The Incidence and Prevention of Catastrophic Injuries in Track and Field Due to Falls: Applications of Haddon's Injury Prevention Countermeasures and Matrix

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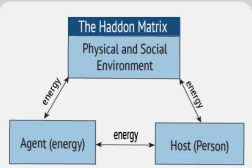
Introduction

- Track and field is the most popular sport for high school women and the second most popular for high school men.[1]
- Track and field is thought to have lower rates of catastrophic injuries compared to other sports, but they still occur and have devastating effects on the athletes who sustain them.[2,3]
- From 1982 to 2019, the National Center for Catastrophic Sport Injury Research (NCCSIR) captured 85 catastrophic injures in track and field.[3]

Haddon's Injury Prevention Matrix and Methods

- Dr. William Haddon believed that injury control could be mitigated by modifying the energy transfer among a host, agent, and environment.[4]



- Haddon's ten countermeasures identify a general injury reduction strategy to guide the formation of prevention strategies for specific events.[5]

Methods

Data Collection

- The data used for this study was collected by NCCSIR from 7/1/1982 to 6/30/2019. Cases are captured via publicly available media reports, direct reports from sport and medical organizations and individuals including school and medical staff, and other researchers.
- Additional cases were gathered through ad hoc searches of public media reports through internet search engines from 8/1/2020 to 10/30/2020.

Inclusion Criteria

- High school and collegiate track and field athletes who sustained a direct catastrophic injury from a fall.
- A direct catastrophic injury was defined as any severe injury sustained during a high school or college sponsored sport that resulted in death, permanent disability, or temporary disability with full recovery.[3]
- Cases were reviewed to confirm that the injury was the result of a fall. Cases that did not have enough information to confirm a fall were excluded from the analysis.

Statistical Analysis

- Descriptive statistical analyses were performed with SPSS Statistics 26. Fisher's exact tests were used to determine differences between injury and athlete demographics by sport level and severity. The level of significance was set at < 0.05.

Countermeasure Analysis

- Case details of 3 catastrophic injuries from falls were presented to determine Haddon's countermeasures.
- A total of 12 cases were selected because of their similar mechanism of injury and because there was an adequate level of detail to complete the analysis.

Results

Incidence

From 1982 to 2019, NCCSIR captured 61 catastrophic injuries in track and field from falls among high school and collegiate athletes.

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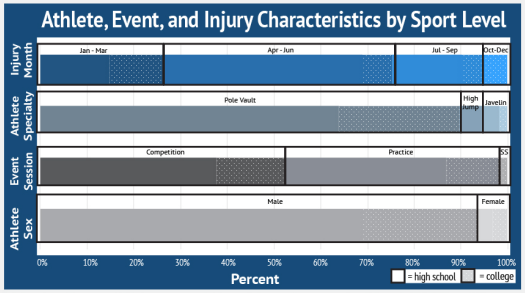
Athlete, Event, and Injury Characteristics by Sport Level

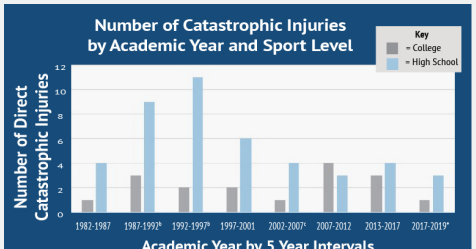


- Most college athletes were injured from January to March (26%) while most high school ahtletes were injured from April to June (49%) ($p<0.05$).
- The remaining variables did not differ by sport level ($p>0.05$).
- All fatal and permanent injuries and 80% of head/skull injures were among pole vaulters.
- The severity of the injury did not vary by sex, sport level, injury month, type of session, or fall height.

Haddon's Ten Countermeasures

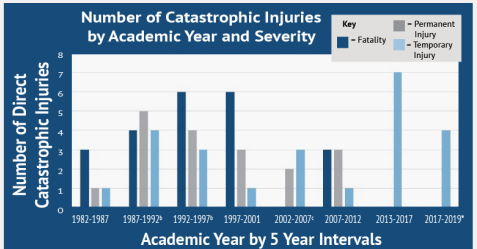
- Countermeasures 9 (Begin to counter damage early from the hazard) and 10 (Stabilize, repair, and rehabilitate the object of damage) were applied to all 12 cases.
- In this study, countermeasure 9 suggests early recognition and implementation of an emergency action plan (EAP), onsite access to an athletic trainer, and rapid activation of EMS. Countermeasure 10 recommends providing definitive medical care.

Number of Catastrophic Injuries by Academic Year and Sport Level



- The number of fall-related catastrophic injuries for high school athletes appeared to decrease, whereas the number for collegiate athletes remained consistent.

Number of Catastrophic Injuries by Academic Year and Severity



- By severity, the number of fatalities and permanent injuries appeared to decrease over the period while the number of temporary injuries appeared to increase.

[a] 1987 rule change: front buns (front pads that extended between the standards and around the box) were mandated
[b] 1995 rule change: athletes' weight must be at or below pole's rating, (recommended) all non-soft surfaces adjacent to pit be padded
[c] 2003 rule change: mandated an increase in pit size to 19'8 x 16'5
* Two-year interval due to data constraints

Table 3. Narrative and Associating Haddon Countermeasure (3/12)

Narrative	Countermeasures
A male senior **high school athlete** was injured during a **meet** when he was **pole vaulting** and his pole snapped. It is unknown if his pole was within regulation. He fell into his pole which impaled and struck his orbital bone. He was transported by EMS via ambulance. A **full recovery** was expected.	**5. Separate the hazard from that which is to be protected by time and space** (limit the distance from the pit allowed to be vaulted from) **9. Begin to counter damage from the hazard** (early recognition and implementation of EAP, have onsite access to an athletic trainer, and rapid activation to EMS) **10. Stabilize, repair, and rehabilitate the object of damage** (provide advanced definitive care)
A male sophomore **high school athlete** was injured during a **meet** when he was **pole vaulting**. His pole stalled as he reached the peak of his arch and fell backwards towards the runway. His head struck the concrete and fractured his skull. A **full recovery** was expected.	**8. Make what is to be protected more resistant to the damage from the hazard** (use protective gear, eg. helmets) **9. Begin to counter damage from the hazard** (early recognition and implementation of EAP, have onsite access to an athletic trainer, and rapid activation to EMS) **10. Stabilize, repair, and rehabilitate the object of damage** (provide advanced definitive care)
A female sophomore **high school athlete** was injured during an indoor **practice** when she was **pole vaulting**. Her pole stalled to the side she fell sideways toward the side mats. As she fell, she misjudged her landing and landed halfway on the mat and her head struck the floor. A **full recovery** was expected.	**6. Separate the hazard from that which is to be protected by a physical barrier** (add additional mats in front of the standards and on the hard arounds surrounding the pit) **8. Make what is to be protected more resistant to the damage from the hazard** (useprotective gear, eg. helmets) **9. Begin to counter damage from the hazard** (early recognition and implementation of EAP have onsite access to an athletic trainer, and rapid activation to EMS) **10. Stabilize, repair, and rehabilitate the object of damage** (provide advanced definitive care)

Results

Haddon's Matrix

	Host (Person)	Agent (Energy)	Physical Environment	Social Environment
Pre-Event	Teach athletes proper technique before vaulting	Use athletic tape and keep poles dry to increase grip and slipping	Ensure minimum mat standads and connections before use	Cultivate social norms of safety and safe practices
Event	Teach athletes how to land to minimize/avoid injury	Teach athletes to push poles away and reduce areas of gaps	Ensure mats are in good condition and consider additional pads around landing area	Ensure coach and athletic trainer are present and available
Post-Event	Teach coaches and athletes how and when to get assistance	Ensure that poles are caught after vault to avoid damage from hitting ground	Place pit and runway in an open area that is easily accessible to athletic trainer and EMS	Ensure that coaches and athletic trainers are equipped with first aid training

Conclusions

- Falls in track and field can lead to severe injuries, including fatalities.
- The greatest number and most severe falls were due to pole vaulting.
- Many different prevention measures can be taken to reduce injuries and any number of these seemingly small strategies could have the potential to reduce the severity of injuries for athletes.
- These fall-related catastrophic injuries highlight the importance of continued surveillance to improve our understanding of the incidence and injury patterns to develop interventions to reduce the impact these injuries have on athletes.

References

[1] High school participation survey archive. National Federation of State High School Associations, 2019 Aug.

[2] Mueller, Frederick O., Kucera, Kristen L., Cox, Leah M., Cantu, Robert C. Catastrophic sports injury research: Thirtieth annual report, Fall 1982 – Spring 2012. The National Center for Catastrophic Sport Injury Research at the University of North Carolina at Chapel Hill, 2012.

[3] Kucera, Kristen L., Cantu, Robert C. Catastrophic sports injury research: Thirty-seventh annual report, Fall 1982 – Spring 2019. The National Center for Catastrophic Sport Injury Research at the University of North Carolina at Chapel Hill, 2019.

[4] Haddon W Jr. Energy damage and the 10 countermeasure strategies. 1973. Inj Prev. 1995 Mar; 1 (1): 40-4.

[5] Runyan CW. "Introduction: back to the future--revisiting Haddon's conceptualization of injury epidemiology and prevention." Epidemiol Rev. 2003; 25: 60-4.

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 American Medical Society for Sports Medicine, and the National Operating Committee on Standards for Athletic Equipment.