# ANNUAL SURVEY OF FOOTBALL INJURY RESEARCH

1931 - 2014

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**Prepared for:**

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

FINAL
March 2015
Report #: 2015-01

**Acknowledgements:**

We acknowledge the significant contributions of recently retired Frederick O. Mueller, Ph.D. who directed The National Center for Catastrophic Sport Injury Research (NCCSIR) from 1982 to 2013. Dr. Mueller's work over the past 30 years has improved the safety of football for the participants and these impacts are demonstrated in the pages of this football report.

We also acknowledge NCCSIR staff members Leah Cox and Sue Wolf, and members of the Consortium for Catastrophic Sport Injury Monitoring: Drs. Douglas Casa, Jonathan Drezner, Kevin Guskiewicz, Johna Register-Mihalik, Steve Marshall, Dawn Comstock, David Klossner, Tom Dompier, and Zack Kerr.

We also thank all the athletes, families, coaches, athletic trainers, medical providers, school staff, state associations, researchers, journalists, and others who have participated in this research and have shared information with the NCCSIR.

**Funding & Disclosures:**

The National Center for Catastrophic Sport Injury Research is funded by the American Football Coaches Association, the National Collegiate Athletic Association, National Federation of State High School Associations, National Athletic Trainers' Association, the National Operating Committee on Standards for Athletic Equipment, and The University of North Carolina at Chapel Hill.

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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 1977, the National Collegiate Athletic Association (NCAA) initiated a *National Survey of Catastrophic Football Injuries*, which is also conducted at the University of North Carolina. 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 and face while blocking and tackling was the direct result of this research.(Mueller & Cantu 2011)

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.(Mueller & Schindler 1991) This clearly illustrates that data collection and analysis is important and plays a major role in injury prevention. 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 (NCCSIR) was established in 1982. The NCCSIR has been directed for the past 30 years by Dr. Frederick Mueller. Dr. Mueller retired Spring of 2013 and the NCCSIR

continues under new direction (Dr. Kucera). The NCCSIR has expanded to become a consortium (University of North Carolina, Boston University, University of Washington, University of Connecticut, University of Colorado, the University of Maryland, and the Datalys Center) with expertise in head/neck, cardiac, and heat-related sport injuries (these three areas account for the overwhelming majority of catastrophic events). The NCCSIR is supported by the American Football Coaches Association (AFCA), the National Collegiate Athletic Association (NCAA), the National Federation of State High School Associations (NFHS), and the National Athletic Trainers' Association (NATA).

## METHODS

### Outcome Definitions

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 (e.g. spine fracture).

**Indirect** – Those fatalities that are caused by systemic failure as a result of exertion while participating in a football activity (e.g. heat stroke) or by a complication which was secondary to a non-fatal injury (e.g. infection).

**Non-exertion related** – Beginning in 2014, NCCSIR is collecting information on suspected cardiac-related deaths that did not occur during exertion (e.g. died in sleep). These events are reported as "Non-exertion related fatalities".

## Data Collection

Data were compiled with the assistance of coaches, athletic trainers, athletic directors, executive officers of state and national athletic organizations, online news reports, and professional associates of the researchers. Throughout the year (January 1 to December 31), upon notification of a suspected football fatality, contact by telephone, personal letter and questionnaire was made with the appropriate individuals including state high school association official, school or team administrator, coach, athletic trainer, and/or team physician. Autopsy reports are used when available.

## Participation in Football

Reports prior to 2012 showed 1,800,000 participants in all levels of football.(Mueller & Colgate 2011) New participation numbers gathered by the National Operating Committee for Standards in Athletic Equipment (NOCSAE), NFHS, and USA Football show the following: NFHS has estimated that there are approximately 1,100,000 high school player's grades 9-12. Research also indicates there are 100,000 post high school players including the National Football League (NFL), NCAA, National Association of Intercollegiate Athletics (NAIA), National Junior College Athletic Association (NJCAA), Arena Football, and Semi-professional football. USA Football estimates there are 3,000,000 youth football players in the United States. Sandlot is defined as non-school, youth football, but organized and using full protective equipment (e.g., Pop Warner, American Football League). These figures give an estimate of 4,200,000 total football participants in the United States each year.(Mueller & Colgate 2012)

NCCSIR staff in collaboration with NFHS staff and Dr. David Klossner, PhD, ATC compiled and prepared this survey report. Medical data for the report were reviewed by Dr. Robert C. Cantu, MD – medical director of NCCSIR.

## Analysis

Yearly incidence rates of football fatality were calculated based on participation estimates as described in the **Participation in Football** section above.

It is important to note that information is continually being updated due to the fact that catastrophic injury information may not always reach the NCCSIR in time to be included in the current report. There may be additional catastrophic football fatalities that are not reported to the NCCSIR.

# RESULTS

## Direct Fatalities

There were six fatalities directly related to football during the 2014 football season: five fatalities were in high school football (all in the fall) and one at the college level (spring football) (Table I). There were no direct fatalities reported in organized youth, professional, or semi-professional levels.

For the approximately 4,200,000 participants in 2014, the rate of direct fatalities was 0.14 per 100,000 participants (95% confidence interval: 0.03 to 0.26). The rate of direct fatalities in 2014 for high school (grades 9-12) was 0.45 per 100,000 participants (95% CI: 0.06 to 0.85) and the rate for college/university was 1.33 per 100,000 participants (95% CI: 0-3.95) (Table III).

The majority (83.3%) of direct fatalities in 2014 occurred during competition; all occurred in regularly scheduled games, and one occurred during practice. The football activities attributed to the direct fatalities were tackling (n=2), helmet to helmet collision (n=1), warm-up drills (n=1), and unknown activities (n=2) (Table V). Of direct fatalities, 83.3% were brain injuries and 16.7% were cervical fractures (Table V).

## Indirect Fatalities

In 2014 there were ten indirect fatalities that occurred among football players during sport activities or physical exertion (Table II). Six fatalities (60%) were associated with high school football (three heart-related, one heat stroke, two hypernatremia/water intoxication), three at the college/university level (two heart-related and one heat stroke), and one at the organized youth level (suspected cardiac) (Table VI). Eight occurred during football-related activities (one game and seven practice), one occurred during other exertional activities (team conditioning session), and one was related to personal conditioning.

## Non-exertional Related Fatalities

There were five fatalities that occurred outside of exertional activity (four athletes died at home and one unknown) (Table VII). The cause of these was suspected to be cardiomyopathy, arrhythmia, and unknown cardiac.

# DISCUSSION

Fatalities in the sport of football are rare but tragic events. A total of sixteen direct and indirect fatalities were recorded for the 2014 football season out of twenty-one fatalities collected by NCCSIR. Even though the rate of direct fatal injuries was very low on a 100,000 participant basis, most occurred during competition situations. It should be noted that practices outnumber the number of game exposures because there are typically five practice sessions for every one game and all players participate during practices. This 2014 report continues a downward trend with six total direct fatal events at an overall rate of 0.14 per 100,000 football

participants (FIGURE II). The 2012 data reported no direct football fatalities in high school, college, or youth football; however, there were two at the semi-professional level. Roughly 80% of brain football-related fatalities from 1990 to 2010 occurred during competition (Boden et al. 2013) and the current year's results continue this trend.

The data illustrates the importance of injury event 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 minimization of football fatalities. Indirect injuries have been in double figures since 1999 with the exception of 2003 and 2007. Since the 1990, indirect fatalities have outnumbered direct fatalities on average 2 to 1 (FIGURE II). An important observation is that the college football level has not recorded a fatality due to complications of sickle cell trait since 2010 when regulations were adopted requiring the athlete know their sickle cell trait status and the publication of multiple best practice documents. Cardiac events were the primary cause of indirect deaths due to exertion in 2014 which is consistent with published research (Harmon et al. 2011). Although rarely reported in the past, there were two reported deaths due to hypernatremia and water intoxication.

Beginning in 2014, NCCSIR is collecting information on non-exertion related fatalities that are suspected to be cardiac-related in order to improve our understanding of the etiology of cardiac-related events and how to prevent sudden cardiac arrest in competitive athletes. NCCSIR captured five fatalities in 2014.

## Head and Neck Injuries

The past 10 years (2005-2014) have recorded the lowest number of head and neck fatalities (36) since data collection began in 1931 (Table VIII and Figure I). This is encouraging and supports the success of past efforts to reduce fatalities in football. Before a 1976 rule change

that eliminated the head as the initial contact point in blocking and tackling, fatalities in football averaged more than 10 a year (Table VIII). There have been fewer than 10 head and neck fatalities per year for the past twenty-five years (Cantu & Mueller 2002; Boden et al. 2013). Rule changes beginning in the 1976 football season that eliminated the head and face as a primary and initial contact area for blocking and tackling were 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 rule 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 (NFHS Football Rules Book 2014). 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. In 2014 the NFHS further defined illegal contact as "targeting" or "an act of taking aim and initiating contact to an opponent above the shoulders with the helmet, forearm, hand, fist, elbow or shoulders." (NFHS Football Rules Book 2014, rule 2-20-2, pg. 31). **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.** Since

1960 most of the direct fatalities have been caused by brain and neck injuries, and in fact since 1990 all but seven of the head and neck deaths have been brain injuries (72). Continuing to reduce head and neck injuries in the sport is paramount.

Another important effort has been and continues to be the improvement of football protective equipment. It is imperative that helmets be purchased, fitted, and properly reconditioned by manufacturer standards. A good rule of thumb is to budget for rotating out a specified number of helmets each year. In addition, helmets 10 years or older will not be reconditioned or returned to the team. Manufacturers, coaches, athletic trainers, athletes, and physicians should continue their joint and individual efforts in preventing head and neck trauma.

The authors of this research report are convinced that the current rules which limit the use of the head in blocking and tackling, coaches teaching the proper fundamentals of blocking and tackling, the helmet technical standard established by the National Operating Committee on Standards for Athletic Equipment (NOCSAE), excellent player physical conditioning, proper medical intervention and care, and an independent data collection system have played a significant role in reducing fatalities and serious brain and neck injuries in football.

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

1. **Conditioning:** Athletes must be given proper conditioning exercises that will strengthen bodies to withstand the workloads and energy expenditure throughout the game given their positions and time played. Strengthening their necks in order to hold their heads in proper position when tackling and to absorb impact energy to control head movement is important. Players should also have appropriate flexibility and range of motion of the shoulder and neck complex. These preparatory activities can

provide the athlete with the ability sustain good tackling and athletic skills throughout the game situations.

2. **Skills:** Coaches should teach and drill the athletes in the proper execution of the fundamental skills, particularly blocking and tackling. Players should keep their head up while tacking and running with the ball. Contact should never with the top of the head/helmet. Initial contact should never be made with the head/helmet or face mask. Research is needed to analyze the mechanisms of impacts during competitions that lead to fatal and catastrophic events.
3. **Rules:** Rules are in place to protect defenseless players, the tackler initiating contact, and the ball carrier. Coaches and game officials should discourage the players from using their helmets in initiating contact when blocking and tackling. The rules prohibiting spearing should be enforced in practice and in games. The players should be taught and held accountable through the rules of play, film sessions, and on the practice field to respect the helmet as a protective device and that the helmet should not be used to initiate contact or as a weapon.
4. **Equipment:** All coaches, equipment managers, athletic trainers, and physicians should take special care to see that players equipment is properly fitted, particularly the helmet. Players should be educated about the use and care of the helmet and other protective equipment and adhere to proper fit guidelines and proper use.
5. **Brain Injury and Concussion:** A brain injury, including concussions, can be caused by a bump, blow, or jolt to the head. This sudden impact or movement of the brain can cause stretching and tearing of brain cells, damaging the cells and create chemical changes in the brain.

a. Signs & Symptoms: When a player has experienced or shown signs and symptoms of head trauma (such as a change in the athlete's behavior, thinking, or physical functioning), they should receive immediate medical attention from an appropriate medical provider and should not be allowed to return to practice or game without an evaluation by an appropriate medical provider and permission from a physician if diagnosed with a brain injury.

b. Reporting & Care: Some cases associated with brain trauma reported that players complained of symptoms or had a previous concussion prior to their deaths. The team physician, athletic trainer, or coach should ensure players understand signs and symptoms of concussion and brain trauma. Players should also be encouraged to inform the team physician, athletic trainer, or coach if they are experiencing any of the signs or symptoms of brain trauma outlined by the CDC.

   HEADS UP ON CONCUSSION IN SPORTS:

   *Information for Parents, Coaches, and School & Sports Professionals.* Available at: http://www.cdc.gov/concussion/headsup/

c. Management & Return to Play: Medical staff must have the unchallengeable authority to assess and make medical decisions for head injuries. Coaches should never make the decision whether a player has a concussion or return the player back to a game or active participation in a practice if that player is experiencing signs or symptoms of brain trauma. In rare cases, an athlete who has not recovered from a concussion and returned to play and receives another severe hit can experience second impact syndrome.

d. Policies: All athletes and athletic personnel should follow the state, NFHS, NCAA, or NFL policies related to concussion prevention, identification, management, and return

to play depending on their level of play. See the following CDC resource for a list of states with concussion policies:

GET A HEADS UP ON CONCUSSION IN SPORTS POLICIES: *Information for Parents, Coaches, and School & Sports Professionals.* Available at: http://www.cdc.gov/concussion/policies.html.

For the most up to date information on concussion management please refer to the updated Consensus Statement on Concussion in Sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012 (McCrory et al. 2013).

Over the last decade, sport governing bodies have adopted new or modified playing rules for football to protect defenseless players, remove targeting from the game, eliminate dangerous play, and stoppage of play for injured players to ensure medical care can be accessed for injuries. In addition, these same governing bodies have published best practices for prevention, recognition, management and return to play for athletes with suspected concussion, spine and brain injuries. Member institutions of these organizations should implement these best practices.

NFHS rules changes affecting risk, (1982-2014). Available at: http://www.nfhs.org/media/1014277/nfhs-risk-minimization-rules-changes-1982-2014.pdf

NCAA changes to minimize risk of injury (2009). Available at: http://fs.ncaa.org/Docs/NCAANewsArchive/2009/Association-wide/ncaa+changes+to+minimize+risk+of+injury+-+12-10-09+-+ncaa+news.html

NCAA Football Practice Guidelines: Year-Round Football Practice Contact Guidelines (http://www.ncaa.org/health-and-safety/football-practice-guidelines). *The Safety in College Football Summit*. Inter-association consensus guidelines for three paramount safety issues in collegiate athletics:

1. Independent medical care in the collegiate setting
2. Concussion diagnosis and management
3. Football practice contact.

NFL timeline of rule changes related to health and safety, (2013). Available at: http://www.nflevolution.com/nfl-timeline/index.html

**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. However, these events were not routinely monitored during this period. From 1960 through 2014 there have been 140 heat stroke cases that resulted in death (Table IV). Authors believe that heat stroke deaths are preventable with the proper precautions. Since 1995, 54 football players have died from heat stroke (42 high school, 9 college, 2 professional, and one sandlot). Ninety percent of recorded heat stroke deaths occurred during practice. During the most recent five year period from 2010-2014 there was an average of 2.6 heat stoke deaths per

year compared to 3.6 per year during the previous five year period 2005-2009. This decline is encouraging and supports continued efforts to educate coaches, school administrators, medical providers, players, and parents concerning the proper procedures and precautions when practicing or playing in the heat. It is important to note that in addition to the two heat stroke deaths this year, there were also two deaths that were a result of athletes *over-hydrating* in order to prevent heat-related issues. Prevention messages must go beyond hydrating but emphasize how to properly hydrate.

Heat stroke and heat exhaustion are prevented by careful control of various factors in the conditioning program of the athlete. The NATA has a heat illness position statement on their web site with recommendations for prevention (http://www.nata.org/sites/default/files/attr-44-03-332.pdf). (Casa & Cisllan, 2009) When football activity is carried on in hot weather, the following suggestions and precautions should be taken:

1. **Pre-Participation Physicals:** 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. **Acclimatization:** Acclimatize athletes to increasing exercise intensity, equipment, and hot/humid environments gradually by providing progressive practice sessions for the first fourteen days of football preseason and any other subsequent practice in hot or humid days. States and governing bodies have rules pertaining to when full football uniforms may be worn.
3. **Monitoring Environmental Conditions:** 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. Anytime the

wet-bulb temperature is over 82 degrees Fahrenheit (28 degrees Celsius) suggests that careful control of all activity should be undertaken. Additional precautions should be taken when wearing protective equipment. The ACSM, NATA, NFHS, and NCAA have all published guidelines for conducting athletic activities in hot and humid environments.

4. **Adjust Activity Levels:** The intensity of exercise is the leading factor that can increase core body temperature higher and faster than any other. Adjusting activity level and providing frequent rest periods can minimize the risk of heat illness in football. Minimize multiple practice sessions during the same day and allow at least three hours of recovery between sessions. Rest during workouts in cool, shaded areas with some air movement and remove helmets and loosen or remove jerseys.
5. **Hydration:** Fluids should be readily available and consumed to aid in the body's ability to regulate itself and reduce the impact of heat stress in practice and games. Players should have water available and be encouraged to drink frequently throughout a practice session. Athletes should drink water before, during, and after practice. Sports drinks that contain sodium (salt) and potassium can be consumed to replace electrolytes lost during activity.
7. **Monitor Athletes:** 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, athlete should return to their previous day's weight before practicing.
8. **Clothing & Equipment:** Clothing is important and a player should wear moisture wicking apparel to dissipate heat. Never use rubberized clothing or sweatsuits.
9. **Identify At-Risk:** Some athletes are more susceptible to heat injury. These individuals are not accustomed to physical activity in the heat, may be overweight, ill

with a fever or other medical condition, and may be the eager athlete who constantly competes at his maximum capacity without heeding warning signs. Athletes with previous heat problems should be monitored.

10. **Emergency Action Plan:** Sports teams should have written emergency procedures in place, all personnel should have copies, and procedures should be reviewed annually. The CDC has guidelines and templates for these plans (http://www.cdc.gov/niosh/docs/2004-101/emrgact/emrgact1.html). NCAA and the NFHS have guidelines for these plans at the following websites: www.nfhs.org and www.ncaa.org.

11. **Heat Illness:**

a. Signs & Symptoms: 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 as athletes are exercising. If heat illness is suspected, seek immediate medical service.

b. Recognition & Care: Coaches, athletic trainers, and players should refer to the multiple published best practices by the NATA, American College of Sports Medicine (ACSM), NFHS, and NCAA on preventing and managing heat illness. Emergency action plans should be activated. First aid should include removal from activity, taking off all equipment and placing the student-athlete in a cool, shaded environment. Fluids should be given orally. Core temperature and vital signs should be serially assessed. The student-athlete should be cooled by ice immersion and ice towels, and use of IV fluid replacement should be determined by a physician. Some

schools have plastic outdoor tubs or swim pools filled with ice water available at practice facilities in hot and humid environments.

## RECOMMENDATIONS

Specific recommendations resulting from the 2014 survey data are as follows:

1. Mandatory medical examinations and medical history should be passed before allowing an athlete to participate in football. The NCAA requires 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 Association. Most state associations require the use of their own medical examination form.
2. All personnel involved with training football athletes should emphasize proper, gradual, and sport-specific physical conditioning.
3. Emergency measures must be in place for all games and practice sessions. Whenever possible certified athletic trainers should be present for all football practices and games. Physicians should be onsite or accessible for all practices and onsite for all games.
4. All personnel associated with football participation should be cognizant of the safety measures related to physical activity in hot weather.
5. Each institution should strive to have a certified athletic trainer.

6. All individuals, groups and organizations interested in sport safety should continue their efforts and collaborations to ensure the safety of football for all participants.
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 of football players in practice and games (rules, facilities, equipment, etc.).
10. Coaches should continue to teach and emphasize the proper fundamentals of blocking and tackling to help reduce brain and neck fatalities. KEEP THE HEAD OUT OF FOOTBALL.
11. Strict enforcement of the rules of the game by both coaches and game 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 (see page 11 of report).
12. When a player has shown signs or symptoms of head trauma, the player should receive immediate medical attention from an appropriate medical provider and should not be allowed to return to practice or game without permission from a physician if diagnosed with a brain injury. All athletes and athletic personnel should follow the state, NFHS, NCAA, or NFL policies related to concussion prevention, identification, management, and return to play depending on their level of play.

13. The number of indirect heart related deaths has increased over the years and it is recommended that schools have and emergency action plan and automated external defibrillators (AED) available for emergency situations.
14. A more recent concern for indirect deaths in football players is sickle cell trait. Research has mentioned that up to 13 college football players have died after an on field collapse due to complication of sickle cell trait. Many athletes do not know their sickle cell status even though screening is done at birth. The NCAA mandates that all student-athletes know their sickle cell trait status or seek testing to confirm their status with a physician. The NATA supports this concept with their statement– *Consensus Statement: Sickle Cell Trait and the Athlete* available at: (http://www.nata.org/sites/default/files/SickleCellTraitAndTheAthlete.pdf). (Inter-Association Task Force on Sickle Cell Trait and the Athlete, 2007) The statement includes precautions for athletes with sickle cell trait.

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## CASE SUMMARIES

*All summaries compiled from publicly available media sources.*

## DIRECT FATALITIES

### HIGH SCHOOL

A male 17 year old senior football player collapsed during the 2nd quarter of a game. He made a tackle near the sideline, got up, jogged about 10 yards, had a seizure, and collapsed. He died at the hospital 2 days later. Media reports indicate that cause of death was due to brain hemorrhage.

A male 17 year old high school junior football linebacker collapsed during a pre-game warmup (running up and down the field). He was rushed to the hospital where he was in a coma. He died 3 days after he collapsed. He had sustained a hit to the back of his head during practice two days prior. He had complained of headaches in the two days prior to his pre-game collapse. Cause of death is due to vertebral artery dissection due to blunt force trauma to the head and neck.

A male 16 year old high school junior football player (offensive linebacker/guard) suffered a head injury during the 3rd quarter of a varsity game after tackling an opponent. It was a big hit in the 3rd quarter of the game. EMS was called and athlete was transported to the hospital where he underwent survey. He died the same day. Cause of death is unknown at this time.

A male junior football lineman sustained an injury during a game. Media reports indicate the possibility of a head-on-head contact during a kick return. Athlete was able to walk off the field where he complained of a headache. Shortly after he collapsed, lost consciousness, and had a seizure. CPR was administered while EMS and med-flight helicopter were called for. He was transported to a local hospital 18 miles away. Shortly after, he was pronounced dead. Preliminary cause of death from the medical examiner is blunt force trauma to the head.

A male 18 year old senior high school football linebacker collapsed during a game due to a traumatic brain injury. During the 3rd quarter he asked the coach if he could sit out the defensive series and was treated by the athletic trainer. The athlete went unconscious and was transported by EMS to the hospital. He was later airlifted to a trauma center where he was treated surgically for a subdural hematoma. He was in a medically induced coma and died 6 days later. Official cause of death is awaiting autopsy.

### SANDLOT

NONE IN 2014

### COLLEGE

A male 19 year old college freshman football running back collapsed during practice. He was airlifted to the hospital and underwent surgery to relieve pressure and swelling in his brain. He was placed in a medically induced coma but died three days later. Review of films did not indicate any particular hit that caused trauma. He had sustained a previous traumatic brain injury in 2012 but had been cleared to play by multiple neurosurgeons and underwent several imaging scans to confirm. No official cause of death has been released.

**PROFESSIONAL**
NONE IN 2014

## INDIRECT FATALITIES

**HIGH SCHOOL**
A male high school junior football linebacker (5'9" 195 pounds) collapsed at home after a workout at the YMCA. Cause of death was due to complications from an enlarged heart.

A male 16 year old high school sophomore football player collapsed at the beginning of football practice after he finished stretching and was walking to the first drill. Paramedics were at practice and immediately attended to him. He was transported to the hospital where he was pronounced dead. Cause of death was due to atrial myxomna, a non-cancerous tumor. Doctors believe the tumor (size of an orange) broke off and blocked blood flow to his heart.

A male 17 year old high school senior football player (offensive lineman) collapsed hours after football practice. He struggled with dehydration and cramping so after the second practice, he consumed 4 gallons of water and electrolyte beverage to prevent these problems. He became ill and was unable to drive himself home. His parent drove him home where he collapsed. He was rushed to the hospital. Six days after collapsing, he was removed from the ventilator. Speculated cause of death is brain swelling due to over hydration (water intoxication).

A male 14 year old high school freshman football player vomited and collapsed at a 2.5 hour morning team-building practice held at an off site location. It was the second day of a 4-day camp and players were wearing full pads. Coaches tried to cool the athlete with water and called EMS. EMS administered CPR and transported the athlete to the hospital where the athlete died. Cause of death was due to heat stroke.

A male 17 year old high school junior defensive tackle football player was acting strangely during a game. His parents took him to the hospital where he began vomiting and having a seizure. He was hospitalized for brain swelling and placed in critical condition. He died 3 days later from cerebral edema secondary to exercise-associated hyponatremia.

A male 16 year old high school junior football defensive tackle (6'2" 321 pound) collapsed during practice after running sprints because he was late. Media reports indicate that he had to run up a steep hill leading to the school to make practice on-time as no local buses run on holidays. Cause of death was ruled as hypertrophic cardiomyopathy (HCM) with obesity as a contributing factor.

**SANDLOT**
A male 12 year old youth league football player collapsed during tackle drills at practice. CPR was begun immediately by an assistant coach who was a fireman. Police arrived shortly after. He was taken to the hospital where he died 5 days later. Cause of death is unknown at this time.±

## COLLEGE

A male 22 year old college football offensive lineman (6'3" 310 pound) collapsed during the beginning of a voluntary conditioning session. Per NCAA rules, no coaches were present besides the strength and conditioning coaches, who administered CPR until paramedics arrived. He died shortly after. Family has stated that he died from cardiac arrest due to an enlarged heart.

A male 18 year old college freshman defensive lineman (6'2" 300 pound) football player became disoriented during practice and was taken to the hospital. He spent 2 weeks in the hospital before his condition deteriorated and he died. Cause of death was heat stroke with complications from enlarged heart and rhabdomyolosis.

A male 21 year old college football defensive end collapsed during a training run. CPR was administered and he was transported to the hospital. The athlete died later. Some reports indicated that he had tested positive for sickle cell trait. He had experienced no health problems in previous workouts. Corner reports cause of death due to an enlarged heart.

## PROFESSIONAL

NONE IN 2014

## NON EXERTION-RELATED FATALITIES

## HIGH SCHOOL

A male 16 year old high school junior football wide receiver/defensive back player was found dead at his home. Cause of death was due to acute cardiac dysrhythmia.

A male 16 year old high school football player died at his home. Cause of death is pending autopsy.±

A male 18 year old senior high school football wide receiver died in his sleep while at home. Cause of death is unknown at this time.±

## COLLEGE

A male 19 year old college freshman football offensive lineman (6'2" 285 pound) became ill over the weekend and was taken by ambulance to the hospital where he died several hours later. Cause of death suspected to be cardiac-related.

A male 21 year old collegiate senior football center lineman failed to show up for morning practice. He was found unresponsive at his home. He was unable to be revived. Corner reports cause of death due to an enlarged heart.

TABLE I: FATALITIES DIRECTLY DUE TO FOOTBALL – 1931-2014[1]

| Year | Sandlot Direct | Pro & Semi-pro Direct | High School Direct | College Direct | Total Direct |
|---|---|---|---|---|---|
| 1931-1965[2] | 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 I (CONTINUED): FATALITIES DIRECTLY DUE TO FOOTBALL – 1931-2014[1]

| Year | Sandlot Direct | Pro & Semi-pro Direct | High School Direct | College Direct | Total Direct |
|---|---|---|---|---|---|
| 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 |
| 2009 | 1 | 0 | 2 | 0 | 3 |
| 2010 | 1 | 0 | 2 | 2 | 5 |
| 2011 | 1 | 0 | 2 | 1 | 4 |
| 2012 | 0 | 2 | 0 | 0 | 2 |
| 2013 | 0 | 0 | 8 | 0 | 8 |
| 2014 | 0 | 0 | 5 | 1 | 6 |
| **TOTALS:** | **180** | **80** | **691** | **90** | **1041** |
| **Percent** | **17.3%** | **7.7%** | **66.4%** | **8.6%** | **100%** |

[1]No study was made in 1942.
[2]Yearly totals available from past reports.

TABLE II: FATALITIES INDIRECTLY DUE TO FOOTBALL – 1931-2014[1]

| Year | Sandlot Indirect | Pro & Semi-pro Indirect | High School Indirect | College Indirect | Total Indirect |
|---|---|---|---|---|---|
| 1931-1965[2] | 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 II (CONTINUED): FATALITIES INDIRECTLY DUE TO FOOTBALL – 1931-2014[1]

| Year | Sandlot Indirect | Pro & Semi-pro Indirect | High School Indirect | College Indirect | Total Indirect |
|---|---|---|---|---|---|
| 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 |
| 2009 | 2 | 0 | 14 | 2 | 18 |
| 2010 | 0 | 0 | 9 | 2 | 11 |
| 2011 | 0 | 0 | 11 | 1 | 12 |
| 2012 | 0 | 0 | 9 | 4 | 13 |
| 2013 | 0 | 0 | 10 | 0 | 10 |
| 2014 | 1 | 0 | 6 | 3 | 10 |
| **TOTAL:** | **116** | **23** | **509** | **122** | **770** |
| **Percent** | **15.1%** | **3.0%** | **66.1%** | **15.8%** | **100.0%** |

[1]No study was made in 1942.
[2]Yearly totals available from past reports.

TABLE III: DIRECT FATALITIES INCIDENCE PER 100,000 PARTICIPANTS – 1931-2014[1, 2]

| Year | High School | College |
|---|---|---|
| 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): DIRECT FATALITIES INCIDENCE PER 100,000 PARTICIPANTS – 1931-2014[1]

| Year | High School | College |
|---|---|---|
| 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 |
| 2009 | 0.13 | 0.00 |
| 2010 | 0.13 | 2.66 |
| 2011 | 0.18 | 1.33 |
| 2012 | 0.00 | 0.00 |
| 2013 | 0.73 | 0.00 |
| 2014 | 0.45 | 1.33 |

[1]No study was made in 1942.
[2]Yearly totals available from past reports.
Rates based on 1,100,000 players grades 9-12, and 75,000 college players.

TABLE IV: HEAT STROKE FATALITIES 1931-2014[1]

| Year | Total |
|---|---|
| 1931-1954[1] | 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): HEAT STROKE FATALITIES 1931-2014[1]

| Year | Total |
|---|---|
| 2000 | 5 |
| 2001 | 3 |
| 2002 | 0 |
| 2003 | 0 |
| 2004 | 3 |
| 2005 | 2 |
| 2006 | 5 |
| 2007 | 2 |
| 2008 | 5 |
| 2009 | 4 |
| 2010[2] | 4 |
| 2011 | 5 |
| 2012 | 1 |
| 2013 | 0 |
| 2014 | 2 |
| **Total since 1995:** | **54** |
| **TOTAL:** | **140** |

[1]No study was made in 1942.
[2]In 2010 two were a combination of heat and sickle cell trait.

TABLE V: CHARACTERISTICS OF DIRECT FATALITIES 2014

| | Sandlot | Pro & Semipro | High School | College | Total (%) |
|---|---|---|---|---|---|
| | n (%) | n (%) | n (%) | n (%) | n (%) |
| **Type of Activity** | | | | | |
| Tackling | 0 | 0 | 2 | 0 | 2 (33.3) |
| Helmet to helmet collision | 0 | 0 | 1 | 0 | 1 (16.7) |
| Warm-up drills | 0 | 0 | 1 | 0 | 1 (16.7) |
| Unknown | 0 | 0 | 1 | 1 | 2 (33.3) |
| **Type of Session** | | | | | |
| Game - regular season | 0 | 0 | 5 | 0 | 5 (83.3) |
| Practice | 0 | 0 | 0 | 1 | 1 (16.7) |
| **Suspected Cause** | | | | | |
| Head/brain | 0 | 0 | 4 | 1 | 5 (83.3) |
| Neck | 0 | 0 | 1 | 0 | 1 (16.7) |
| **Position** | | | | | |
| Running back | 0 | 0 | 1 | 1 | 2 (33.3) |
| Lineman | 0 | 0 | 1 | 0 | 1 (16.7) |
| Line backer | 0 | 0 | 2 | 0 | 2 (33.3) |
| Defensive back | 0 | 0 | 1 | 1 | 2 (33.3) |
| **TOTAL (%)** | **0** | **0** | **5 (83.3)** | **1 (16.7)** | **6 (100)** |

TABLE VI: CHARACTERISTICS OF INDIRECT FATALITIES 2014

| | Sandlot | Pro & Semipro | High School | College | Total |
|---|---|---|---|---|---|
| | n (%) | n (%) | n (%) | n (%) | n (%) |
| **Suspected cause** | | | | | |
| Heart - cardiomyopathy | 0 | 0 | 2 | 2 | 4 (40.0) |
| Heart - other | 0 | 0 | 1 | 0 | 1 (10.0) |
| Heat stroke | 0 | 0 | 1 | 1 | 2 (20.0) |
| Hypernatremia/water intoxication | 0 | 0 | 2 | 0 | 2 (20.0) |
| Unknown± | 1 | 0 | 0 | 0 | 1 |
| **Type of Session** | | | | | |
| Game - regular season | 0 | 0 | 1 | 0 | 1 (10.0) |
| Practice | 1 | 0 | 4 | 2 | 7 (70.0) |
| Team conditioning | 0 | 0 | 0 | 1 | 1 (10.0) |
| Personal conditioning | 0 | 0 | 1 | 0 | 1 (10.0) |
| **TOTAL** | **1 (6.7)** | **0 (0)** | **6 (60.0)** | **3 (33.3)** | **10 (100.0)** |

±Note: event suspected to be Cardiac but there was very little media information about the event.

TABLE VII: CHARACTERISTICS OF NON-EXERTION RELATED FATALITIES 2014

| | Sandlot | Pro & Semipro | High School | College | Total |
|---|---|---|---|---|---|
| | n (%) | n (%) | n (%) | n (%) | n (%) |
| **Suspected cause** | | | | | |
| Heart - cardiomyopathy | 0 | 0 | 0 | 1 | 1 (20.0) |
| Heart - arrhythmia | 0 | 0 | 1 | 0 | 1 (20.0) |
| Heart - unknown | 0 | 0 | 2 | 1 | 3 (60.0) |
| **Type of Session** | | | | | |
| At home | 0 | 0 | 3 | 1 | 4 (80.0) |
| Unknown | 0 | 0 | 0 | 1 | 1 (20.0) |
| **TOTAL** | **0 (0)** | **0 (0)** | **3 (60.0)** | **2 (40.0)** | **5 (100.0)** |

TABLE VIII: HEAD AND CERVICAL SPINE FATALITIES BY DECADE, 1945-2014

| | Head | | Cervical Spine | |
|---|---|---|---|---|
| **Year** | **Frequency** | **Percent** | **Frequency** | **Percent** |
| **1945-1954** | 87 | 16.1% | 32 | 25.8% |
| **1955-1964** | 115 | 21.2% | 23 | 18.5% |
| **1965-1974** | 162 | 29.9% | 42 | 33.9% |
| **1975-1984** | 69 | 12.7% | 14 | 11.3% |
| **1985-1994** | 34 | 6.3% | 5 | 4.0% |
| **1995-2004** | 45 | 8.3% | 2 | 1.6% |
| **2005-2014** | 30 | 5.5% | 6 | 4.8% |
| **TOTALS** | **542** | **100.0%** | **124** | **100.0%** |

FIGURE I: HEAD AND CERVICAL SPINE FATALITIES BY DECADE, 1945 to 2014

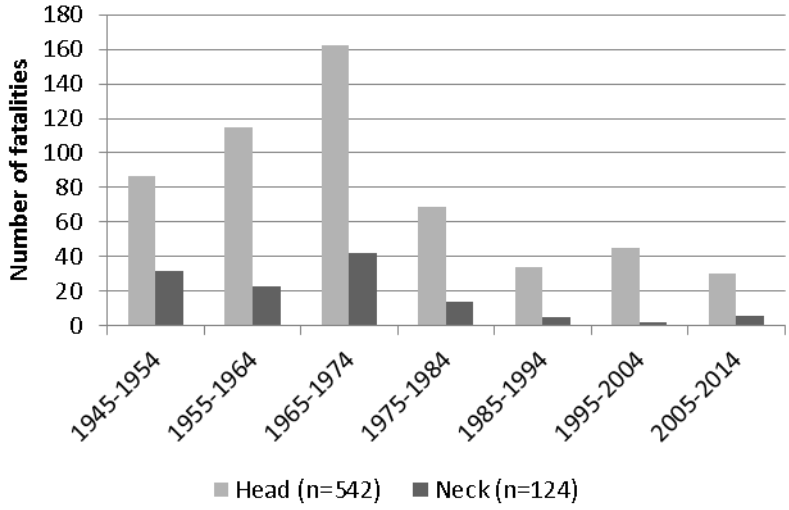

FIGURE II: NUMBER OF DIRECT AND INDIRECT FATALITIES BY 5-YEAR PERIOD, 1970 to 2014