	50
		Soccer and weights	51
		Soccer, baseball and swimming	52
		Soccer, weights and swimming	53
		Soccer, running and weights	54
		Weights, baseball and basketball	55
		Baseball and heavy work	56
		Bicycle riding and weights	57
		Rope jumping	58
		Swimming, running, basketball and tennis	59
		Running, basketball, baseball and swimming	60
		Tennis, baseball and weights	61
		Running and golf	62
		Weights, running, swimming and golf	63
		Swimming and work	64
		Karate, surfing and construction work	65
		Cut grass	66
		Running and cut grass	67
		Isometrics, tennis, running and sprints	68
		Work, running and weights	69
		Working, weights and agility drills	70
		Weights and swimming	71
		Golf	72
		Unknown	XX
53-54	Why is boy playing football?	Likes or loves the game	01
		Enjoys the game	02
		Likes to play	03
		Wants to win(win games, etc.)	04
		Wants to play some sport	05
		Loves the contact	06
		For fun	07
		Self discipline, makes self a better man	08
		It is the best sport	09
		Loves to hit	10
		Likes the game and to hit	11
		To get a scholarship to college	12
		Think it will help in track	13
		The excitement	14
		For the attention of girls	15
		"Want to bust somebody"	16
		Keeps you in good shape	17
		Just want to	18
		Coach wants me to	19
		To kill somebody	20
		To prepare for wrestling	21
		Personal satisfaction I get	22

Column	Item	Classification	Code
		In order to become famous	23
		In order to meet people	24
		Team work	25
		For good health	26
		To learn	27
		To represent my school	28
		It is challenging	29
		I am stupid or crazy I guess	30
		To help the team	31
		To help the school to win	32
		To be a pro player someday	33
		It makes a man of you	34
		I like the competition and the contact	35
		I want to kick	36
		To get in shape for basketball	37
		A chance to be on a championship team	38
		For the competition, contact, fellowship and chance for college	39
		I play this sport best	40
		For contact and to win	41
		Do not know	42
		For the popularity it brings	43
		It relieves frustrations	44
		It keeps me out of trouble with teachers and grades	45
		Because I am big	46
		It is the only reason I come to school at all	47
		I want to become a pro	48
		I love acting, so I love football	49
		To get in shape for baseball	50
		To build myself up	51
		My mother made my play	52
		In order to lose weight	53
		I was just interested in what went on at football	54
		It relieves tension	55
		Helps my ability to play other sports	56
		I like the hard work	57
		It is a family tradition	58
		Unknown	XX
55-79	Blanks	Blanks	--
80	Card Type	Section I Population Data	2

EPIDEMIOLOGY OF HIGH SCHOOL FOOTBALL INJURIES

SECTION II INJURY DATA

CODING SPECIFICATIONS

Column	Item	Classification	Code
1-4	Study Number		3000-5999
5-7	School Number	See attached list of code assignments	700-999
8	Where did injury occur?	Game Field	1
		Practice Field	2
		Locker Room	3
		Training Room	4
		Activity Bus	5
		Other	-
		Unknown	X
9	Did injury occur during?	Game	1
		Practice	2
		Other	-
		Unknown	X
10	Game opponents Classification	4A	1
		3A	2
		2A or 1A	3
		Unknown	X
		If other than 1 in Column 9	-
11	Was game at home or away?	Home	1
		Away	2
		Unknown	X
		If other than 1 in Column 9	-
12	In what quarter of the game did injury occur?	First	1
		Second	2
		Third	3
		Fourth	4
		Unknown	X
		If other than 1 in Column 9	-
13-14	Player's estimate of time played before the injury occurred	Number of minutes	00-99
		Unknown	XX
		If other than 1 in Column 9	-
15	Was injured a starter?	Yes	1
		No	2
		Unknown	X
		If other than 1 in Column 9	-

Column	Item	Classification	Code
16-17	Position played when injured (starred on form)	End, Defense	01
		End, Offense (Tight)	02
		End, Offense (Split)	03
		Tackle, Defense	04
		Tackle, Offense	05
		Guard, Defense	06
		Guard, Offense	07
		Center	08
		Linebacker	09
		Quarterback	10
		Halfback, Defense	11
		Halfback, Offense	12
		Flanker	13
		Wingback	14
		Safety	15
		Fullback	16
		Blocking Back	17
		Slotback	18
		Kicker	19
		Middle Guard	20
		Tailback	21
		Other	22
		Unknown	XX
18-19	Second position played by injured	Same code structure as above (enter blanks if only one position played)	--
20-21	Type of injury	Abrasion	01
		Contusion	02
		Laceration	03
		Puncture Wound	04
		Sprain	05
		Fracture	06
		Strain	07
		Internal Injury	08
		Heat Exhaustion	09
		Muscle Contusion	10
		Heat Stroke	11
		Joint Contusion	12
		Burn	13
		Dislocation	14
		Separation	15
		Inflammation	16
		Infection	17
		Nerve Injury	18
		Hemorrhage	19
		Concussion	20
		Foreign Body	21
		Ruptured Blood Vessel	22

Column	Item	Classification	Code
		Torn Ligament	23
		Pulled Muscle	24
		Torn Tendon	25
		Boil(s)	26
		Torn Cartilage	27
		Blister(s)	28
		Hernia	29
		Chipped Bone	30
		Slipped Disc	32
		Pinched Nerve	33
		Other	34
		Unknown	XX
22-23	Second injury	Same code structure as Columns 20-21 (enter blanks if only one injury)	--
24-25	Part of the body injured	Head	01
		Eyes	02
		Mouth	03
		Teeth	04
		Ear	05
		Face	06
		Neck	07
		Throat	08
		Nose	09
		Shoulder	10
		Collar Bone	11
		Upper Arm	12
		Lower Arm	13
		Elbow	14
		Hand	15
		Spine	16
		Back	17
		Pelvis, Hips	18
		Buttocks	19
		Upper Leg	20
		Knee	21
		Lower Leg	22
		Ankle	23
		Foot	24
		Ribs	25
		Viscera	26
		Finger(s)	27
		Toe(s)	28
		Spleen	29
		Chin	30
		Groin	31
		Testicles	32
		Stomach	33

Column	Item	Classification	Code
		Heel	34
		Thumb	35
		Chest	36
		Sternum	37
		Kidney	38
		Coccyx	39
		Lung	41
		Wrist	42
		Achilles Tendon	43
		Jaw	44
		Navel	45
		Side	46
		Unknown	XX
26-27	Second part of the body injured	Same code structure as for Column 24-25. (enter blanks if no second injury)	--
28-32	Date of the injury	January	01
		February	02
		March	03
		April	04
		May	05
		June	06
		July	07
		August	08
		September	09
		October	10
		November	11
		December	12
		Unknown	XX
33		Day	01-31
		Unknown	XX
		Year 1968	8
		Year 1969	9
		Year 1970	0
		Unknown	X
33	Was this a new injury to part?	Yes	1
		No	2
		Unknown	X
34-36	Date of earlier injury	January	01
		February	02
		March	03
		April	04
		May	05
		June	06
		July	07

Column	Item	Classification	Code
		August	08
		September	09
		October	10
		November	11
		December	12
		Unknown	XX
		No in Column 33	--
		Year 1965	5
		Year 1966	6
		Year 1967	7
		Year 1968	8
		Year 1969	9
		Unknown	X
		No in Column 33	-
37	Was doctor seen?	Yes	1
		No	2
		Unknown	X
38-39	Reason the doctor was seen	Pain	01
		Swelling	02
		Bleeding	03
		Coach suggested	04
		Recurring injury	06
		Doctor suggested	07
		Team doctor's orders	08
		Unconsciousness	09
		Unable to move legs	10
		Unable to speak	11
		Unable to move comfortably	13
		Dizziness	14
		Disfigured	15
		Infection	16
		Loss of memory	17
		Fainted or passed out	18
		Unknown	XX
		No in Column 37 enter blanks	--
40	Interval between injury and receipt of Medical treatment	Same day	1
		1 day	2
		2-3 days	3
		4-7 days	4
		8+ days	5
		Unknown	X
		No in Column 37	-
41-42	What treatment was received for the injury?	Sutures	01
		Wrap (ace)	02
		Bandage	03

Column	Item	Classification	Code
		X-ray	04
		Surgery	05
		Oral Medication	06
		Injection	07
		Physical Therapy, n.e.c.	08
		Examination, n.e.c.	09
		EEG	10
		Ice or Cold	11
		Aspiration of joint	12
		Whirlpool	13
		Aspiration, Oral Medication and X-ray	14
		X-ray and Cast	15
		Sling	16
		X-ray and Physical Therapy	17
		X-ray and Wrap	18
		X-ray and Sutures	19
		X-ray and Injection	20
		X-ray and Hospitalization	21
		X-ray and Traction	22
		X-ray and Aspiration	23
		Hospitalization	24
		Cast	25
		Aspiration, Traction and Cast	26
		X-ray and Sling	27
		Heat	28
		Medication, Ice, Brace	29
		Salt	30
		Splint	31
		X-ray and Oral Medication	32
		X-ray and Whirlpool	33
		X-ray, Injection and Cast	34
		Wrap and Heat	35
		X-ray, EEG and Hospital	36
		X-ray and Brace	37
		Rest	38
		Wrap and Whirlpool	39
		X-ray and Crutches	40
		Aspiration and Whirlpool	41
		Ultrasound	42
		Set and Pack	43
		Harness and Injection	44
		Injection and Oral Medication	45
		Sutures and Injection	46
		Unknown	XX
		None Received	--
43	Was game or practice activity resumed after injury	Yes	1
		No	2
		Unknown	X

Column	Item	Classification	Code
44	If player did not resume play, what did he do?	Hospital	1
		Sat on bench	2
		Dressed and went home	3
		Sat out with ice on injured part	4
		Went to doctor's office	5
		Went in and placed part in whirlpool	6
		Walked it off	7
		Went in and applied heat	8
		Other	9
		Unknown	X
		Yes in Column 43	-
45	If injured player continued to play, how soon after injury did he return to activity?	Stayed in	1
		Next play	2
		First offensive or defensive series following injury	3
		Beginning of next period	4
		After half-time	5
		1-5 minutes	6
		6-9 minutes	7
		10-15 minutes	8
		16-30 minutes	9
		30+ minutes	0
		Unknown	X
		No in Column 43	-
46	If injured continued to play, who made this decision?	Physician	1
		Trainer	2
		Student Trainer	3
		Coach	4
		Parent	5
		Self	6
		Unaware of injury	7
		Unknown	X
		No in Column 43	-
47	How long did injury prevent participation?	Less than one day	0
		1 day	1
		2 days	2
		3 days	3
		4 days	4
		5 days	5
		6 days	6
		7+ days	7
		Unknown	X
48-49	Condition of field or place where injury occurred	Turf or grass - dry	01
		Turf or grass - wet	02
		Sparce grass - rough	03

Column	Item	Classification	Code
		Sparce grass - rocky	04
		Dusty or sandy	05
		Hard -packed clay	06
		Hard earth	07
		Mud	08
		Turf n.e.c.	09
		Dry hard surface, n.e.c.	10
		Dry, n.e.c.	11
		Loose dirt	13
		Unknown	XX
50-52	Activity at the time of the injury	<u>Conditioning</u>	
		Warm-up drills, n.e.c.	000
		Reaction drills	004
		Running, n.e.c.	005
		Running, up-hill	006
		Shoulder rolls	007
		Sit-ups	008
		Leg rolls	009
		Wind sprints	012
		Horseplay	015
		Tug-of-war	018
		Stretching exercise	019
		<u>Agility Drills</u>	
		Monkey rolls	020
		All fours drill	021
		Tire hazard	022
		Coffee grinder	023
		<u>Tackling Drills</u>	
		Tackling drill, n.e.c. (tackler)	024
		Alabama drills, tackler	031
		One-on-one, tackler	026
		Head-on drill, tackler	027
		Form tackling drill, tackler	029
		Reaction tackling drill, tackler	032
		Tackling drill, n.e.c., Ballcarrier	040
		Head-on drill, ballcarrier	041
		Alabama drill, ballcarrier	042
		Ball carrying drill, n.e.c.	043
		One-on-two tackling drill	044
		Side line tackling drill	062
		Alabama drill, blocker	025
		<u>Blocking Drills</u>	
		Two-on-one drill	045
		Trap blocking drill	046
		One-on-one blocking	047

Column	Item	Classification	Code
		Three-on-one blocking	048
		Cross-body blocking drill	049
		Blocking with boards	053
		Two-on-two blocking	051
		Equipment Work	
		7-man sled blocking	050
		2-man sled blocking	052
		Hitting dummies	057
		Holding dummies	056
		Hitting sled from run	066
		Hitting Buckaroo machine	054
		Other Drills	
		King of the Mountain	075
		Bull in the ring	030
		Punt return drill	064
		Passing drill, receiver	030
		Pass defense drill	034
		Defensive end drill	035
		Passing drill, passer	064
		Pursuit drill	078
		Group Work	
		Half-speed scrimmage	077
		Half-line blocking	074
		Goal line drill	075
		Offensive Scrimmage Situations	
		Scrimmage, offensive, n.e.c.	100
		Running, n.e.c.	102
		Carrying ball, n.e.c.	103
		Drop back passing	112
		Receiving pass	109
		Blocking, n.e.c.	130
		Downfield blocking	135
		Other blocking	133
		Running pass cuts	110
		Defensive Scrimmage Situations	
		Lateral pursuit	140
		Recipient of block LOS	143
		Rushing passer	148
		Tackling, n.e.c.	155
		Sideline tackling	152
		Downfield tackling	153
		Head-on tackle	156
		Open-field tackle	157
		Cross body tackle	158

Column	Item	Classificiation	Code
		Tackling as blocked	159
		Tackling QB on rush	166
		Avoiding block	160
		Trailing play	164
		Recovering fumble	169
		Standing at sideline	161
		Scrimmage Speciality Activity	
		Blocking punt	173
		Blocking PAT	174
		Returning kickoff	181
		Returning punt	180
		Making tackle under punt	183
		Being blocked under punt	184
		Blocking under punt	195
		Game Activity- Offense	
		Running ball laterally - QB	202
		Hit on drop-back-QB	204
		Being tackled head-on	211
		Being tackled LOS	213
		Being tackled downfield	214
		Being tackled sideline	215
		Being tackled in a crowd	216
		Being tackled with a cross-body tackle/ block	217
		Being tackled from behind	218
		Being tackled, n.e.c.	212
		Carrying ball, n.e.c.	210
		Hit on ground after tackle	220
		Hit on ground after block	221
		Hit on ground after recovering fumble	222
		Hit while uncoiling from pile-up	223
		Hurdling downed player	225
		Blocking LOS	230
		Blocking on and by back	231
		Throwing block, n.e.c.	232
		Throwing cross-body	233
		Blocking downfield	234
		Running as pulled guard	235
		Forward roll after missing block	237
		Throwing roll block	238
		Pass blocking	239
		Crab blocking	240
		Passing, being tackled after release	250
		Drop back pass hit after release	252
		End fighting off block	260
		Trailing play, n.e.c.	262
		Running pass cuts	265

Column	Item	Classificiation	Code
		Receiving pass, n.e.c.	270
		Receiving pass being hit	271
		Recieving pass downfield	272
		Diving to catch pass	275
		Game - Defensive Activity	
		Pursuing to tackle, blocked from side	300
		Chasing ballcarrier, n.e.c.	301
		Chasing from behind, n.e.c.	303
		Chasing QB, n.e.c.	304
		Charging into offensive backfield, n.e.c.	305
		Recovering ball, false start	310
		Tackling QB in dropback	350
		Pursuing ball carrier on all fours, laterally	356
		Cutting to intercept pass	308
		Positioning for pass defense	309
		Stopping after tackle was made	311
		Running, n.e.c. not ballcarrier	313
		Being blocked LOS	318
		Meeting blocker with forearm	319
		Tackling, n.e.c.	320
		Tackling, while being blocked	321
		Tackling LOS	323
		Tackling, openfield	324
		Tackling from behind	325
		Tackling at sideline	326
		Tackling head-on openfield	327
		Gang tackle participation	328
		Tackling head-on LOS	329
		Attempting tackle	337
		Blocked LOS	330
		Double-teamed LOS	331
		Trapped LOS	332
		Being blocked downfield	333
		Being shoulder blocked	334
		Hurdling line	342
		Hurdling to avoid piling-on	345
		Fighting-off blocker	360
		Hit on ground after block	361
		Going after loose ball	362
		Game - Speciality Activity	
		Under punt, n.e.c.	400
		Tackling under punt	402
		Being blocked under punt	403
		Blocking under punt	404
		Receipt of multiple blocks under punt	406
		Blocking punt	407

Column	Item	Classification	Code
		Returning punt, n.e.c.	409
		Punting	430
		PAT offensive blocking	410
		PAT kicking	412
		PAT hurdling line to block	415
		Under kickoff, n.e.c.	420
		Being blocked under kickoff	421
		Attempting tackle under kickoff	422
		Blocking under kickoff	423
		Tackling under kickoff	424
		Open-field blocking under kickoff	425
		Returning kickoff	427
		<u>Other Game Situations</u>	
		Pre-game warm-ups	440
		Accumulation of minor blows over whole game or participation in football generally	500
		Fighting	470
		Unknown	599
53-55	Cause or agent of the injury	<u>Blow from Object</u>	
		Ball	001
		Helmet, ballcarrier	002
		Helmet, tackler	003
		Helmet, blocker	004
		Helmet, opponent, n.e.c.	005
		Helmet, n.e.c.	006
		Shoulder pad, ballcarrier	010
		Shoulder pad, tackler	011
		Shoulder pad, blocker	012
		Shoulder pad, n.e.c.	013
		Shoe or cleat (kicked)	015
		Shoe or cleat (stepped-on)	016
		Show or cleat, n.e.c.	017
		Knee, ballcarrier	020
		Knee, tackler	021
		Knee, blocker	022
		Knee, opponent	023
		Leg, opponent	024
		Elbow, ballcarrier	030
		Elbow, tackler	031
		Elbow, blocker	032
		Elbow, n.e.c.	033
		Fist	035
		Hand	036
		Finger(s)	037
		Forearm	038
		Thigh pad	040

Column	Item	Classification	Code
		Hip	045
		Object, unknown	049
		Falls	
		Fall, being tackled, arm and hand extended	050
		Fall, after tackling, arm and hand extended	051
		Fall, after blocking	052
		Fall, tripped over downed player	054
		Fall, stumble, n.e.c.	055
		Fall, another player fell on extended arm	056
		Fall while catching pass	057
		Fall after hitting dummy	058
		Fall, leg caught under body	059
		Fall, foot imbedded in ground	061
		Fall, another player fell on top	063
		Fell, on tire	064
		Tripped, fell, n.e.c.	065
		Fall, n.e.c.	069
		Collision with Object	
		with ground, after fall	071
		With ground, after block	073
		With ground, after tackling	074
		With ground, after being tackled	075
		With ground after being blocked	076
		With ground after hitting dummy	077
		With ground, after undercut	078
		With ground, after jump landing	079
		With ground, after dive	080
		With ground, n.e.c.	085
		With ground after being thrown down on tackle	086
		Collision with sled	087
		Collision with dummy	088
		Collision, n.e.c.	089
		Contact with Sharp, Rough or Hard Object	
		Pipe	090
		Fence	091
		Loose Headgear	093
		Overlapping faceguards	092
		Helmet	094
		Blocking board	095
		Helmet part or pads	096
		Exposed pad	097
		Shoulder pad	098
		Rock	099

Column	Item	Classificiation	Code
		Glass	100
		Sideline cable	101
		Telephone pole	102
		Metal on sled or machine	103
		Tire	104
		Cleat or shoe	105
		Bench - at out of bounds	106
		Rough, hard surface	107
		<u>Ill-fitting, Broken or Defective Equipment</u>	
		Improper fit of helmet	110
		Broken suspension or webbing	112
		Ill-fitting shoes	114
		Defective cleats	115
		Hitting without pads	116
		Broken face-bar	117
		Ill-fitting hip pads	119
		Helmet came off, n.e.c.	109
		No cleat on screw	115
		<u>Caught in or Between Objects</u>	
		Caught in helmet	118
		Caught between two helmets	120
		Between knee and ground	121
		Caught in shoulder pads	122
		Between two shoulder pads	123
		Caught in jersey	125
		Caught in thigh pads	127
		Caught in or between, n.e.c.	130
		Arm caught between running ballcarrier's legs	131
		Caught in face mask	132
		<u>Torsion</u>	
		Twisted, two men tackling	135
		Twisted, gang tackle foot imbedded	136
		Twisted on cut, no contact	138
		Twisted on landing, no contact	140
		Twisted, being tackled	142
		Twisted, avoiding block no contact	144
		Twisted when hit high	148
		Twisted while being blocked, feet planted	150
		Twisted while being blocked, feet not planted	151
		Twisted while blocking, n.e.c.	152
		Whiplash, blow from behind	155
		Twisted when dragged by ballcarrier	157
		Hyperextension	159

Column	Item	Classification	Code
		Twisted by tackler	161
		Twisted going for thrown ball	162
		Twisted while tackling, n.e.c.	163
		Hung cleat in turf	165
		Strain on previously injured part, knee or ankle	166
		Stepped On or In Object	
		Hole	170
		Rough or uneven surface	172
		Rim of tire	173
		Glass	175
		Player's foot	177
		Rock	178
		Sandy spot on field	179
		Mud hole, or muddy area	180
		Equipment left on field	181
		Helmet of another player	182
		Wet, slippery grassy area	183
		Pile-up	
		Pile-up, LOS	185
		Pile-up, n.e.c.	186
		Pile on recover of fumble or loose ball	188
		Illegal Acts	
		Clipping	190
		Crackback clip	191
		Hit late while down	192
		Piled-on	193
		Face mask grabbed	194
		Spearing	195
		Hit out-of-bounds	197
		Illegal act, n.e.c.	198
		Improper Technique	
		Blocking, head down	200
		Tackling, head down	201
		Improper technique, n.e.c.	203
		Blocking with head on sled	204
		Arm tackling	206
		No mouthpiece worn	207
		Coach manhandled player	208
		Inadequate warm-up kicker	209
		Inadequate Care	
		Blisters and boils	210
		Minor cuts	212

Column	Item	Classification	Code
		Heat	
		Heat	215
		Other	
		General	220
		Own weight caused joint to give in	222
		Accumulation of blows	224
		Aggravation of old injury	226
		Collision with Person	
		Ballcarrier with tackler	230
		Ballcarrier with tackler, head-on	231
		Ballcarrier with tackler, from side	232
		Ballcarrier with tackler, from back	233
		Ballcarrier with tackler, from blind side	234
		Ballcarrier by gang tackle	235
		Ballcarrier hit from both sides	236
		Pass rush gang tackle	237
		Ballcarrier hit while held up by a tackler	238
		Tackler, with ballcarrier from side	240
		Tackler, with ballcarrier from head-on	241
		Tackler, with ballcarrier, n.e.c.	241
		Tackler, with much heavier ballcarrier	243
		Receipt of block from front	250
		Receipt of cross body block	251
		Receipt of roll block	252
		Receipt of block from side	253
		Receipt of block high and low	254
		Receipt of block, n.e.c.	256
		Receipt of block from behind	255
		Collision with another lineman, defensive	260
		Collision with another defensive back	262
		Collision with another lineman, offensive	264
		Closing moment play - pile on ballcarrier	266
		Unknown	999
56	Head position when injury was received	Chin tucked, head straight	1
		Chin tucked, head to right	2
		Chin tucked, head to left	3
		Chin extended, head straight	4
		Chin extended, head to right	5
		Chin extended, head to left	6
		Normal eyes front position	7
		Back of head struck ground	8
		Unknown	X
		Not applicable no head injury	-

Column	Item	Classification	Code
57-58	Symptoms resulting from injury to head	Headache	01
		Headache and visual disturbance	02
		Headache and memory loss	03
		Headache and unconsciousness	04
		Headache, visual disturbance and memory loss	05
		Headache, visual disturbance and unconsciousness	06
		Headache, visual disturbance, memory loss and unconsciousness	07
		Headache, memory loss and unconsciousness	08
		Visual disturbance	09
		Visual disturbance and memory loss	10
		Visual disturbance and unconsciousness	11
		Visual disturbance, memory loss and unconsciousness	12
		Memory loss	13
		Memory loss and unconsciousness	14
		Unconsciousness only	15
		Unknown	XX
		None	00
		Not applicable no head injury	--
59-62	Blanks	Blanks	--
63	Interviewer	Robey	1
		Mueller	2
		Blyth	3
		DeWalt	4
		Jamerson	5
		Ward	8
		Gay	9
		Unknown	X
64-68	Date of Interview	Month	01-12
		Day	01-31
		Year	8 9 0
		Unknown	XXXX
69	Film check	Confirmed	1
		Unable to locate	2
		Discrepancy	3
		Unknown	X
		Film not available	4
		Non-game injury	-

Column	Item	Classification	Code
70-79	Blank	Blanks	-
80	Card type	Section II - injury data	1

APPENDIX F

HELMET FIT CRITERIA

Too Large

Excess movement of helmet, either from side to side or up and down.

Too Small

Helmet too high on forehead - Should be finger width above eyebrow - Ear holes should be even with auditory canal.

Suspension Up

Top of suspension not tight and suspension hitting helmet shell.

Shims Thin

Cheek pads too thin which causes excess movement of helmet from side to side.

Chin Strap Off Center

Chin piece not centered on chin.

FIGURE II

CONTACT PROGRAM FOLLOWED BY STUDY SCHOOLS PARTICIPATING IN LIMITED CONTACT PROGRAM 1971 - 1972

I. First Week of Practice (Helmet and Shoes)

  A. Stress Drills for Conditioning

    1. Agility drills

    2. Conditioning drills

  B. Exercises

    1. Stretching and flexibility exercises

    2. Strength exercises (Isometric and Isotonic)

    3. Isometric neck exercise

    4. Bridge exercises for the neck

  C. Running - Start short distances and increase daily, both distance and sprints

II. Second Week of Practice (First week in pads)

  A. Continue emphasis on conditioning drills

  B. Continue exercises for flexibility and strength

  C. Continue neck exercises

  D. Continue to build endurance by running both sprints and distance

  E. Begin live blocking and tackling drills

    1. Stress proper fundamentals and techniques of execution

    2. Tackler and ballcarrier or blocker and blocker never more than two-thirds yards apart

  F. It was deemed desirable for contact work to be limited only to the extent necessary consistent with the need to teach skill execution. Sled and Dummy work were to be emphasized for teaching the proper methods of blocking and tackling instead of live work.

III. Third Week Until First Game

  A. Practice sessions limited to no longer than one hour and thirty minutes.

(Contact Program Followed by Study Schools Participating in Limited Contact Program 1971-1972 Figure II. continued from page 249)

B. Scrimmages limited to twice a week (middle and end of week)

C. Continued restrictions on live blocking and tackling drills with emphasis on teaching proper fundamentals and proper skill execution (Limit on distance between contestants still two to three yards).

NOTE: No live punt coverage or kick-off coverage.

IV. Practice After First Game Until End of Season

A. No live full scrimmages

B. Continue fundamental work on sleds and dummies

C. No live blocking and tackling activity of any kind.