CATASTROPHIC

SPORTS INJURY RESEARCH

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Frederick O. Mueller, Ph.D.
University of North Carolina
Chapel Hill, NC 27514

Robert C. Cantu, M.D.
Emerson Hospital
Concord, MA 01742

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Introduction

In 1931 the American Football Coaches Association initiated the First Annual Survey of Football Fatalities and this research has been conducted at the University of North Carolina at Chapel Hill since 1965. In 1977 the National Collegiate Athletic Association initiated a National Survey of Catastrophic Football Injuries, which is also conducted at the University of North Carolina. As a result of these research projects important contributions to the sport of football have been made. Most notable have been the 1976 rule changes, the football helmet standard, improved medical care for the participants, and better coaching techniques.

Due to the success of these two football projects the research was expanded to all sports for both men and women, and a National Center for Catastrophic Sports Injury Research was established in 1982. The decision to expand the research was based on the following factors:

1. Research based on reliable data is essential if progress is to be made in sports safety.
2. The paucity of information on injuries in all sports.
3. The rapid expansion and lack of injury information in women's sports.

For the purpose of this research the term catastrophic is defined as any severe injury incurred during participation in a school/college sponsored sport. Catastrophic will be divided into the following three definitions:

1. **Fatality**
2. **Non-Fatal** - permanent severe functional disability.
3. **Serious** - no permanent functional disability but severe injury. An example would be fractured cervical vertebra with no paralysis.

Sports injuries are also considered direct or indirect. The definition for direct and indirect is as follows:

Direct - Those injuries that resulted directly from participation in the skills of the sport.

Indirect - Those injuries that were caused by systemic failure as a result of exertion while participating in a sport activity or by a complication that was secondary to a non-fatal injury.

Data Collection

Data were complied with the assistance of coaches, athletic trainers, athletic directors, executive officers of state and national athletic organizations, a national newspaper clipping service and professional associates of the researchers. Data collection would not have been possible without the support of the National Collegiate Athletic Association (NCAA) the National Federation of State High School Associations (NFHS), and the American Football Coaches Association (AFCA). Upon receiving information concerning a possible catastrophic sports injury, contact by telephone, personal letter and questionnaire was made with the injured player's coach or athletic director. Data collected included background information on the athlete (age, height, weight, experience, previous injury, etc.), accident information, immediate and post-accident medical care, type injury and equipment involved. Autopsy reports are used when available.

In 1987, a joint endeavor was initiated with the Section on Sports Medicine of the American Association of Neurological Surgeons. The purpose of this collaboration was to enhance the collection of medical data. Dr. Robert C. Cantu, Chairman, Department of Surgery and Chief, Neurosurgery Service, Emerson Hospital, in Concord, MA, has been responsible for evaluating the medical data. Dr. Cantu is also a Past-President of the American College of Sports Medicine.

Summary

Fall Sports (Tables I - VIII)

Football

As indicated in Tables I through VIII, football is associated with the greatest number of catastrophic injuries. For the 2006 football season there was a total of 20 high school direct catastrophic injuries, which is an increase of nine over 2005. College football was associated with six direct catastrophic injuries in 2006, which is an increase of five over the 2005 data.

In 1990, as shown in the **Annual Survey of Football Injury Research 1931-2007**, there were no fatalities directly related to football. The 1990 football report is historic in that it is the

first year, and the only year, since the beginning of the research in 1931 that there has not been a direct fatality in football at any level of play. This clearly illustrates that this type of data collection and constant analysis of the data is important and plays a major role in injury prevention. The 1994 data shows zero fatalities at the high school level and one at the college level, with a slight rise in high school football in 1995 to four. These numbers are very low when one considers that there were 36 football direct fatalities in 1968.

In addition to the direct fatalities in 2006 there were also 14 indirect fatalities. Twelve of the indirect fatalities were at the high school level and two were at the college level. The causes of the high school indirect deaths were three heat stroke, , eight heart related, and one related to sickle cell trait.. The college indirect deaths were one heat stroke and one related to sickle cell trait.

In addition to the fatalities there were 17 permanent disability injuries in 2006. Ten were cervical spine injuries and seven were brain injuries. This number is an increase of nine when compared to the 2005 data. Fifteen of the injuries were at the high school level and two at the college level.

Serious football injuries with no permanent disability accounted for eight injuries at the high school and college levels in 2006 – four at each level.

' This decrease in catastrophic football injuries illustrates the importance of data collection and being sure that the information is passed on to those responsible for conducting football programs. A return to the injury levels of the 1960's and 1970's would be detrimental to the game and the participants.

Cross Country

Cross-country was not associated with any direct injuries in 2006. There were two indirect deaths at the high school level. For the 25 years indicated in Tables I through VIII, cross-country was associated with one direct non-fatal injury and 24 indirect fatalities at the high school level and one indirect fatality at the college level. Twenty-three of the indirect fatalities

were heart related, one was caused by a seizure, and the cause of one was unknown. Autopsy reports revealed congenital heart disease in four of these cases.

Soccer

Table I shows that high school soccer had no direct catastrophic injury in 2006 and a total of 16 direct catastrophic injuries for the past 25 seasons. The three direct catastrophic injuries in 1992 were the highest number in the past 25 years. There were no high school soccer indirect fatalities in 2006. In 2006 college soccer was not associated with any direct or indirect catastrophic injuries.

Concussion injuries related to heading is a controversial area in soccer. There are helmet manufacturers that are now making soccer helmets to protect the participants from brain injuries while heading, even though the research indicates that concussion injuries during heading are related to head-to-head contact and not ball contact. In a special edition of the Journal of Athletic Training, July-September 2001, an article by Donald Kirkendall and William Garrett, Jr. the authors stated that it is difficult to blame purposeful heading for the reported cognitive deficits when actual heading exposure and details of the nature of head-ball impact are unknown. They go on to say that concussions are a common head injury in soccer (mostly from head-head or head-ground impact) and a factor in cognitive deficits and are probably the mechanism of the reported dysfunction. In October 2001 the Institute of Medicine at the National Academy of Sciences held a one-day conference. Experts on head injuries discussed the potential risk of heading, but reached no firm conclusions. The American Academy of Pediatrics issued the following recommendation in March 2000: "The potential for permanent cognitive impairment from heading the ball needs to be explored further. Currently, there seems to be insufficient published data to support a recommendation that young soccer players completely refrain from heading the ball. However, adults who supervise participants in youth soccer should minimize the use of the technique of heading the ball until the potential for permanent cognitive impairment is further delineated." In July of 2003 the National Federation of State High School Associations approved a rule that will allow soccer players to wear a head guard. Prior to this

rule only goalkeepers could wear such a device. The National Center will keep abreast of this controversial area.

In 2005 there was another case of a child being struck by the goal post and dying. A 15 year old male was struck in the head by a goal post that fell over and struck him in the head. This type of accident should never happen. The Consumer Product Safety Commission has stated that there have been at least 34 deaths and 51 injuries from falling soccer goal posts between 1979 and 2008. The latest was an eight year-old boy who was hit by the goal post cross bar. Most occurred with moveable goal posts and resulted from errors in moving the structures or anchoring them. Soccer goal posts should be anchored to the ground and only moved by responsible adults. Players should not climb on the goal posts or hang on the crossbars.

Field Hockey

In 1988 field hockey was associated with its first catastrophic injury since the study began in 1982. It was listed as a serious injury at the college level. The athlete was struck by the ball after a free hit. She received a fractured skull, had surgery and has recovered from the injury. The 1996 data showed two field hockey direct injuries at the high school level. Both injuries involved being hit by the ball and resulted in a head and an eye injury. The 1999 data show one non-fatal injury at the high school level and one serious injury at the college level. The high school injury involved the loss of an eye after being hit with the stick during a drill, and the college injury resulted in a fractured skull after being hit by a ball. There were no direct catastrophic injuries in high school or college field hockey during the 2006 season. There have been no indirect catastrophic injuries in field hockey since the beginning of the study in 1982.

Water Polo

In 1992-93 high school water polo was associated with its first indirect fatality and in 1988-89 college water polo had its first indirect fatality. There have been a total of four high school indirect fatalities in water polo and one at the college level. There were no water polo fatalities in 2006..

Fall Summary

In summary, high school fall sports in 2006 were associated with 20 direct catastrophic injuries. All twenty were associated with football. Football had one fatality, fifteen involved permanent disability, and four were considered serious. For the 25-year period 1982-2006, high school fall sports had 623 direct catastrophic injuries and 603, or 96.8%, were related to football participants. In 2006 high school fall sports were also associated with twelve football indirect fatalities and two in cross country for a total of fourteen indirect fatalities. For the period from 1982-2006 there was a total of 231 indirect fall high school catastrophic injuries. Two-hundred and thirty of the indirect injuries were fatalities and 171 were related to football. Fifteen of the indirect fatalities involved females – six soccer players, one water polo player, and eight cross-country athletes. Females were also associated with four direct catastrophic injuries – three in field hockey and one in soccer

During the 2006 college fall sports season there were six direct catastrophic injuries- all in football. For the 25 years, 1982-2006, there was a total of 139 college direct fall sport catastrophic injuries, and 133 were associated with football. Three were associated with soccer and three with field hockey. There were two indirect college fatalities during the fall of 2006 and they were associated with football. From 1982 through the 2006 fall season there were a total of 49 college fall sport indirect catastrophic injuries, and 48 of them were fatalities. Forty-one of the indirect fatalities were associated with football.

High school football accounted for the greatest number of direct catastrophic injuries for the fall sports, but high school football was also associated with the greatest number of participants. There are approximately 1,500,000 high school and middle school football players participating each year. As illustrated in Table II, the 25-year rate of direct injuries per 100,000 high school and middle school football participants was 0.30 fatalities, 0.75 non-fatal injuries and 0.72 serious injuries. These catastrophic injury rates for football are higher than those for both cross-country and soccer, but all three classifications of catastrophic football injuries have an injury rate of less than one per 100,000 participants. Table IV shows that the indirect fatality

rates for high school football, soccer and cross country are similar and are also less than one per 100,000 participants. Water polo rates are higher, but are based on only fifteen years of data, and water polo has approximately 24,000 male and female participants each year.

College football has approximately 75,000 participants each year and the direct injury rate per 100,000 participants is higher than the other fall sports. The rate for the 25-year period indicated in Table VI, for college football fatalities is less than one per 100,000 participants, but the rate increases to 1.89 per 100,000 for non-fatal injuries and 4.80 per 100,000 participants for serious injuries.

Indirect fatality rates are similar in college cross-country and soccer, increase in football, with water polo being associated with the highest indirect fatality rate. Based on 19 years of data, water polo has approximately 1700 participants each year (Table VIII).

There were four college female athletes receiving a direct catastrophic injury in a fall sport for this 25-year period of time. There was one non-fatal injury and two serious injuries in field hockey, and one non-fatal injury in soccer. There were also three female indirect deaths and all three were in soccer.

Incidence rates are based on 25-year participation figures received from the National Federation of State High School Associations and the National Collegiate Athletic Association. (Figure I)

Winter Sports (Tables IX - XVI)

As shown in Table IX, high school winter sports were associated with four direct catastrophic injuries in 2006-2007.Basketball was associated with one serious, and wrestling had two non-fatal and one serious..

High school winter sports were also associated with three indirect fatalities during the 2006-2007 school year (Table XI). Basketball was associated with all three fatalities.

College winter sports, Tables XIII - XVI, were not associated with any direct catastrophic injuries during the 2006-2007 school year. During this same time period there were three

indirect fatalities. Two of the indirect fatalities were associated with basketball, and one in swimming. The swimming fatality was a female.

A summary of high school winter sports, 1982-1983 – 2006-2007, show a total of 123 direct catastrophic injuries (8 fatalities, 66 non-fatal, and 49 serious) and 149 indirect. Wrestling was associated with 58 or 47.2 % of the direct injuries. Gymnastics was associated with 13, or 10.6%, of the direct injuries. Basketball was associated with 19 (15.4%), ice hockey was associated with 19 (15.4%), swimming was associated with 13 (10.6%) direct injuries, and volleyball one (0.81%). Basketball accounted for the greatest number of indirect fatalities with 112, or 75.2%, of the winter total.

College winter sports from 1982-1983 – 2006-2007 were associated with a total of 30 direct catastrophic injuries. Gymnastics was associated with six (20.0%), ice hockey 12 (40.0%), basketball nine (30.0%), swimming one (3.3%), skiing one (3.3%) and wrestling one (3.3%). There were also 43 indirect injuries (41 fatalities) during this time period. Twenty-nine, or 67.4%, were associated with basketball, three in wrestling, two in ice hockey, six in swimming, one in skiing, one in gymnastics, and one in volleyball.

High school wrestling accounted for the greatest number of winter sport direct injuries, but the injury rate per 100,000 participants was less than one for all three categories. High school wrestling has averaged approximately 239,000 male and 1,600 female participants each year. High school basketball and swimming were also associated with low direct injury rates. As shown in Table X, ice hockey and gymnastics were associated with the highest injury rates for the winter sports. Gymnastics has averaged approximately 3,800 males and 24,000 female participants during the past twenty-five years. Ice hockey averages 27,000 male and 2,556t female participants each year. A high percentage of the ice hockey injuries involve a player being hit by an opposing player, usually from behind, and striking the skate rink boards with the top of his/her head.

Indirect high school catastrophic injury rates, as indicated in Table XII, are all below one per 100,000 participants.

Catastrophic direct injury rates for college winter sports are higher when compared to high school figures. Gymnastics had five non-fatal and one serious injury for the past twenty-five years, but the injury rate is 20.07 per 100,000 participants for non-fatal male injuries, and 5.35 per 100,000 for female non-fatal injuries. Participation figures show approximately 597 male and 1,493 female gymnastic participants each year.

College ice hockey was associated with eight serious and four non-fatal injuries in twenty-five years, but the injury rate is 4.18 per 100,000 male participants for non-fatal and 7.32 for male serious injuries. There are approximately 3,800 male ice hockey participants each year. The first female college ice hockey player received a direct serious injury during the 1999-2000 season. The serious injury rate for females was 6.49 injuries per 100,000 participants and females averaged approximately 616 participants per year for the past 25 years. Swimming non-fatal incidence rates were not as high as gymnastics or ice hockey, but could be totally eliminated if swimmers would not use the racing dive into the shallow end of pools during practice or meets. In fact there has not been a direct injury in college swimming since the one non-fatal injury in 1982-1983.

College wrestling had only one direct catastrophic injury from the fall of 1982 to the spring of 2007. For this period of time there were 169,043 participants in college wrestling for an average of approximately 6761 per year. The injury rate for this twenty-five year period of time was 0.59 per 100,000 participants. College skiing has approximately 580 female participants each year and the one fatality in 1989-1990 produced an eighteen-year injury rate of 6.89 per 100,000 participants. This was the only skiing direct fatality since the study was initiated.

Injury rates for male college indirect fatalities were high when compared to the high school rates. Basketball had an injury rate of 6.99 fatalities per 100,000 male participants, skiing 6.11, ice hockey 1.05, and swimming 2.57. The year 1997-98 was the first year there were any indirect fatalities in wrestling. There were three deaths due to heat stroke associated with

wrestlers trying to make weight for a match. The indirect injury rate for wrestling was 1.77 per 100,000 participants.

The female indirect injury rate for basketball was 0.96 per 100,000 participants, 0.60 per 100,000 for volleyball, 0.45 for swimming and 2.68 for gymnastics.

Spring Sports (Tables XVII - XXIV)

High school spring sports were associated with five direct catastrophic injuries in 2007. There were three catastrophic injuries in baseball, one in lacrosse, and one in track. High school spring sports were also associated with seven indirect fatalities in 2007. Three of the indirect fatalities were in lacrosse and four in track.

College spring sports were not associated with any direct catastrophic injuries in 2007. - There were also no indirect fatalities in college spring sports..

From 1983 through 2007, high school spring sports were associated with 118 direct catastrophic injuries (Table XVII). Thirty-three were listed as fatalities, 39 as catastrophic non-fatal and 46 as serious. Baseball accounted for 47, track 59, lacrosse nine, and softball three. Injury rates were less than one per 100,000 participants for each sport in all categories. There were seven direct injuries to females in track, three in softball, and one in lacrosse. There were also 59 indirect fatalities in high school spring sports during this time span (Table XIX). Thirty-four were related to track, 14 in baseball, seven in lacrosse and three in tennis. There was also one serious indirect injury in golf. Six of the indirect fatalities involved female track athletes.

As illustrated in Table XXI, college spring sports were associated with 35 direct catastrophic injuries from 1983 to 2007. Eleven of these injuries resulted in fatalities, 13 were listed as non-fatal and 11 were listed as serious. Baseball accounted for twelve injuries, lacrosse eleven, track ten, softball one, and equestrian one. College females were associated with two non-fatal injuries in lacrosse, one in track, and one fatality in equestrian. Table XXIII shows that there were also ten indirect fatalities in college spring sports during this time. Two indirect

fatalities were associated with tennis, one was associated with track, two in baseball, three in rowing, and two in lacrosse. There was one female fatality in tennis.

Injury rates for high school spring sport direct injuries were low as illustrated in Table XVIII. Baseball participation reveals an average of approximately 417,000 male players and 900 female players each year, track 506,000 males and 409,000 females, and tennis 139,000 males and 145,000 females. The baseball figures do not include the 310,000 female softball participants each year (plus 1,100 males).. Lacrosse has approximately 31,000 male and 21,000 female participants each year. Injury rates, as shown in Table XX, for high school indirect injuries are also low.

College spring sports, Table XXII, are related to low injury rates for direct injuries, with the exception of equestrian and men's lacrosse. Men's lacrosse had four fatalities, three non-fatal and two serious injuries and the injury rates were higher than the other college spring sports. Female lacrosse players were associated with two non-fatal injuries and female track (pole vault) was associated with one non-fatal injury. Equestrian was associated with a female fatality. Participation figures reveal approximately 5,696 men and 3,972 women lacrosse players each year. The 1991 and 2003 injuries were to female lacrosse players.

Rates for indirect college fatalities in baseball, tennis, and track are low with lacrosse being slightly higher. There were two indirect tennis fatalities, one male and one female, but participation figures are low. Men average approximately 7,600 and women 7,800 participants each year. Rowing had the highest indirect injury rate at 25.65 injuries per 100,000 male participants and 0.00 for female participants. There are approximately 1,950 male rowers and 6,700 female rowers each year.(Table XXIV)

Discussion

Football is associated with the greatest number of catastrophic injuries for all sports, but the incidence of injury per 100,000 participants is higher in both gymnastics and ice hockey. There have been dramatic reductions in the number of football fatalities and non-fatal

catastrophic injuries since 1976 and the 1990 data illustrated an historic decrease in football fatalities to zero. This is a great accomplishment when compared to the 36 fatalities in 1968. This dramatic reduction can be directly related to data collected by the American Football Coaches Association Committee on Football Injuries (1931-2007) and the recommendations that were based on that data. Non-fatal football injuries, permanent disability, decreased to one for college football in 1995, 1999, 2004, and 2005. There was a dramatic reduction in high school football from 13 in 1990 and 1993 to six in 2002 and five in 2005. There was an increase to eleven in 1995 and 1996, and 14 in 1997. The 2006 data shows 15 non-fatal injuries (head and neck combined) and one fatality in high school football. The 15 non-fatal injuries is the highest number since the 1989 season when there were 18. Fifteen is a dramatic increase over the six high school non-fatal injuries in 2005. Permanent disability injuries in football have seen dramatic reductions when compared to the data from the late 1960's and early 1970's, but a continued effort must be made to eliminate these injuries. In addition, there were four serious injuries in high school football in 2006 . All of the serious cases involved head or neck injuries and in a number of these cases excellent medical care saved the athlete from permanent disability or death. College football in 2006 was associated with a total of six catastrophic injuries – zero fatalities, two non-fatal, and four serious.

Football catastrophic injuries may never be totally eliminated, but progress has been made. Emphasis should again be focused on the preventive measures that received credit for the initial reduction of injuries.

1. The 1976 rule change which prohibited initial contact with the head in blocking and tackling. There must be continued emphasis in this area by coaches and officials.
2. The NOCSAE football helmet standard that went into effect at the college level in 1978 and at the high school level in 1980. There should be continued research in helmet safety.
3. Improved medical care of the injured athlete. An emphasis on placing certified athletic trainers in all high schools and colleges. There should be a written emergency plan for catastrophic injuries both at the high school and college levels.

4. Improved coaching technique when teaching the fundamental skills of blocking and tackling.

Keeping the head out of blocking and tackling!

A major concern in football fatalities has been the number of indirect deaths due to heat stroke, both at the college and high school levels. During the past ten years there have been 25 heat stroke deaths in football. This number is unacceptable since heat stroke deaths are preventable with the proper precautions. Every effort should be made to continuously educate coaches concerning the proper procedures and precautions when practicing or playing in the heat. In the Annual Survey of Football Injury Research – 1931-2006 there are recommendations for safety during football activity in hot weather. New regulations by the National Collegiate Athletic Association for volunteer summer conditioning programs and pre-season football practice went into effect during the 2003 season and it will be very interesting to see how they effect heat related injuries at the college level.

It should be noted that from 1979 to 2008, according to the Consumer Product Safety Commission, there have been 34 deaths and 51 injuries from movable soccer goals. The most recent case involved an eight year-old male playing on a soccer goal when it tipped over and hit his head, causing his death. There has been one fatality in this study, which involved a college athlete hanging on a soccer goal and the goal falling and striking the victim's head.

On May 4, 1999, the Consumer Product Safety Commission and the soccer goal industry announced the development of a new safety standard that will reduce the risk of soccer goal tip-over. The 'Provisional Safety Standard and Performance Specification for Soccer Goals" (ASTM-PS-75-99) requires that movable soccer goals, except very lightweight goals, not tip over when the goal is weighted in a downward or horizontal direction. The standard also specifies warning labels must be attached to the goal, such as: "Warning: Always anchor goal. Unsecured goal can fall over causing serious injury or death." For a free copy of : "Guidelines

for Movable Soccer Goal Safety," send a postcard to CPSC, Washington, DC 20207. Also available online: http:cpsc.gov.

A Loss Control Bulletin from K & K Insurance Group, Inc., Fort Wayne, IN, suggests the following safeguards:

1. Keep soccer goals supervised and anchored.
2. Never permit hanging or climbing on a soccer goal.
3. Always stand to the rear or side of the goal when moving it - NEVER to the front.
4. Stabilize the goal as best suits the playing surface, but in a manner that does not create other hazards to players.
5. Develop and follow a plan for periodic inspection and maintenance (e.g., dry rot, joints hooks).
6. Advise all field maintenance persons to re-anchor the goal if moved for mowing the grass or other purposes.
7. Remove goals from field no longer in use for the soccer program as the season progresses.
8. Secure goals well from unauthorized access when stored.
9. Educate and remind all players and adult supervisors about the past tragedies of soccer goal fatalities.

There is also a list of guidelines available for movable soccer goal safety and warning labels. To obtain a copy contact the following:

The Coalition to Promote Soccer Goal Safety
C/O Soccer Industry Council of America
200 Castlewood Drive
North Palm Beach, FL 33408

High school wrestling, gymnastics, ice hockey, baseball and track should receive close attention. Wrestling has been associated with 58 direct catastrophic injuries during the past twenty-five years. Due to the fact that college wrestling was only associated with one

catastrophic injury during this same time period, continued research should be focused on the high school level. High school wrestling coaches should be experienced in the teaching of the proper skills of wrestling and should attend coaching clinics to keep up-dated on new teaching techniques and safety measures. They should also have experience and training in the proper conditioning of their athletes. These measures are important in all sports, but there are a number of contact sports, like wrestling, where the experience and training of the coach is of the utmost importance. Full speed wrestling in physical education classes is a questionable practice unless there is proper time for conditioning and the teaching of skills. The physical education teacher should also have expertise in the teaching of wrestling skills. It should also be emphasized that wrestling coaches need to be aware of the dangers associated with athletes making weight. Improper weight reduction can lead to serious injuries and death. During the 1997-1998 academic year there were three college wrestlers that died while trying to make weight for a match. All three died of heat stroke complications. These were the first wrestling deaths associated with weight reduction; however, there is no information on the number of wrestlers who had medical problems associated with weight loss, but recovered. All three of these wrestlers were trying to lose large amounts of weight in a short period of time. All three were also working out in areas of high heat, and were all wearing sweat clothes or rubber suits. Making weight has always been a part of the wrestling culture, but it is dangerous and life threatening. New rule changes went into effect for the 1998-99 high school and college seasons, and hopefully, making weight will be a thing of the past and will never result in the deaths of young high school or college athletes. A significant rule change approved by the NFHS Board of Directors in April 2005, states that in 2006-07 stronger guidelines discouraging rapid weight loss will take effect. The revised rule includes a specific gravity not to exceed 1.025, a body fat assessment no lower than 7 percent (males)/12 percent (females) and a monitored, weekly weight loss plan not to exceed 1.5% a week.

There is also a national trend for an increased number of females participating in wrestling. In 2006-2007 there were 5,048 females in high school wrestling.

Men's and women's gymnastics and ice hockey were associated with higher injury rates at both the high school and college levels. Gymnastics needs additional study at both levels of competition. Both levels have seen a dramatic participation reduction and this trend may continue with the major emphasis being in private clubs. Lacrosse also had a higher injury rate at the college level.

Ice hockey injuries are low in numbers but the injury rate per 100,000 participants is high when compared to other sports. Ice hockey catastrophic injuries usually occur when an athlete is struck from behind by an opponent, slides across the ice in a prone position, and makes contact with the crown of his/her head and the boards surrounding the rink. The results are usually fractured cervical vertebrae with paralysis. Research in Canada has revealed high catastrophic injury rates with similar results. After an in-depth study of ice hockey catastrophic injuries in Canada, Dr. Charles Tator has made the following recommendations concerning prevention:

1. Enforce current rules and consider new rules against pushing or checking from behind
2. Improve strength of neck muscles.
3. Educate players concerning risk of neck injuries.
4. Continued epidemiological research.

Catastrophic injuries in swimming were all directly related to the racing dive in the shallow end of pools. There has been a major effort by both schools and colleges to make the racing dive safer and the catastrophic injury data support that effort. There has not been a college injury for the past 24 years. High school swimming has been associated with 13 catastrophic injuries and the racing dive in the shallow end of the pool has been involved in all cases. It is a fact that the swimming community has been made aware of the problem with the racing dive into the shallow end of the pool, and hopefully along with rule changes and coach's awareness, the number of direct catastrophic injuries in swimming will be reduced. The competitive racing start has changed and now involves the swimmer getting more depth when entering the water. Practicing or starting competition in the deep end of the pool or being extremely cautious could eliminate catastrophic injuries caused by the swimmer striking his/her head on the bottom of the

pool. The National Federation of State High School Associations Swimming and Diving Rules Book (Rule 2-7-2) states that in pools with water depth less than three and one-half feet at the starting end, swimmers will have to start the race in the water. The rules read that in four feet or more of water, swimmers may use a starting platform up to a maximum of 30 inches above the water, and the pool depth shall be measured for a distance of 16 feet, 5 inches from the end wall. Between three and one-half and less than four feet, swimmers start from the pool deck or in the water The National Collegiate Athletic Association and USA Swimming have or are in the process of moving standards for use of starting blocks to a minimum depth of five feet. In April 1995 the National Federation revised rule 2-7-2, which now states that starting platforms shall be securely attached to the deck/wall in pools with water depth of four feet or more in the starting end. If they are not, they shall not be used and deck or in-water starts will be required. These new rules point out the importance of constant data collection and analysis. Rules and equipment changes for safety reasons must be based on reliable injury data. The National Center has not received any information concerning high school or college direct catastrophic swimming injuries during the 2006-2007 season.

High school spring sports have been associated with low incidence rates during the past twenty-five years, but baseball was associated with 47 direct catastrophic injuries and track 59. A majority of the baseball injuries have been caused by the head first slide or by being struck with a thrown or batted ball. If the headfirst slide is going to be used, proper instruction should be involved. Proper protection for batting practice should be provided for the batting practice pitcher and he/she should always wear a helmet. This should also be true for the batting practice coach. During the 2007 baseball season three high school pitchers were stuck in the head with batted balls. One pitcher recovered, one injury was non-fatal at the time of this writing, and one died One injury took place in a scrimmage game, one in batting practice, and one in a batting cage. A new rule in fast pitch soft ball will require players to wear batting helmets equipped with NOCSAE approved facemasks/guards. The rule went into effect January 1, 2006.

The pole vault was associated with a majority of the fatal track injuries. There have been 18 high school and college fatal pole-vaulting injuries from 1983 to 2006. This includes the high school coach who was demonstrating in 1998, bounced out of the pit, struck his head on concrete, and died. In addition to the fatalities there were also eleven permanent disability (8 high school and 3 college) and seven serious injuries (5 high school, one college, and one middle school). All 36 of these accidents involved the vaulter bouncing out of or landing out of the pit area. The three pole vaulting deaths in 1983 were a major concern and immediate measures were taken by the National Federation of State High School Associations. Beginning with the 1987 season all individual units in the pole vault landing area had to include a common cover or pad extending over all sections of the pit.

In 2001 there was a pole vaulting injury to a female college athlete. The athlete was vaulting indoors, bounced out of the pit, and hit her head on the floor. She had an epidural hematoma and a posterior skull fracture. At the time of the accident it was not possible to determine the extent of any long-term disability. There was one pole vaulting injury in 2005 and none in 2006 and 2007

Whenever there is a pole vaulting death there are more proponents of eliminating the event. The crux of the opposition appears to be the potential liability and also the lack of qualified coaches to teach the pole vault. Additional recommendations in the 1991 rule book included stabilizing the pole-vault standards so they cannot fall into the pit, pad the standards, remove all hazards from around the pit area, and control traffic along the approach. Obvious hazards like concrete or other hard materials around the pit should be eliminated. In the National Federation of State High Schools Track and Field Rules Book, Section 4, Article10, it states as follows: Hard or unyielding surfaces, such as but not limited to concrete, metal, wood or asphalt around the landing pad, or between the planting box and the landing pad, shall be padded or cushioned with a minimum of two (2) inches of dense foam or other suitable material. It is also recommended that any excess material such as asphalt or concrete that extends out from beneath the landing pad be removed.

Due to the numbers of pole vaulting injuries there have also been a number of recommendations stating that pole vaulters should wear helmets. The National Federation of State High School Associations has made the following statement concerning pole vaulting helmet use: The NFHS has been asked if it would be permissible for high school students to wear some type of helmet while pole vaulting and they stated that it would be permissible for an athlete to wear a helmet of his/her choosing without violating the NFHS rules. A helmet designed exclusively for pole vault, the KDMax, was released in October 2004. Six state high school associations already require some type of helmet for pole vaulters, and 30 states indicated on the 2004 NFHS track and field survey that they would support mandatory helmet use if a national standard was in place. In the NCAA helmets will continue to be an option for pole vaulters.

It has been estimated that there are approximately 25,000 high school pole vaulters annually. If this number were correct, the catastrophic injury rate for high school pole vaulters would be higher than any of the sports included in the research. High school coaches and officials should be aware of the National Federation rules pertaining to the pole vault.

There have also been 23 accidents in high school track involving participants being struck by a thrown discus, shot put or javelin. In 1992, a female athlete was struck by a thrown discus in practice and died. In 1993, a track manager was struck in the neck by a javelin, but he was lucky and completely recovered from the accident. In 1994, a female track athlete was struck in the face by a javelin and will recover. In 1995, a male athlete was struck in the head by a shot put during warm-ups and had a fractured skull. In 1997, a male athlete was struck by a discus and died. In 1998 a female athlete was struck by a discus and died, and a male athlete was struck in the head by a shot-put and recovered. In 1999 a male athlete was struck by a javelin and a female athlete was struck by a discus. In 2000 a junior high school athlete was struck in the head by a discus and has permanent disability. In 2001 a high school athlete was struck in the cheek with a javelin during practice. In 2002 there were three athletes struck by a shot putt and one by a discus. In 2002 there was also a coach that was struck by a shot putt. In 2004 a

male track athlete was hit in the head with a shot putt and was in critical condition. In 2005 a track athlete was impaled with a javelin in the shoulder. In 2006 a male track athlete was hit in the head with a javelin which went four inches into his brain. He was very lucky and recovered. In 2007 a female track athlete was struck in the ankle by a javelin and needed a bone graft. There have also been spectators struck by the discus during high school meets. On June 23, 2005, a 77 year old official died after being struck in the head by a shot put while athletes were practicing for the US championships. Safety precautions must be stressed for these events in both practice and competitive meets with the result being the elimination of this type of accident. The National Federation of State High School Associations put a new rule in for the 1993 track season that fenced off the back and sides of the discus circle to help eliminate this type of accident. Good risk management should eliminate these types of accidents. These types of injuries are not acceptable and should never happen.

The fatality in high school lacrosse during the 1987 season was associated with a player using his head to strike the opponent. He struck the opponent with the top or crown of his helmet. This technique is prohibited by the lacrosse rules and should be strictly enforced. In 2002 a high school lacrosse player was also blocking and suffered permanent paralysis. Lacrosse has been a fairly safe sport when considering the fact that high school lacrosse has been involved with nine direct catastrophic injuries in twenty-five years. A possible new area of concern is the recent lacrosse deaths being associated with players being struck in the chest with the ball and causing death (commotio cordis). There have been seven cases (6 deaths) (two high school, one high school club, three college, and one lacrosse summer camp) in the past nine years. The most recent commotio cordis death happened when the player was struck in the chest with the opponents stick. Currently there is research being funded by the National Operating Committee for Standards in Athletic Equipment that is studying chest protectors to help reduce commotio cordis fatalities. The lacrosse community will have to keep a close watch on these types of deaths and possibly carry out in-depth evaluations of these injuries.

There was a female college lacrosse player in 1993 that was hit in the eye with a ball and had permanent vision damage. In the spring of 2004 protective eyewear was required for all high school participants in states that follow NFHS rules, and for all competitors at the NCAA championships. In 2005, the requirement was extended to the entire season for all NCAA teams. Early reports indicate a major reduction in eye injuries for female lacrosse players.

College spring sports are also associated with a low injury incidence. Injury rates are slightly higher in lacrosse but the participation figures are so low that even one injury will increase the incidence rate dramatically. It is important to point out that there have been nine college male and two female lacrosse catastrophic injuries during the past twenty-five years. The college death in 2005 involved a male player being struck in the neck by a ball. In a college club lacrosse game on October 15. 2005, there was a non-fatal catastrophic injury to a male participant. He was hit with a point blank range shot off of his helmet. The injury was a subdural hematoma and the athlete had surgery. There have been questions concerning the particular helmet the player was wearing at the time. There were no direct or indirect college lacrosse injuries in the 2006-2007 school year. It should be mentioned that there is general concern about concussion injuries in lacrosse, and according to a study from Temple University, female lacrosse players have the highest percentage of concussions during a game, followed by women's soccer.

For the twenty-five year period from the fall of 1982 through the spring of 2007 there have been 1068 direct catastrophic injuries in high school and college sports. High school sports were associated with 149 fatalities, 369 non-fatal and 346 serious injuries for a total of 864. College sports accounted for 22 fatalities, 63 non-fatal and 119 serious injuries for a total of 204. During this same twenty-five year period of time there have been a total of 541 indirect injuries and all but eleven resulted in death. Four hundred and thirty-nine of the indirect injuries were at the high school level and 102 were at the college level. It should be noted that high school annual athletic participation (for sports with catastrophic injuries) for 2006-2007 includes

approximately 7,445,742, athletes (4,605,347 males and 2,840,395 females). National Collegiate Athletic Association participation (for those sports with catastrophic injuries) for 2006-2007 was 404,728athletes. There were 245,512 males and 159,216 females.

During the twenty- five year period from the fall of 1982 through the spring of 2007 there have been 147,115,293 high school athletes participating in the sports covered by this report. Using these participation numbers would give a high school direct catastrophic injury rate of 0.59 per 100,000 participants. The indirect injury rate is 0.30 per 100,000 participants. If both direct and indirect injuries were combined the injury rate would be 0.89 per 100,000. This means that approximately one high school athlete out of every 100,000 participating would receive some type of catastrophic injury. The combined fatality rate would be 0.39 per 100,000, the non-fatal rate 0.25, and the serious rate 0.24.

During this same time period there were approximately 8,029,283 college participants with a total direct catastrophic injury rate of 2.54 per 100,000 participants. The indirect injury rate is 1.27 per 100,000 participants. If both indirect and direct injuries were combined the injury rate would be 3.81. The combined fatality rate would be 1.51, the non-fatal rate 0.81, and the serious rate 1.49.

Female Catastrophic Injuries

There have been a total of 112 direct and 60 indirect catastrophic injuries to high school and college female athletes from 1982-83 – 2006-2007, which includes cheerleading. Eighty of these were direct injuries at the high school level and 32 at the college level. The 80 high school direct injuries included nine in gymnastics, 44 in cheerleading, five in swimming, four in basketball, seven in track, three in softball, three in field hockey, two in ice hockey, one in lacrosse, one in soccer, and one in volleyball. The 50 high school indirect fatalities included twelve in basketball, eight in swimming, six in track, six in soccer, eight in cross country, two in volleyball, one in water polo, and seven in cheerleading. The 32 college direct injuries were associated with cheerleading(19), gymnastics(2), field hockey(3), soccer(1), skiing(1), ice

hockey(1), track (pole vault)(1), equestrian(1), softball(1), and lacrosse(2). The ten college indirect fatalities included one in tennis, three in basketball, three in soccer, one in gymnastics, one in swimming, and one in volleyball. Catastrophic injuries to female athletes have increased over the years. As an example, in 1982-83 there was one female catastrophic injury and during the past 25 years there has been an average of 6.94 per year. A major factor in this increase has been the change in cheerleading activity, which now involves gymnastic type stunts. If these cheerleading activities are not taught by a competent coach and keep increasing in difficulty, catastrophic injuries will continue to be a part of cheerleading. High school cheerleading accounted for 55.0% of all high school direct catastrophic injuries to female athletes (two males not included) and 59.4% at the college level (four males not included). Of the 112 direct catastrophic injuries to high school and college female athletes from 1982-83 – 2006-2007, cheerleading was related to 63 or 56.3%. The cheerleading numbers have been updated from previous reports and male cheerleaders were not included. Read the special section on cheerleading.

Athletic administrators and coaches should place equal emphasis on injury prevention in both female and male athletics. Injury prevention recommendations are made for both male and female athletes.

Athletic catastrophic injuries may never be totally eliminated, but with reliable injury data collection systems and constant analysis of the data these injuries can be dramatically reduced.

TABLE 1

HIGH SCHOOL FEMALE DIRECT CATASTROPHIC INJURIES

1982-83 – 2006-07

SPORT	FATALITY	NON-FATAL	SERIOUS	TOTAL
Cheerleading*	2	13	29	44
Gymnastics	0	6	3	9
Track	1	1	5	7
Swimming	0	4	1	5
Basketball	0	1	3	4
Ice Hockey	0	0	2	2
Field Hockey	0	3	0	3
Softball	1	2	0	3
Lacrosse	0	0	1	1
Soccer	0	1	0	1
Volleyball	0	1	0	1
TOTAL	**4**	**32**	**44**	**80**

* Cheerleading does not include two males

TABLE 2

HIGH SCHOOL FEMALE INDIRECT CATASTROPHIC INJURIES

1982-83 – 2006-07

SPORT	FATALITY	NON-FATAL	SERIOUS	TOTAL
Basketball	11	0	1	12
Swimming	7	0	1	8
Cheerleading	7	0	0	7
Cross Country	8	0	0	8
Soccer	6	0	0	6
Track	6	0	0	6
Volleyball	1	1	0	2
Water Polo	1	0	0	1
TOTAL	**47**	**1**	**2**	**50**

TABLE 3

COLLEGE FEMALE DIRECT CATASTROPHIC INJURIES

1982-82 – 2006-07

SPORT	FATALITY	NON-FATAL	SERIOUS	TOTAL
Cheerleading*	1	5	13	19
Field hockey	0	1	2	3
Lacrosse	0	2	0	2
Gymnastics	0	2	0	2
Equestrian	1	0	0	1
Soccer	0	1	0	1
Ice Hockey	0	0	1	1
Skiing	1	0	0	1
Track (Pole Vault)	0	1	0	1
Softball	0	0	1	1
TOTAL	**3**	**12**	**17**	**32**

*Cheerleading does not include four males

TABLE 4

COLLEGE FEMALE INDIRECT CATASTROPHIC INJURIES

1982-83 – 2006-07

SPORT	FATALITY	NON-FATAL	SERIOUS	TOTAL
Soccer	3	0	0	3
Basketball	3	0	0	3
Tennis	1	0	0	1
Volleyball	1	0	0	1
Gymnastics	1	0	0	1
Swimming	1	0	0	1
TOTAL	**10**	**0**	**0**	**10**

Recommendations for Prevention

1. Mandatory medical examinations and a medical history taken before allowing an athlete to participate.
2. All personnel concerned with training athletes should emphasize proper, gradual and complete physical conditioning in order to provide the athlete with optimal readiness for the rigors of the sport.
3. Every school should strive to have a certified athletic trainer who is a regular member of the faculty and is adequately prepared and qualified. There should be a written emergency procedure plan to deal with the possibility of a catastrophic injury.
4. There should be an emphasis on employing well trained athletic personnel, providing excellent facilities and securing the safest and best equipment available.
5. There should be strict enforcement of game rules and administrative regulations should be enforced to protect the health of the athlete. Coaches and school officials must support the game officials in their conduct of the athletic contests.
6. Coaches should know and have the ability to teach the proper fundamental skills of the sport. This recommendation includes all sports, not only football. The proper fundamentals of blocking and tackling should be emphasized to help reduce head and neck injuries in football. **Keep the head out of blocking and tackling.**
7. There should be continued safety research in athletics (rules, facilities, equipment).
8. Strict enforcement of the rules of the game by both coaches and game officials will help reduce serious injuries.
9. When an athlete has experienced or shown signs of head trauma (loss of consciousness, visual disturbance, headache, inability to walk correctly, obvious disorientation, memory loss) he/she should receive immediate medical attention and should not be allowed to return to practice or game without permission from the proper medical authorities. It is important for a physician to observe the head injured athlete for several days following

the injury. Coaches should encourage athletes to let them know if they have any of the above mentioned symptoms (that can't be seen by others, such as headaches) and why it is important.

10. Athletes and their parents should be warned of the risks of injuries.
11. Coaches should not be hired if they do not have the training and experience needed to teach the skills of the sport and to properly train and develop the athletes for competition.
12. Weight loss in wrestling to make weight for a match can be dangerous and cause serious injury or death. Coaches should be aware of safety precautions and rules associated with this practice.

*****SPECIAL NOTE*****

All of the information has been thoroughly checked and the data cleaned. Some of the numbers in Tables I - XXIV have been changed due to this process. All of the data in this report now meet the stated definition of injury for high school and college sports. It is important to note that information is constantly being updated due to the fact that catastrophic injury information may not always reach the center in time to be included in the current final report. The report includes data that is reported to the NCCSIR by the NCAA, the NFHS, a national newspaper clipping service, colleagues, coaches, and athletic trainers. There may be additional catastrophic injuries that are not reported to the Center.

References

1. TATOR CH, EDMONDS VE: National Survey of Spinal Injuries in Hockey Players, Canada Medical Association 1984; 130: 875-880.

CASE STUDIES

FOOTBALL

High school and college case studies in football are not duplicated for this report. They are included in the football reports on the www site – www.unc.edu/depts/nccsi

CROSS COUNTRY

HIGH SCHOOL

A 16 year-old high school junior died during a practice session on October 6, 2006. He had just completed running a warm-up mile and was walking off the track when he collapsed. Cause of death was related to a congenital heart problem.

A 16 year-old high school female collapsed and died on August 15, 2006. She collapsed shortly after the start of practice. Cause of death was a congenital heart defect. CPR was given to the victim by the coaches and paramedics, but she did not respond. A defibrillator was not available.

SOCCER

NONE

FIELD HOCKEY

COLLEGE

NONE

ICE HOCKEY

HIGH SCHOOL

NONE

SWIMMING

COLLEGE

A 19 year-old female college swimmer was found unconscious at the bottom of the pool during a practice session on 12/16/06. Circumstances and cause of death were not clear at the time of this writing. It was noted that the swimmer did have epilepsy. The swimmer was not feeling well during the practice and was told to get out of the water. No one saw her re-enter or fall into the water until she was seen at the bottom of the pool.

BASKETBALL

HIGH SCHOOL

A 14 year-old eighth grader collapsed while playing in a middle school game in the fall of 2006. The athlete died and the autopsy was inconclusive. The school did not have an automated external defibrillator, but the victim was given CPR.

An 18 year-old high school basketball player collapsed and died during a practice session on 11/29/06. Death was heart related. The victim's mother died of a genetic heart condition in November 2007.

A 15 year old high school ninth grader collapsed during a practice session on 12/6/06 and died on 12/13/06. Cause of death was a heart infection which resulted in a coma and loss of brain function.

A 17 year-old high school basketball player was undercut while going for a lay-up during a game in January 2007. He hit his head on the floor with the result being a fractured skull and a blood clot on the brain. He had surgery and a full recovery was expected.

UPDATE 2003 – Athlete was playing in a freshman game and was undercut going for a rebound. The accident took place in December of 2003. He fractured his lower spine and had eight hours of surgery in August of 2004. He has recovered and is playing football again.

COLLEGE

A college freshman collapsed in the locker room during halftime of a game on February 14, 2007. He died later at the hospital. An automated external defibrillator was on the campus but no one knew where it was. Cause of death was heart related.

A 21 year-old college basketball player collapsed during conditioning drills in October of 2006. He died later at the hospital. A preliminary autopsy showed a ruptured blood vessel to the heart. He received CPR on-site until the ambulance arrived.

WRESTLING

HIGH SCHOOL

A high school junior wrestler was injured in a match on January 12, 2007. He landed on his head and injured his neck when taken down. He was in the hospital and had paralysis from the chest down.

A high school wrestler fractured a cervical vertebra during a match 0n January 28, 2007. His opponent performed a barrel roll and drove the victim's head into the mat. He had a full recovery.

A 17 year old high school wrestler was injured during a match on March 10, 2007. He fractured cervical vertebrae 5-6 and had surgery. He was injured when taken down to the mat onto his head. At the present time he is paralyzed and is not expected to walk again.

LACROSSE

HIGH SCHOOL

A 14 year-old eighth grade lacrosse player collapsed during a non-contact drill and later died at the hospital. No other information was available.

An 18 year-old high school lacrosse player was hit in the chest by a hard shot on May 7, 2007. He was a defensive player and the shot hit him in the left lateral chest. He immediately collapsed, was not breathing, but did have a pulse on the initial first aid evaluation. Coaches tried to start CPR but could not get the mouth open. With CPR player coughed and spit out blood, started breathing, and seemed to feel fine. Was down for 5 to 6 minutes. Diagnosed with heart and lung contusion. Player has recovered.

A 14 year-old high school lacrosse player died from what was first believed to be a ball to the head during pre-game activity. He died of a cerebral artery aneurysm with no indication that he was struck with a lacrosse ball.

A 15 year-old high school lacrosse player collapsed during running drills and later died. Cause of death was cardiac sudden death.

A high school club lacrosse player died of commotio cordis after being hit with a legal stick check to the chest. Commotio cordis is a sudden disturbance of the heart's electrical rhythm usually caused by a blunt impact to the chest. The accident took place on 11/28/06 and he died on 11/30/06.

BASEBALL

HIGH SCHOOL

A 14 year-old high school baseball player was hit in the head by a line drive off of a metal bat. He was pitching varsity batting practice. Injuries included a fractured skull and bleeding in the brain. He was behind a safety screen at the time of the accident. At the present time he has impaired ability to speak and recovery is incomplete. Recovery is expected in the future.

A high school baseball player was injured on January 1, 2007 while pitching in a scrimmage game. He was hit in the right temple by a line drive and received a fractured skull, fractured bone behind the eye, fractured cheek bone, and a blood clot. He is recovering, but will have to wear protective face/head gear when he returns to play. Bat was metal.

A 17 year-old high school baseball player was injured on February 23, 2007 and died on February 25, 2007, after being hit by a line drive while pitching to a teammate in a batting cage. The ball was hit from another batting cage and went through both nets and hit the victim in the back of the head.

TRACK

HIGH SCHOOL

A 13 year-old female seventh grader became ill at track practice, collapsed, and later died of cardiac arrhythmia.

A high school track athlete collapsed during practice in April 2007 and later died. His death was thought to be heart related.

A high school track athlete was struck by lightning shortly before a track meet. He was 18 years old. Coaches and others tried to revive him, but he died by the time he reached the hospital.

An 18 year-old track athlete collapsed and died while running sprints with other athletes during practice. He did have asthma, but the cause of death was unknown.

A 14 year-old female track athlete was impaled by a javelin during a meet. She was going to get her javelin after a throw and was hit in the ankle by another thrower's javelin. She was walking outside the danger area when hit. She required a bone graft, but will recover.

VOLLEYBALL

HIGH SCHOOL

NONE

GOLF

HIGH SCHOOL

NONE

FIELD HOCKEY

HIGH SCHOOL AND COLLEGE

NONE

SOFTBALL

COLLEGE – 2006 UPDATE

A college softball player was hit in the face by a line drive while pitching in a game on March 9, 2006. She had a number of facial fractures and had surgery. She has recovered and returned to play in 2007.

A 12 year-old female was playing in a non-school traveling softball team practice when she was hit in the head by a ground ball. She was unconscious after being hit, and never regained consciousness.

TENNIS

HIGH SCHOOL AND COLLEGE

NONE

WATER POLO

HIGH SCHOOL AND COLLEGE

NONE

GYMNASTICS

HIGH SCHOOL AND COLLEGE

NONE

ROWING

HIGH SCHOOL AND COLLEGE

NONE

EQUESTRIAN

HIGH SCHOOL AND COLLEGE

NONE

Special Section on Cheerleading

The Consumer Product Safety Commission reported an estimated 4,954 hospital emergency room visits in 1980 caused by cheerleading injuries. By 1986 the number had increased to 6,911, in 1994 the number increased to approximately 16,000, in 1999 the number increased to 21,906, and in 2004 the number increased to 28,414. Granted, the number of cheerleaders has also increased dramatically during this time frame. It is important to stress that catastrophic injuries have also been a part of cheerleading during the last 25 years and coaches and administrators should be aware of the situation.

The National Center for Catastrophic Sports Injury Research has been collecting cheerleading catastrophic injury data during the past twenty-five years, 1982-83 – 2006-2007 (see Tables 5 and 6). There was one high school cheerleading catastrophic injury during the 2006-2007 school year. The athlete fractured cervical vertebrae six and seven, and had surgery. College cheerleaders were involved in two accidents during 2006-2007. Both cheerleaders fractured cervical vertebrae during a routine and had a full recovery.

Following is a sample review of the data:

1. In the early 1980's a female college cheerleader fractured her skull after falling from a human pyramid. She recovered and returned to cheerleading after several weeks in the hospital.
2. In 1983 two female college cheerleaders received concussions within a period of five days in the same gymnasium. One struck her head on the floor after falling from a pyramid and the second cheerleader struck her head on the floor after falling backward from the shoulders of a male partner.
3. In the summer of 1984 a female high school cheerleader was injured at practice when she fell from a pyramid. She was partially paralyzed.
4. A male college cheerleader was injured in a tumbling accident during a basketball game in December 1983. He fractured and dislocated several cervical vertebrae and was paralyzed. He received his injuries after diving over a mini-trampoline and several

cheerleaders. The stunt is called a dive into a forward roll. He has made progress and can now walk unaided for several blocks and is able to feed himself.

5. In 1985 a female high school cheerleader was paralyzed from the chest down after attempting a back flip off the back of another cheerleader.
6. In 1985 a female college cheerleader fractured her skull after a fall from the top of a pyramid striking her head on the gym floor. She was in critical condition for a period of time but has made progress and is back in school. She is now involved in occupational therapy.
7. A male college cheerleader was paralyzed after a fall in practice. He was attempting a front flip from a mini-trampoline. He dislocated several cervical vertebrae and is now quadriplegic.
8. In 1986 a female college cheerleader fell from a pyramid and was knocked unconscious after striking the floor. Her status was unknown at the time of this writing.
9. In 1986 a college female cheerleader died from injuries suffered in a cheerleading accident. She suffered multiple skull fractures and massive brain damage after falling from the top of a pyramid type stunt and striking her head on the gym floor.
10. In 1987 a 17-year-old high school cheerleader fell from a pyramid. She was tossed into the air by two other cheerleaders and was supposed to flip backwards and land on the shoulders of two other girls. Her spinal cord was not severed but she is paralyzed from the waist down.
11. During the 1987-1988 school year a female cheerleader suffered a fractured collarbone, a damaged eardrum and a basal skull fracture. She was practicing a pyramid and was six feet off the gym floor with no spotters. She has suffered partial hearing loss and has to wear special glasses for reading.
12. In January 1988 a female cheerleader fell from a pyramid and landed on her face and shoulder. She suffered a fractured collarbone and head injuries. She was in a light coma in the hospital but complete recovery is expected.

13. In January 1989 a high school cheerleader fractured a cervical vertebra after falling from a mount in practice. She will recover with no permanent disability.
14. On July 11, 1989 a 16-year-old high school cheerleader fractured a cervical vertebra and is quadriplegic. She slipped while doing a series of back flips on damp grass.
15. On March 10, 1990 a female high school cheerleader was thrown into the air by two other cheerleaders. She fell to the floor onto her neck and was in the hospital for one week. The routine was called a basket toss. She has recovered and is back in school.
16. On March 1, 1990 a 21-year-old male college cheerleader was injured at practice. In attempting to do a back flip he hit his head against a wall. He was taken to the hospital by ambulance. He has since recovered and the injuries were not serious.
17. In June of 1991 a 15-year-old cheerleader suffered injuries to the head. She was struck in the head by her falling partner and also after striking the ground. The injury took place in a cheerleading camp. The cheerleader was taken to the hospital but her condition is not known at this time.
18. A middle school cheerleader was injured in October 1991 and died the next week. She fell from a double level cheerleading stance during practice. She hit her head on the gym floor.
19. A 20-year-old college cheerleader suffered a head injury while practicing a cheerleading stunt in which she was thrown into the air but was not caught by her teammates. She landed on the gym floor. She was in critical condition but has been upgraded to serious and is expected to recover.
20. In May of 1992 a college cheerleader was doing a tumbling sequence when she landed on her back and fractured T-12. The practice was not supervised. There was a complete recovery.
21. A high school cheerleader was injured during a basketball game doing a back handspring tuck. She hit her head on the floor. She had surgery to remove a blood clot. Her condition is not known at this time.

22. A high school cheerleader was tossed in the air during a routine, was not caught, and fell hitting her face on the basketball floor. She remained motionless for approximately 30 minutes. She is expected to recover. The accident happened in December 1993.
23. A high school cheerleader fell and hit her head on the basketball floor while being lifted by the feet by two other cheerleaders. She was taken to the hospital for observation and is expected to recover. The accident happened in December 1993.
24. A college cheerleader was doing a tumbling run when he lost control and fell on his head. He fractured a cervical vertebra and is expected to recover. The accident happened in August 1994.
25. A college cheerleader was injured in a cheerleading competition in April 1994. She struck another cheerleader while doing a backflip and fell to the floor. She suffered a fractured cervical vertebra and is expected to recover.
26. A female college cheerleader received a fractured skull during warm-ups for a performance of stunts for a Christmas parade. She was injured in a four man back tuck basket toss. She landed on her head. There was no permanent disability, but she was in rehabilitation for memory. The injury occurred in November 1994.
27. A high school cheerleader was kicked in the face by a teammate who was falling from the top of a pyramid. The injured cheerleader suffered convulsions and was transported to the hospital. She was in stable condition and was expected to recover. The injury occurred in January 1995.
28. A high school cheerleader received a closed head injury in March 1995 during a basket toss stunt. She landed on a hard rubberized basketball court. There was no permanent disability.
29. A college cheerleader was paralyzed in April 1995 after being injured while performing a double flip during a basket toss. At the present time she is quadriplegic.

30. A high school cheerleader was injured during a stunt when a fellow cheerleader fell on her head. She has had permanent medical problems since the accident. This was an update from November 1993.
31. In 1997, a high school cheerleader suffered a 15-foot fall. She had spinal cord trauma and is paralyzed. No other information was available.
32. A college cheerleader was injured in 1997 during a tumbling routine and is now quadriplegic. She was attempting a back handspring into a single back tuck during practice and landed on her head.
33. In 1997, two cheerleaders collapsed and died - one during a game and one in tryouts. Cause of death was heart related.
34. A high school junior cheerleader was doing a warm-up for a stunt in a state cheerleading competition. The stunt involved the cheerleader doing a flip off the hands of a teammate into the arms of several teammates. The teammates failed to catch her and she landed on her back. She suffered a fractured elbow, a concussion, and a back injury that later required spinal fusion. She was not able to return to school and had to be tutored her final high school years. (This case was a 1992 update)
35. On September 11, 1998 a 17-year-old high school cheerleader was cheering at a football game. She attempted a back flip, slipped on wet artificial turf, and landed on her head. She had spinal cord shock and temporary paralysis. Recovery was going to take approximately six months.
36. A 17-year-old high school cheerleader was injured in practice while practicing a pyramid formation. She fell and bruised her spinal column. She has recovered from the injury and is back cheering.
37. A 14-year-old high school cheerleader was injured while doing a dance routine at practice. She slipped on some water, fell and hit her head, and was taken to the hospital. She was in intensive care but has recovered.

38. A middle school cheerleader fell during a stunt while practicing with her squad before a game. She injured the ligaments around her spinal cord and was placed in a halo brace. She is prohibited from participating in contact sports, but will recover.
39. While cheerleading at a basketball game the athlete collided with a player chasing a loose ball. She received a fractured skull and had a blood clot removed. Full recovery was expected.
40. Squad was practicing a new stunt and the athlete was up in an extension of her partner's arm when she fell and landed on her head. She had a fractured skull and was on a ventilator for 12 hours. Full recovery was expected.
41. Athlete was on the third level of a pyramid during practice and fell on her head. She had a fractured skull and full recovery was expected.
42. During the 2001-2002 academic year three high school cheerleaders and one college cheerleader had catastrophic injuries. All four involved fractured skulls.
43. In August of 2005 a 14 year-old female high school cheerleader died after being thrown into the air and landing chest down in the arms of her teammates. She died of a lacerated spleen caused by blunt abdominal trauma.
44. A 16 year-old high school female cheerleader suffered spinal shock on 9/24/05 after fall onto her back from the shoulders of a teammate. She had a full recovery.
45. A 14 year old high school female cheerleader fell on her head during a cheerleading stunt on October 27, 2005, and was taken to the hospital. No other information was available.
46. A college female cheerleader fractured a cervical vertebra and suffered a concussion on March 5, 2006, performing a stunt during a basketball game. She fell 15 feet onto her head. A recovery was expected.
47. A male 18 year-old high school cheerleader landed on his neck after performing a standing back tuck on September 12, 2005. It was during a practice session. The injury was a fractured cervical vertebra and he is recovering. He was 6' 2" tall and weighed 215 pounds.

48. A 14 year-old female high school cheerleader suffered a fractured skull on November 15, 2005, when her teammates did not catch her during a stunt. She has recovered.
49. A female high school cheerleader fractured her skull on January 2, 2006, during a basket toss in the school cafeteria. She landed on her head and was taken to the hospital. She has recovered.
50. A 14 year-old female high school cheerleader collapsed and died during a cheerleading practice. She collapsed after being the flyer on a basket toss. Cause of death was cardiac arrest. A defibrillator was used after the accident.
51. In 2002 a 16 year-old male high school cheerleader was injured during a practice session. He fractured a cervical vertebra and is quadriplegic.
52. In January 2007 a 15 year-old high school cheerleader was performing a double front flip into a cushioned landing when she took an odd bounce and landed on her neck. She had damage to cervical vertebrae 6-7 and had a five hour surgery. She has a permanent titanium plate and screws along her spine. She has recovered, but will not participate in cheering again.
53. An 18 year-old college cheerleader fractured her neck in two places when she fell head first from a height of about 15 feet. She was a flyer during practice. She had a halo brace bolted to her skull for two months. She has recovered, but will not cheer again and her movements are highly restricted.
54. In March of 2007 a college cheerleader fractured her neck, had a concussion, and bruised a lung after falling 15 feet from a pyramid during a basketball game. She lost her balance and fell to the floor.

Cheerleading has changed dramatically in the past twenty-five years and now has two distinctive purposes; 1) of a service-oriented leader of Cheer on the sideline; and 2) as a highly skilled competing athlete. A number of schools, both high schools and colleges, across the country have limited the types of stunts that can be attempted by their cheerleaders. Rules and safety guidelines now apply to both practice and competition. As already stated in this report,

high school and college cheerleaders account for over one-half of the catastrophic injuries to female athletes. Inexperienced and untrained coaches should not attempt to teach stunts with a higher level of difficulty than their team is capable of achieving or they have the knowledge and ability to teach.

The basic question that has to be asked is what is the role of the cheerleader? Approximately 20-25 states have a state championship for competitive cheer and it is not clear how many states consider cheerleading a sport. The 2006-2007 high school participation survey shows 95,177 females. There were also 2,147 male cheerleaders. College participation numbers are hard to find since cheerleading is not an NCAA sport. Is cheerleading an activity that leads the spectators in cheers or is it a sport? If the answer is to entertain the crowd and to be in competition with other cheerleading squads, then there must be safety guidelines initiated. Following are a list of sample guidelines that may help prevent cheerleading injuries:

1. Cheerleaders should have medical examinations before they are allowed to participate. Included would be a complete medical history.
2. Cheerleaders should be trained by a qualified coach with training in gymnastics and **partner stunting**. This person should also be trained in the proper methods for spotting and other safety factors.
3. Cheerleaders should be exposed to proper conditioning programs and trained in proper spotting techniques.
4. Cheerleaders should receive proper training before attempting gymnastic and partner type stunts and should not attempt stunts they are not capable of completing. A qualification system demonstrating mastery of stunts is recommended.
5. Coaches should supervise all practice sessions in a safe facility.
6. Mini-trampolines and flips or falls off of pyramids and shoulders should be prohibited.
7. Pyramids over two high should not be performed. Two high pyramids should not be performed without mats and other safety precautions.

8. If it is not possible to have a physician or certified athletic trainer at games and practice sessions, emergency procedures must be provided. The emergency procedure should be in writing and available to all staff and athletes.
9. There should be continued research concerning safety in cheerleading.
10. When a cheerleader has experienced or shown signs of head trauma (loss of consciousness, visual disturbances, headache, inability to walk correctly, obvious disorientation, memory loss) she/he should receive immediate medical attention and should not be allowed to practice or cheer without permission from the proper medical authorities.
11. Cheerleading coaches should have some type of safety certification. The American Association of Cheerleading Coaches and Advisors offers this certification.

According to the National Federation of State High School Associations, a primary purpose of sideline spirit groups (dance, pom, drill or cheer) is to serve as support groups for the interscholastic athletic programs within the school. A primary purpose for competitive spirit groups is to represent the school in organized competition. In January of 1993, 18 rules revisions were adopted for spirit groups. One of the major rules prohibits tumbling over, under, or through anything (people or equipment). All of the other rules were adopted to enhance the safety of the participants. Today, emphasis is placed not only on the stunting athlete, but also on the base and the spotter. Proper conditioning and attentiveness will help minimize the risk involved in a competition. Information concerning these new rules and updates are available from the National Federation of State High School Associations in Indianapolis, Indiana. The contact person is Susan Loomis.

On July 1, 2006, the Missouri State High School Activities Association no longer sanctioned cheerleaders to take part in regional or state competitions. The association will maintain jurisdiction over sideline cheerleading at school athletic events. Squads that want to compete must do so as a club. In the fall of 2007 the South Dakota High School Activities Association will sanction competitive cheerleading and dance, and compete for state championships. The

decision was made from a student interest survey, and female four top sports were cheer, dance, softball, and soccer.

In July 2006 the National Collegiate Athletic Association (NCAA) and Varsity Brands have formed an alliance to enhance cheerleading safety at NCAA institutions by creating the College Cheerleading Safety Initiative. An important part of this program is the safety program developed by the American Association of Cheerleading Coaches and Administrators (AACCA). The latest addition of the AACCA Cheerleading Safety Manual was published in 2006 and is very informative for college coaches. All college coaches should have a copy of this safety manual and be familiar with its contents.

In 2005 the NCAA Insurance program stated that 25% of money spent on student athlete injuries resulted from cheerleading. The rate of cheerleaders to football players is 12 to 100.

It is the opinion of the authors that following cheerleading rules and safety manual guidelines that are written by cheerleading experts is an excellent way to help prevent cheerleading injuries. The new restrictions can be found on the AACCA web site www.aacca.org. The web site also has safety measures for high school cheerleading and other safety information. There is also a publication on the website called "A Parents Guide to Cheerleading Safety" which offers the five top questions parents should be asking when their child joins a school cheerleading squad.

TABLE 5
HIGH SCHOOL CHEERLEADING
DIRECT INJURIES

1982-83 – 2006-2007

SPORT	YEAR	FATALITIES	NON-FATAL	SERIOUS	TOTAL
CHEERLEADING	1982-1983	0	0	0	0
	1983-1984	0	0	0	0
	1984-1985	0	1	0	1
	1985-1986	0	1	0	1
	1986-1987	0	0	0	0
	1987-1988	0	2	1	3
	1988-1989	0	0	1	1
	1989-1990	0	1	1	2
	1990-1991	0	0	1	1
	1991-1992	1	1	0	2
	1992-1993	0	0	1	1
	1993-1994	0	0	2	2
	1994-1995	0	1	2	3
	1995-1996	0	0	0	0
	1996-1997	0	1	1	2
	1997-1998	0	0	0	0
	1998-1999	0	0	3	3
	1999-2000	0	0	3	3
	2000-2001	0	0	0	0
	2001-2002	0	3	2	5
	2002-2003	0	1	2	3
	2003-2004	0	2	2	4
	2004-2005	0	0	2	2
	2005-2006	1	0	5	6
	2006-2007	**0**	**0**	**1**	**1**
	TOTAL	2	14	30	46

** INCLUDES TWO MALE CHEERLEADERS

TABLE 6

COLLEGE CHEERLEADING

DIRECT INJURIES

1982-83 – 2006-2007

SPORT	YEAR	FATALITIES	NON-FATAL	SERIOUS	TOTAL
CHEERLEADING	1982-1983	0	1	1	2
	1983-1984	0	0	2	2
	1984-1985	0	1	0	1
	1985-1986	1	1	0	2
	1986-1987	0	0	1	1
	1987-1988	0	0	0	0
	1988-1989	0	0	0	0
	1989-1990	0	0	1	1
	1990-1991	0	0	0	0
	1991-1992	0	0	1	1
	1992-1993	0	0	0	0
	1993-1994	0	0	2	2
	1994-1995	0	1	1	2
	1995-1996	0	0	0	0
	1996-1997	0	1	1	2
	1997-1998	0	0	0	0
	1998-1999	0	0	0	0
	1999-2000	0	0	1	1
	2000-2001	0	0	0	0
	2001-2002	0	0	1	1
	2002-2003	0	0	0	0
	2003-2004	0	2	0	2
	2004-2005	0	0	0	0
	2005-2006	0	0	1	1
	2006-2007	**0**	**0**	**2**	**2**
	TOTAL	1	7	15	23

**INCLUDES FOUR MALE CHEERLEADERS

In 2008 the National Center for Catastrophic Sports Injury Research (NCCSIR) was contacted by Ms. Kimberly Archie, Director of the National Cheer Safety Foundation. The National Cheer Safety Foundation was created by parents for parents, and is interested in cheer safety and the collection of cheerleading injury data. Cheer injuries can be reported to www.cheerinjuryreport.com. Jessica Smith, a college cheerleader who had a serious injury while cheering, is the National Spokesperson.

The Foundation was interested in collecting cheerleading injury data from across the United States and was interested in collaborating with the NCCSIR. The NCCSIR was interested in working with the Foundation since it is always an asset to get as much injury data as possible for all sports from all sources. Ms. Archie sent me an initial list of 86 cheerleading injuries, of which NCCSIR had only a small number. After going through the list, a decision was made to include 30 of the injuries and to combine them with the NCCSIR data. A recommendation was also made to the Foundation as to the kinds of data that should be collected for catastrophic cheerleading injuries in the future. It is expected that future data will meet all of the requirements. As an example, the NCCSIR did not include concussion injuries unless they were severe brain injuries and created ongoing medical problems. The Center also did not include injuries that could not be verified. Catastrophic injuries as defined by the NCCSIR can be found in the introduction to this report.

The following Table (Table 7) illustrates the high school and college injuries that were accepted from the Foundation:

TABLE 7

CHEERLEADING CATASTROPHIC INJURIES

DATA FROM NATIONAL CHEER SAFETY FOUNDATION

1982 – 2007

LEVEL	FATALITIES	DISABILITY	SERIOUS	TOTAL
HIGH SCHOOL	0	8	15	23
COLLEGE	0	4	3	7
TOTAL	0	12	18	30

If the high school and college injury data from the National Cheer Safety Foundation were combined with the high school and college cheerleading injury data collected by the NCCSIR, the results would be as illustrated in the following tables (Tables 8-9).

TABLE 8

CHEERLEADING CATASTROPHIC INJURIES

HIGH SCHOOL COMBINED DATA

1882-1983 - 2006-2007

YEAR	FATALITY	NON-FATAL	SERIOUS	TOTAL
1982-1983	0	0	0	0
1983-1984	0	0	0	0
1984-1985	0	2	0	2
1985-1986	0	1	0	1
1986-1987	0	0	1	1
1987-1988	0	2	1	3
1988-1989	0	0	1	1
1989-1990	0	1	1	2
1990-1991	0	1	1	2
1991-1992	1	1	0	2
1992-1993	0	0	1	1
1993-1994	0	0	2	2
1994-1995	0	2	2	4
1995-1996	0	0	1	1
1996-1997	0	1	1	2
1997-1998	0	1	0	1
1998-1999	0	0	5	5
1999-2000	0	0	4	4
2000-2001	0	1	1	2
2001-2002	0	4	3	7
2002-2003	0	2	2	4
2003-2004	0	3	3	6
2004-2005	0	0	4	4
2005-2006	1	0	9	10
2006-2007	0	0	2	2
TOTAL	2	22	45	69

TABLE 9

CHEERLEADING CATASTROPHIC INJURIES

COLLEGE COMBINED DATA

1982 – 2007

YEAR	FATALITY	NON-FATAL	SERIOUS	TOTAL
1982-1983	0	1	1	2
1983-1984	0	1	2	3
1984-1985	0	1	0	1
1985-1986	1	1	0	2
1986-1987	0	0	1	1
1987-1988	0	0	0	0
1988-1989	0	0	0	0
1989-1990	0	0	1	1
1990-1991	0	0	0	0
1991-1992	0	0	1	1
1992-1993	0	0	0	0
1993-1994	0	0	2	2
1994-1995	0	1	1	2
1995-1996	0	0	0	0
1996-1997	0	1	1	2
1997-1998	0	0	1	1
1998-1999	0	1	0	1
1999-2000	0	0	1	1
2000-2001	0	1	0	1
2001-2002	0	1	2	3
2002-2003	0	0	0	0
2003-2004	0	2	0	2
2004-2005	0	0	0	0
2005-2006	0	0	1	1
2006-2007	0	0	3	3
TOTAL	1	11	18	30

Table 10 illustrates high school female catastrophic injuries for the past 25 years, but the table now includes the combined cheerleading injury data from the National Cheer Safety Foundation and the NCCSIR. In the original table (Table 1) high school cheerleading accounted for 55.0% of all high school female sports catastrophic injuries. In Table 10, high school cheerleading accounts for 65.1% of all female high school sports catastrophic injuries.

TABLE 10

HIGH SCHOOL FEMALE DIRECT CATASTROPHIC INJURIES

1982-83 – 2006-07

SPORT	FATALITY	NON-FATAL	SERIOUS	TOTAL
Cheerleading*	2	21	44	67
Gymnastics	0	6	3	9
Track	1	1	5	7
Swimming	0	4	1	5
Basketball	0	1	3	4
Ice Hockey	0	0	2	2
Field Hockey	0	3	0	3
Softball	1	2	0	3
Lacrosse	0	0	1	1
Soccer	0	1	0	1
Volleyball	0	1	0	1
TOTAL	**4**	**40**	**59**	**103**

*Cheerleading combined data with Cheer Safety Foundation and NCCSIR

Table 11 illustrates college female catastrophic injuries for all sports for the past 25 years, but the table now includes the combined cheerleading injury data from the National Cheer Safety Foundation and the NCCSIR. In the original table (Table 3) college cheerleading accounted for 59.4% of all college female sports catastrophic injuries. In Table 11, college cheerleading accounts for 66.7% of all college female sports catastrophic injuries.

TABLE 11

COLLEGE FEMALE DIRECT CATASTROPHIC INJURIES

1982-82 – 2006-07

SPORT	FATALITY	NON-FATAL	SERIOUS	TOTAL
Cheerleading*	1	9	16	26
Field hockey	0	1	2	3
Lacrosse	0	2	0	2
Gymnastics	0	2	0	2
Equestrian	1	0	0	1
Soccer	0	1	0	1
Ice Hockey	0	0	1	1
Skiing	1	0	0	1
Track (Pole Vault)	0	1	0	1
Softball	0	0	1	1
TOTAL	**3**	**16**	**20**	**39**

*Cheerleading combined data with Cheer Safety Foundation and NCCSIR

The NCCSIR will continue to share data with the National Cheer Safety Foundation, and in future reports the cheerleading and female catastrophic injury tables will be combined into single tables.

ANNUAL SURVEY OF FOOTBALL INJURY RESEARCH

1931 - 2008

Frederick O. Mueller, Ph.D.
Chairman, American Football Coaches Committee on Football Injuries

and

Bob Colgate
Assistant Director of the National Federation of State High School Associations

Prepared for:

American Football Coaches Association, Waco, Texas
National Collegiate Athletic Association, Indianapolis, Indiana
The National Federation of State High School Associations,
Indianapolis, Indiana

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INTRODUCTION

In 1931 the American Football Coaches Association initiated the First Annual Survey of Football Fatalities. The original survey committee was chaired by Marvin A. Stevens, M.D., of Yale University, who served from 1931-1942. Floyd R. Eastwood, Ph.D., Purdue University succeeded Dr. Stevens in 1942 and served through 1964. Carl S. Blyth, Ph.D., University of North Carolina at Chapel Hill was appointed in 1965 and served through the 1979 football season. In January 1980, Frederick O. Mueller, Ph.D., University of North Carolina at Chapel Hill was appointed by the American Football Coaches Association and the National Collegiate Athletic Association to continue this research under the new title, **Annual Survey of Football Injury Research**.

The primary purpose of the Annual Survey of Football Injury Research is to make the game of football a safer and, therefore, a more enjoyable sports activity. Because of these surveys the game of football has realized many benefits in regard to rule changes, improvement of equipment, improved medical care, and improved coaching techniques. The 1976 rule change that made it illegal to make initial contact with the head while blocking and tackling was the direct result of this research.

The 1990 report was historic in that it was the first year since the beginning of the research, 1931, that there was not a direct fatality in football at any level of play. This clearly illustrates that data collection and analysis is important and plays a major role in injury prevention.

Data Collection

Throughout the year, upon notification of a suspected football fatality, immediate contact is made with the appropriate officials (coaches, administrators, physicians, athletic trainers). Pertinent information is collected through questionnaires and personal contact.

Football fatalities are classified for this report as direct and indirect. The criteria used to classify football fatalities are as follows:

Direct - Those fatalities which resulted directly from participation in the fundamental skills of football.

Indirect - Those fatalities that are caused by systemic failure as a result of exertion while participating in football activity or by a complication which was secondary to a non-fatal injury.

In several instances of reported football fatalities, the respondent stated the fatality should not be attributed to football. Reasons for these statements are that the fatality was attributed to physical defects that were unrelated to football injuries.

Participation numbers were updated in the 1989 report. The National Federation of State High School Associations has estimated that there are approximately 1,500,000 high school, junior high school, and non-federation school football participants in the United States. The college figure of 75,000 participants includes the National Collegiate Athletic Association, the National Association of Intercollegiate Athletics, the National Junior College Athletic Association, and an estimate of schools not associated with any national organization. Sandlot and professional football have been estimated at 225,000 participants. These figures give an estimate of 1,800,000 total football participants in the United States for the 2008 football season.

Dr. Mueller compiled and prepared the survey report on college, professional, and sandlot levels, and Mr. Bob Colgate of the National Federation of State High School Associations assumed responsibility for collecting and preparing the senior and junior high school phase of the study. Sandlot is defined as non-school football, but organized and using full protective equipment.

At the conclusion of the football season, both reports are compiled into this **Annual Survey of Football Injury Research**. This report is sponsored by the American Football Coaches Association, the National Collegiate Athletic Association, and The National Federation of State High School Associations.

Acknowledgments

Medical data for the 2008 report were compiled by Dr. Robert C. Cantu, Chairman, Department of Surgery and Chief, Neurosurgery Service, Emerson Hospital, in Concord, MA. Dr. Cantu is a Past-President of the American College of Sports Medicine and is the Medical Director for the National Center for Catastrophic Sports Injury Research at the University of North Carolina at Chapel Hill.

Summary

1. There were seven fatalities directly related to football during the 2008 football season. All seven fatalities were in high school football. (Table I)

2. The rate of direct fatal injuries is very low on a 100,000 player exposure basis. For the approximately 1,800,000 participants in 2008, the rate of direct fatalities was 0.39 per 100,000 participants.

3. The rate of direct fatalities in high school and junior high school football was 0.47 per 100,000 participants. The rate of direct fatalities in college was 0.00 per 100,000 participants. (Table III)

4. Most direct fatalities usually occur during regularly scheduled games. In 2008 five direct fatalities occurred in games, one in practice, and one in a scrimmage game.

5. The 2008 survey shows that three of the injuries took place in August, three in September, and one in October.

6. The major activities in football would naturally account for the greatest number of fatalities. In 2008 three fatalities happened while tackling, one while being tackled, one being blocked, and two in a collision. Three of the brain fatalities involved tackling, one being tackled, and one being blocked. (Table V)

7. In 2008 five fatalities resulted from injuries to the brain, one to an abdominal injury, and one to a chest injury. (Table VI)

8. In many cases football cannot be directly responsible for fatal injuries (heat stroke, heart related and so forth). In 2008 there were 13 indirect fatalities. Seven were associated with high school football, three with college football, and three with sandlot football. The high school indirect deaths were four heat stroke and three heart related deaths. The three college indirect deaths were two heat related and one sickle cell death. All three of the sandlot deaths were heart related. (Table II)

Discussions And Recommendations

After a slight rise in the number of football fatalities during the 1986 season, the 1990 data revealed the elimination of direct football fatalities. That was the first time since 1931 that there have been no direct football fatalities. The 2008 data continues the trend of single digit direct fatalities that started in the 1978 football season. There was a decrease from nine direct fatalities in 2001 to six in 2002, three in 2003, five in 2004, three in 2005, one in 2006, four in 2007, and a slight rise in 2008 to seven. The data illustrates the importance of data collection and the analysis of this data in making changes in the game of football that help reduce the incidence of serious injuries. This effort must be continued in order to keep these numbers low and to strive for the elimination of football fatalities. Indirect injuries have been in double figures since 1999 with the exception of 2003 and 2007. The 2008 indirect injuries show an increase of four when compared to the 2007 data.

Head and Neck Injuries

Past efforts that were successful in reducing fatalities to the levels indicated from 1990 through 2008, and the elimination of direct fatalities in 1990, should again be emphasized. Rule changes for the 1976 football season that eliminated the head and face as a primary and initial contact area for blocking and tackling is of utmost importance. The original 1976 rule defined spearing as “the intentional use of the helmet (including the face mask) in an attempt to punish an opponent.” In the new 2005 definition in the rules “intentional” has been dropped. The new

rule states "spearing is the use of the helmet (including the face mask) in an attempt to punish an opponent". A 2006 point of emphasis covers illegal helmet contact and defines spearing, face tackling, and butt blocking. High school rule changes effective during 2006-07 stated that at least a 4-point chinstrap shall be required to secure the helmet, and all mouth guards must be colored, not white or clear. Also rules revisions regarding illegal helmet contact were made in February 2007. The committee placed butt blocking, face tackling, and spearing under the heading of "Helmet Contact – Illegal" to place more emphasis on risk-minimization concerns. Examples of illegal helmet contact that could result in disqualification include illegal helmet contact against an opponent lying on the ground, illegal helmet contact against an opponent held up by other players, and illegal helmet-to-helmet contact against a defenseless opponent. **Coaches who are teaching helmet or face to the numbers tackling and blocking are not only breaking the football rules, but are placing their players at risk for permanent paralysis or death. This type of tackling and blocking technique was the direct cause of 36 football fatalities and 30 permanent paralysis injuries in 1968. In addition, if a catastrophic football injury case goes to a court of law, there is no defense for using this type of tackling or blocking technique**. Since 1960 most of the direct fatalities have been caused by brain and neck injuries, and in fact since 1990 all but six of the head and neck deaths have been brain injuries. We must continue to reduce head and neck injuries.

Several suggestions for reducing head and neck injuries are as follows:

1. Athletes must be given proper conditioning exercises that will strengthen their necks so that participants will be able to hold their heads firmly erect when making contact.
2. Coaches should drill the athletes in the proper execution of the fundamental football skills, particularly blocking and tackling. **Contact should always be made with the head-up and never with the top of the head/helmet. Initial contact should never be made with the head/helmet or face mask**.
3. Coaches and officials should discourage the players from using their heads as

battering rams when blocking and tackling. The rules prohibiting spearing should be enforced in practice and in games. The players should be taught to respect the helmet as a protective device and that the helmet should not be used as a weapon.

4. All coaches, physicians, and trainers should take special care to see that the player's equipment is properly fitted, particularly the helmet.
5. When a player has experienced or shown signs of head trauma (loss of consciousness, visual disturbances, headache, inability to walk correctly, obvious disorientation, memory loss), he should receive immediate medical attention and should not be allowed to return to practice or game without permission from a physician.
6. A number of the players associated with brain trauma complained of headaches or had a previous concussion prior to their deaths. The team physician, athletic trainer, or coach should make players aware of these signs. Players should also be encouraged to inform the team physician, athletic trainer, or coach if they are experiencing any of the above mentioned signs of brain trauma.
7. Coaches should never make the decision whether a player returns to a game or active participation in a practice if that player experiences brain trauma.
8. Of the five brain injuries in 2008, two were diagnosed as second impact syndrome. Players with second impact syndrome received an initial concussion and returned to play before being fully healed.

Another important effort has been and continues to be the improvement of football protective equipment. It is imperative that old and worn equipment be properly renovated or discarded and continued emphasis placed on developing the best equipment possible. Manufacturers, coaches, trainers, and physicians should continue their joint and individual efforts toward this end.

The authors of this research are convinced that the current rules which eliminate the head in blocking and tackling, **coaches teaching the proper fundamentals of blocking and tackling**,

the helmet research conducted by the National Operating Committee on Standards for Athletic Equipment (NOCSAE), excellent physical conditioning, proper medical supervision, and a good data collection system have played the major role in reducing fatalities and serious brain and neck injuries in football. This is best illustrated by Table IX and Graph I which shows the increase in both brain and cervical spine fatalities during the decade from 1965-1974. This time period was associated with blocking and tackling techniques that involved the head as the initial point of contact. The reduction in brain and cervical spine injuries is shown in the decade from 1975-1984. This decade was associated with the 1976 rule change that eliminated the head as the initial contact point in blocking and tackling. There is no doubt that the 1976 rule change has made a difference and that a continued effort should be made to keep the head out of the fundamental skills of football. Data from the decade 1985-1994 continues to illustrate the reduction in brain and neck fatalities. A concern is that the data from 1995-2004 shows an increase in brain fatalities over that of 1985-1994. There has been an increase of 11 brain deaths during the decade 1995-2004, which is an increase of 2.1% over 1985-1994. The decade from 2005-2014 will have to be watched closely.

Heat Stroke

A continuous effort should be made to eliminate heat stroke deaths associated with football. Since the beginning of the survey through 1959 there were five cases of heat stroke death reported. From 1960 through 2008 there have been 120 heat stroke cases that resulted in death (Table IV). **The 2008 data show four cases of heat stroke death at the high school level and two at the college level. The six heat stroke deaths accounted for the third highest number since the eight in 1970, and seven in 1972. There is no excuse for any number of heat stroke deaths since they are all preventable with the proper precautions. Since 1995 there have been 39 football players die from heat stroke (29 high school, 7 college, 2 professional, and one sandlot). Every effort should be made to continuously educate coaches concerning the proper procedures and precautions when practicing or playing in**

the heat. Since 1974 there has been a dramatic reduction in heat stroke deaths with the exception of 1978, 1995, 1998, when there were four each year, and 2000 and 2006 when there were five each year. There were no heat stroke deaths in 1991, 1993, 1994, 2002, and 2003. All coaches, trainers, and physicians should place special emphasis on eliminating football fatalities that result from physical activity in hot weather.

Heat stroke and heat exhaustion are prevented by careful control of various factors in the conditioning program of the athlete. When football activity is carried on in hot weather, the following suggestions and precautions should be taken:

1. Each athlete should have a complete physical examination with a medical history and an annual health history update. History of previous heat illness and type of training activities before organized practice begins should be included.
2. Acclimatize athletes to heat gradually by providing graduated practice sessions for the first seven to ten days and other abnormally hot or humid days. Obey the rules pertaining to when full football uniforms may be used.
3. Know both the temperature and the humidity since it is more difficult for the body to cool itself in high humidity. Use of a sling psychrometer is recommended to measure the relative humidity and anytime the wet-bulb temperature is over 78 degrees practices should be altered.
4. Adjust activity level and provide frequent rest periods. Rest in cool, shaded areas with some air movement and remove helmets and loosen or remove jerseys. Rest periods of 15-30 minutes should be provided during workouts of one hour.
5. Provide adequate **cold** water replacement during practice. **Water should always be available and in <u>unlimited quantities</u> to the athletes. <u>GIVE WATER REGULARLY</u>**. Athletes should drink water before, during, and after practice.
5. Salt should be replaced daily and liberal salting of the athletes' food will accomplish this purpose. Coaches should not provide salt tablets to athletes. Attention must be

directed to water replacement.

7. Athletes should weigh each day before and after practice and weight charts checked in order to treat the athlete who loses excessive weight each day. Generally, a three percent body weight loss through sweating is safe, and a five percent loss is in the danger zone.
8. Clothing is important and a player should avoid using long sleeves, long stockings and any excess clothing. Never use rubberized clothing or sweatsuits.
9. Some athletes are more susceptible to heat injury. These individuals are not accustomed to work in the heat, may be overweight, and may be the eager athlete who constantly competes at his capacity. Athletes with previous heat problems should be watched closely.
10. It is important to observe for signs of heat illness. Some trouble signs are nausea, incoherence, fatigue, weakness, vomiting, cramps, weak rapid pulse, flushed appearance, visual disturbances, and unsteadiness. Heat stroke victims, contrary to popular belief, may sweat profusely. If heat illness is suspected, seek a physician's immediate service. Recommended emergency procedures are vital. Plan should be in writing and all personnel should have copies.
11. An increasing number of medical personnel are using a treatment for heat illnesses that involves immersing the athlete in ice water. This technique will help bring down the body temperature and has proven to be effective. Some schools have plastic outdoor swim pools filled with ice water available at practice facilities.
12. The National Athletic Trainers Association also has a heat illness position statement on their web site with recommendations for prevention.

Recommendations

Specific recommendations resulting from the 2008 survey data are as follows:

1. Mandatory medical examinations and medical history should be taken before allowing

an athlete to participate in football. The NCAA recommends a thorough medical examination when the athlete first enters the college athletic program and an annual health history update with use of referral exams when warranted. If the physician or coach has any questions about the athlete's readiness to participate, the athlete should not be allowed to play. High school coaches should follow the recommendations set by their State High School Athletic Associations.

2. All personnel concerned with training football athletes should emphasize proper, gradual, and complete physical conditioning. Particular emphasis should be placed on neck strengthening exercises and acclimatization to hot weather.
3. A physician should be present at all games and practice sessions. If it is impossible for a physician to be present at all practice sessions, emergency measures must be provided. Written emergency procedures are recommended for both coaches and medical staff.
4. All personnel associated with football participation should be cognizant of the problems and safety measures related to physical activity in hot weather.
5. Each institution should strive to have a certified athletic trainer who is a regular member of the faculty and is adequately prepared and qualified.
6. Cooperative liaison should be maintained by all groups interested in the field of Athletic Medicine (coaches, trainers, physicians, manufacturers, administrators, and so forth).
7. There should be strict enforcement of game rules, and administrative regulations should be enforced to protect the health of the athlete. Coaches and school officials must support the game officials in their conduct of the athletic contests.
8. There should be a renewed emphasis on employing well-trained athletic personnel, providing excellent facilities, and securing the safest and best equipment possible.
9. There should be continued research concerning the safety factor in football (rules,

facilities, equipment, and so forth).

10. Coaches should continue to teach and emphasize the proper fundamentals of blocking and tackling to help reduce head and neck fatalities. **KEEP THE HEAD OUT OF FOOTBALL**.

11. Strict enforcement of the rules of the game by both coaches and officials will help reduce serious injuries. Be aware of the 2005 rule change to the 1976 definition of spearing, and to the 2007 high school rules concerning illegal helmet contact.

12. When a player has experienced or shown signs of head trauma (loss of consciousness, visual disturbances, headache, inability to walk correctly, obvious disorientation, memory loss), he should receive immediate medical attention and should not be allowed to return to practice or game without permission from the proper medical authorities.

13. The number of indirect heart related deaths has increased over the years and it is recommended that schools have automated external defibrillators (AED) available for emergency situations.

CASE STUDIES DIRECT FATALITIES

HIGH SCHOOL

A 17 year-old high school football player was injured on 8/22/08 during a practice session. He was making a one-on-one tackle at the time and contact was made with his head to the shoulder pads of his opponent. He was unconscious after the hit and was taken to the hospital. The accident took place on 8/22/08 and he was in a coma for four days and died on 8/26/08. Cause of death was a subdural hematoma.

A 15 year-old high school football player was injured during a game on 8/22/08. He was a linebacker and was blocked by a pulling lineman. Helmet to helmet contact was made by the pulling lineman. He was taken to a hospital, had surgery, and died on 8/24/08 after being taken off of life support. Cause of death was a subdural hematoma.

A 15 year-old high school football player was injured during a junior varsity game on 8/29/08 and died on 8/30/08. He was playing wide receiver at the time and was involved with a collision with two opposing players. The injury was a lacerated liver and he died of internal complications.

A 16 year-old high school football player was injured during a game scrimmage against another school. He was hit in the chest by an opponent and died a short time later at the hospital. Autopsy results failed to identify the cause of death.

A high school sophomore football player was injured during a game on 9/12/08 and died on 9/16/08. He was a defensive back tackling the ball carrier at the time of the injury. Contact was made with the legs of the ball carrier. Cause of death was a brain injury.

A 16 year-old high school football player was injured during a game on 9/19/08 and died later the same day. He collapsed on the sideline after being tackled while running the ball. He received a concussion in practice two days before the game and did not have clearance from a physician. Cause of death was a brain injury due to second impact syndrome.

A 16 year-old high school football player was injured during a game on 10/13/08 and died on 10/15/08. He was playing the linebacker position making a tackle during a junior varsity game. He suffered a concussion three weeks before the fatal injury. Cause of death was a subdural hematoma with possible second impact syndrome. He was cleared by a physician to return to play after the initial concussion.

CASE STUDIES INDIRECT FATALITIES

HIGH SCHOOL

A 17 year-old high school football player was injured on 8/14/08 and died on 8/15/08. He was participating in a practice session in full pads from 4:30 PM to 7:00 PM in 103 to 104 degree heat. He also participated in a light morning practice that same day. The county coroner ruled the death to be related to an electrolyte imbalance from drinking too much water after working in the heat for a long period. Actual cause of death is known as hyponatremia. He is listed in this report as a heat related death.

A 17 year-old high school football player died on 8/12/08 after participating in a high school football scrimmage against another high school. The autopsy report was still not available in December of 2008, but all indications are that the cause of death was heat related. There has been a long investigation going on at the high school and also with the local EMT who visited the athlete's home after a 911 call. This case will be updated as more information is available.

A 15 year-old high school junior varsity football player collapsed at practice on 5/28/08. Cause of death was congenital heart failure.

A 15 year-old high school football player collapsed after practice on 8/20/08. The temperature was 94 degrees and practice started at 4:30 PM and ended at 6:00 PM. The coach stated that they had three water breaks. The athlete's core temperature was 107 degrees. There

was no autopsy, but the coroner called it a heat stroke death. Another player on the team also collapsed, but recovered after two days in the hospital.

A 16 year-old high school football player collapsed at the end of a team camp practice on 7/14/08. He died at the hospital. He was 5'11" tall and weighed 240 lbs. Cause of death was hypertrophic cardiomyopathy.

A 17 year-old high school football player collapsed and died after an off season workout on 5/15/08. Preliminary findings indicate it was a heart related death.

A 16 year old high school football player collapsed during a practice session on 8/26/08 and died on 8/31/08. Cause of death was heat stroke. He was 6'5" tall and weighed 360 lbs. His body temperature at the hospital was 108 degrees. On 8/1/08 he suffered from heat exhaustion and spent two days in the hospital;

COLLEGE

An 18 year-old college football player collapsed and died after the first practice of the year on 8/14/08. The temperature was 89 degrees and the athlete was 6'1" tall and weighed 240 lbs. The practice lasted 1 ½ hours and the players wore shorts and helmets, but no pads. Cause of death was heat related.

A 19 year-old college football player collapsed during an off-season workout on March 18, 2008 and later died at the hospital. Cause of death listed by the medical examiner was dysrhythmia due to acute exertional rhabdomyolysis with sickle cell trait. The case was controversial as related to the care he received after collapsing and to the intensity of the workout.

A 22 year-old college football player died after an off-season workout on May 28, 2008. Cause of death was heat stroke. School officials stated they were unaware of the athlete having sickle cell trait and have begun screening for the condition in light of the recent heat death. The athlete was 6'4" inches tall and weighed 280 lbs.

SANDLOT

A 13 year-old youth football player collapsed and died after running drills on 8/25/08. Cause of death was believed to be heart related.

A 12 year-old youth football player collapsed at practice and later died. Cause of death was heart related.

A 13 year-old youth football player collapsed during a practice session and later died on 7/28/08. He was 6'1" tall and weighed 231 lbs. Cause of death was an enlarged heart.

TABLE I

FATALITIES: DIRECTLY DUE TO FOOTBALL – 1931-2008*

YEAR	SANDLOT DIRECT	PRO AND SEMIPRO DIRECT	HIGH SCHOOL DIRECT	COLLEGE DIRECT	TOTAL DIRECT
**1931-1965	134	72	348	54	608
1966	4	0	20	0	24
1967	5	0	16	3	24
1968	4	1	26	5	36
1969	3	1	18	1	23
1970	3	0	23	3	29
1971	2	0	15	3	20
1972	3	1	16	2	22
1973	2	0	7	0	9
1974	0	0	10	1	11
1975	1	0	13	1	15
1976	3	0	15	0	18
1977	1	0	8	1	10
1978	0	0	9	0	9
1979	0	0	3	1	4
1980	0	0	9	0	9
1981	2	0	5	2	9
1982	2	0	7	0	9
1983	0	0	4	0	4
1984	1	0	4	1	6
1985	2	0	4	1	7
1986	0	0	11	1	12
1987	0	0	4	0	4
1988	0	0	7	0	7
1989	0	0	4	0	4

TABLE 1 CONTINUED

1990	0	0	0	0	0
1991	0	0	3	0	3
1992	0	0	2	0	2
1993	0	0	3	1	4
1994	0	0	0	1	1
1995	0	0	4	0	4
1996	0	0	5	0	5
1997	0	0	6	1	7
1998	0	0	6	1	7
1999	1	0	4	1	6
2000	0	0	3	0	3
2001	1	0	8	0	9
2002	1	1	3	1	6
2003	1	0	2	0	3
2004	1	0	4	0	5
2005	0	1	2	0	3
2006	0	0	1	0	1
2007	0	1	3	0	4
2008	**0**	**0**	**7**	**0**	**7**
TOTALS	**177**	**78**	**672**	**86**	**1013**

*No study in 1942 ** Yearly totals available from past reports

TABLE II

FATALITIES: INDIRECTLY DUE TO FOOTBALL - 1931-2008*

YEAR	SANDLOT INDIRECT	PRO AND SEMIPRO INDIRECT	HIGH SCHOOL INDIRECT	COLLEGE INDIRECT	TOTAL INDIRECT
**1931-1965	85	15	159	40	299
1966	0	0	6	2	8
1967	0	0	4	1	5
1968	2	0	8	2	12
1969	3	1	8	3	15
1970	0	0	12	2	14
1971	2	1	7	2	12
1972	0	0	10	1	11
1973	0	0	5	3	8
1974	0	0	5	3	8
1975	2	0	3	3	8
1976	1	0	7	2	10
1977	0	0	6	0	6
1978	0	0	8	1	9
1979	1	0	8	1	10
1980	0	0	4	0	4
1981	0	0	6	0	6
1982	1	0	7	3	11
1983	0	0	6	3	9
1984	0	0	3	0	3
1985	0	0	1	1	2
1986	0	0	6	1	7
1987	0	0	4	3	7
1988	1	0	10	0	11
1989	0	0	9	2	11

TABLE 11 CONTINUED

1990	0	0	3	3	6
1991	0	0	3	1	4
1992	1	0	9	1	11
1993	0	0	8	1	9
1994	1	0	2	2	5
1995	1	0	7	1	9
1996	0	1	10	1	12
1997	1	0	7	0	8
1998	1	0	6	1	8
1999	1	0	11	0	12
2000	0	0	11	2	13
2001	0	2	10	3	15
2002	1	0	7	3	11
2003	1	1	4	1	7
2004	0	0	7	3	10
2005	1	1	8	2	12
2006	2	0	12	2	16
2007	1	1	6	1	9
2008	**3**	**0**	**7**	**3**	**13**
TOTALS	**113**	**23**	**450**	**110**	**696**

* No study in 1942 ** Yearly totals available from past reports

TABLE III

DIRECT FATALITIES INCIDENCE PER 100,000 – 1931-2008*

YEAR	HIGH SCHOOL	COLLEGE
**1931-1959		
1960	1.78	1.53
1961	1.62	9.23
1962	1.94	0.00
1963	1.94	3.04
1964	2.23	4.56
1965	2.00	1.33
1966	2.00	0.00
1967	1.60	4.00
1968	2.60	6.60
1969	1.64	1.33
1970	1.92	4.00
1971	1.25	4.00
1972	1.33	2.67
1973	0.58	0.00
1974	0.83	1.33
1975	1.08	1.33
1976	1.00	0.00
1977	0.53	1.33
1978	0.60	0.00
1979	0.23	1.33
1980	0.69	0.00
1981	0.38	2.67
1982	0.54	0.00
1983	0.30	0.00
1984	0.30	1.33
1985	0.30	1.33
1986	0.84	1.33
1987	0.30	0.00
1988	0.46	0.00
1989	0.27	0.00

TABLE III CONTINUED

1990	0.00	0.00
1991	0.20	0.00
1992	0.14	0.00
1993	0.20	1.33
1994	0.00	1.33
1995	0.27	0.00
1996	0.33	0.00
1997	0.40	1.33
1998	0.40	1.33
1999	0.27	1.33
2000	0.20	0.00
2001	0.46	0.00
2002	0.20	0.00
2003	0.13	0.00
2004	0.27	0.00
2005	0.13	0.00
2006	0.07	0.00
2007	0.20	0.00
2008	0.47	0.00

* No study was made in 1942.

** Yearly totals available from past reports.

Based on 1,500,000 junior and senior high school players and 75,000 college players.

TABLE IV

HEAT STROKE FATALITIES 1931-2008*

YEAR	TOTAL
**1931-1954	0
1955	1
1956-1958	0
1959	4
1960-1964	15
1965	6
1966	1
1967	2
1968	5
1969	5
1970	8
1971	4
1972	7
1973	3
1974	1
1975	0
1976	1
1977	1
1978	4
1979	2
1980	1
1981	2
1982	2
1983	1
1984	3
1985	0
1986	0
1987	1
1988	2
1989	2
1990	1
1991	0
1992	1
1993	0
1994	0
1995	4
1996	2
1997	1
1998	4
1999	2

TABLE IV CONTINUED

2000	5
2001	3
2002	0
2003	0
2004	3
2005	2
2006	5
2007	2
2008	**6**
TOTALS	**125**

* No study was made in 1942.

TABLE V

DIRECT FATALITIES 2008: TYPE OF ACTIVITY ENGAGED IN

Type of Activity	Sandlot	Pro	High School	College	Total
Tackled Running Ball	0	0	1	0	1
Blocked	0	0	1	0	1
Tackling	0	0	3	0	3
Collision	0	0	2	0	2
TOTAL	**0**	**0**	**7**	**0**	**7**

TABLE VI

DIRECT FATALITIES 2008: CAUSE OF DEATH

Causes	Sandlot	Pro	High School	College	Total
Brain Injury	0	0	5	0	5
Neck Injury	0	0	0	0	0
Internal	0	0	2	0	2
TOTAL	**0**	**0**	**7**	**0**	**7**

TABLE VII

DIRECT FATALITIES 2008: POSITION PLAYED

Position	Sandlot	Pro	High School	College	Total
Running Back	0	0	2	0	2
Wide Receiver	0	0	1	0	1
Safety	0	0	1	0	1
Linebacker	0	0	2	0	2
Lineman	0	0	1	0	1
TOTAL	0	0	7	0	7

TABLE VIII

INDIRECT FATALITIES 2008: CAUSE OF DEATH

Causes	Sandlot	Pro	High School	College	Total
Heart Related	3	0	3	0	6
Heat Stroke	0	0	4	2	6
Sickle Cell	0	0	0	1	1
TOTAL	**3**	**0**	**7**	**3**	**13**

TABLE IX

HEAD AND CERVICAL SPINE FATALITIES

Year	Head		Cervical Spine	
	Frequency	Percent	Frequency	Percent
1945-1954	87	17.1	32	27.3
1955-1964	115	22.5	23	19.7
1965-1974	162	31.8	42	35.9
1975-1984	69	13.5	14	12.0
1985-1994	33	6.5	5	4.3
1995-2004	44	8.6	1	0.8
TOTALS	510	100.0	117	100.0