Pediatric and Adolescent Injury in Skiing

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No disclosures

[2015 GoPro Jr Big Mountain Challenge - Breck]

But First…

Dylan Ladd

Treating him and his brothers since they were in elementary school

His younger brother is just as good…

Introduction

• Alpine skiing participation significantly increased over the last three decades

• Children and adolescents account for 13-27% of the estimated 200 million skiers globally

• Inclusion of skiing (alpine, freestyle) in the Youth Olympics is a factor possibly driving the popularity of skiing among children and adolescents and potentially increasing incidence and severity of injuries

Introduction

- We used the key words “skiing”, “snow sports”, “skiing injuries”, “adolescent skiing”, “youth skiing”, and “avalanche”

- Screened using the following inclusion criteria:
  - potentially relevant information
  - primary research
  - pediatric and adolescent skiers, specifically alpine (on- and off-piste)
  - cohort for study was > 10 subjects
  - mean age of cohort was < 17 years of age

- 70 studies used for this review

Limitations

- Only manuscripts written in English
- Grouping of pediatric and adult populations and did not provide a separate analysis of pediatric injuries
- Wide variety of injury outcomes, which differed greatly in definition, type and severity of injury
- Data on skiing and snowboarding injuries were combined in many studies, making it difficult to extrapolate ski-specific injury data

Who is affected by injury?

• School-aged children to young teenagers (7-14 years) were more likely to sustain an injury than children (0-6 years) and older teenagers (15-17 years)

• A higher injury incidence was reported in children/adolescents (< 17 years) relative to adults (> 18 years)

• Macnab and Cadman (1996) reported the highest rate of injuries among children 7-12 years (4.75 injuries/1000 skier exposures), followed by 13-17 years (4.35 injuries/1000 exposures), and 0-6 years (3.81 injuries per 1000 exposures)

Who is affected by injury?

• Selig et al. (2012) found that the greatest proportion of child/adolescent alpine skiers requiring HEMS were 10-14 years of age (69.3%), followed by 6-9 years (25.2%), and 3-5 years (5.5%)

• However, these findings may not necessarily reflect differences in risk since the subjects may have been differentially exposed to risk of injury

Where does injury occur?

• Lower limb injuries are the most common recreational injuries with the proportion of lower limb injuries ranging from 22%-72% of all injuries

• These findings are consistent with competitive alpine skiing as reported by Ruedl et al. (2016) (41.7% of overall injuries to knee, lower leg, and ankle) and Westin et al. (2012) (49% of overall injuries to the knee and lower leg) in skiers younger than 18 years

• Knee injuries were the most common injury, reported to be 10.3%-47.7% of all lower limb injuries

• Lower leg injuries consisted of 9%-37.5% of all injuries, while ankle injuries made up 3.1%-10% of all injures

Where does injury occur?

- Upper extremity injuries are also common in youth alpine skiing, making up 5-42.3% of all injuries
    - Hand/wrist/thumb injuries 11%-16.67% of injuries
    - Arm/shoulder accounted for 7.8%-9% of injuries

- Head injuries 5%-51.5%, Neck injuries 2.82-7.7%, Face injuries 4.32%-6.72%

- Spine injuries 0.34%-35%

- Abdominal injuries 3.7%-20%

Where does injury occur?

- Snowfall of 0-2.9 inches resulted in a significant increase in injuries compared to increased amounts of snowfall, and less snowfall resulted in an increased severity of the injury

- When comparing different slope conditions, icy conditions were associated with the highest prevalence of injury (40%-51.5% of injuries), followed by powder snow (29.7% of injuries), and wet snow (16.8% of injuries)

Where does injury occur?

- Terrain parks, jumps, half-pipe and rails are also associated with the highest prevalence of injury and incidence of severe injuries (fractures of any type or location, concussions, ruptures, sprains, strains, and dislocations)

Where does injury occur?

- Risk of collisions is highest at slope intersections

- The highest prevalence of injury was observed on “flat” slopes (66.7% of injuries), “moderately” steep (25.7% of injuries) and "medium" steepness (4% of injuries)

When does injury occur?

- Majority of injuries and mortalities occurred during the first few minutes of skiing (<0.1 hours) or in the afternoon, which is defined as after 12:00 PM or after approximately three hours of skiing

- Saturday shows the highest prevalence of injury or mortality

- January and February have the highest reported injury rate

When does injury occur?

- From the 1970's to the early 2000's, ACL injuries increased in the pediatric population

- Head/neck/face injuries and TBI incidence significantly increased in the pediatric population from 1996-2010

What is the outcome?

• Fractures, lacerations, sprains, and contusions contributed to the major types of injuries seen in pediatric and adolescent skiing

• Leg contusions, medial collateral ligament injuries, skier's thumb, concussions, tibia fractures, wrist injuries, upper body lacerations, soft tissue shoulder injuries, ACL injuries, and ankle sprains are the top 10 injuries seen in the children/adolescent for skiing injuries

What is the outcome?

- Head trauma is considered the leading cause of mortality from skiing/snowboarding injuries (67%)

- The annual average incidence rate for TBI has been reported 2.24 per 10,000 resort visits in children and 3.13 per 10,000 resort visits for adolescents

- Majority of injuries from skiing are severe enough to require patients to rest for 8-28 days (48%) before returning to skiing

- Orthopedic and spinal surgeries are the most common surgical intervention

What are the risk factors?

- Individuals attending ski school reported fewer injuries compared to those who did not attend

- Generally agreed that the literature regarding injury or mortality risk due to gender for children is inconclusive

- In skiers aged 3-12, it was found that injuries were more when bindings were ill-adjusted versus well-adjusted (odds ratio: 2.11)

- For children aged 3-12, the odds ratio was as high as 7.14 with increased risk of injury when using rented versus owned ski equipment

What are the risk factors?

- Ability, measured by skill or experience level, is one of the most studied risk factors for snow sport injuries

- In Hume et al.'s (2015) meta-analysis review, the pooled odds ratio for 16 studies was 2.72 for beginner level snow sports participants

- This is only specifically documented in pediatric aged skiers in Goulet et al. (1999) where low-level skiers were more likely to be injured than high-level skiers (odds ratio ≤ 7.54)

What are the risk factors?

- The literature supports helmet use as protective against injury

- Macnab et al. (2002) found helmet reduced the risk of head, neck, or face injury in skiers under 13 years with a relative risk of 2.24 for participants who were not helmet users

- Milan et al. (2017) found that among pediatric ski and snowboard injuries admitted to the Intensive Care Unit (ICU), those wearing a helmet had significantly lower injury severity scores (ISS; $p = 0.007$) and abbreviated injury severity scores (AIS; $p = 0.011$) than unhelmeted patients

- Helmet use does not appear to increase risk-taking behavior by snow sports participants and does not increase risk of injury (Haider et al., 2012)

What are the inciting events?

- Falls and non-collision events are the most common cause of injury in skiing

- Falls were 84.8% of injuries compared to collisions in a study of trauma admissions for ski and snowboard injuries

- Fatalities at Colorado ski resorts revealed that most child skiing fatalities occur due to traumatic brain injury from collision, most frequently with trees

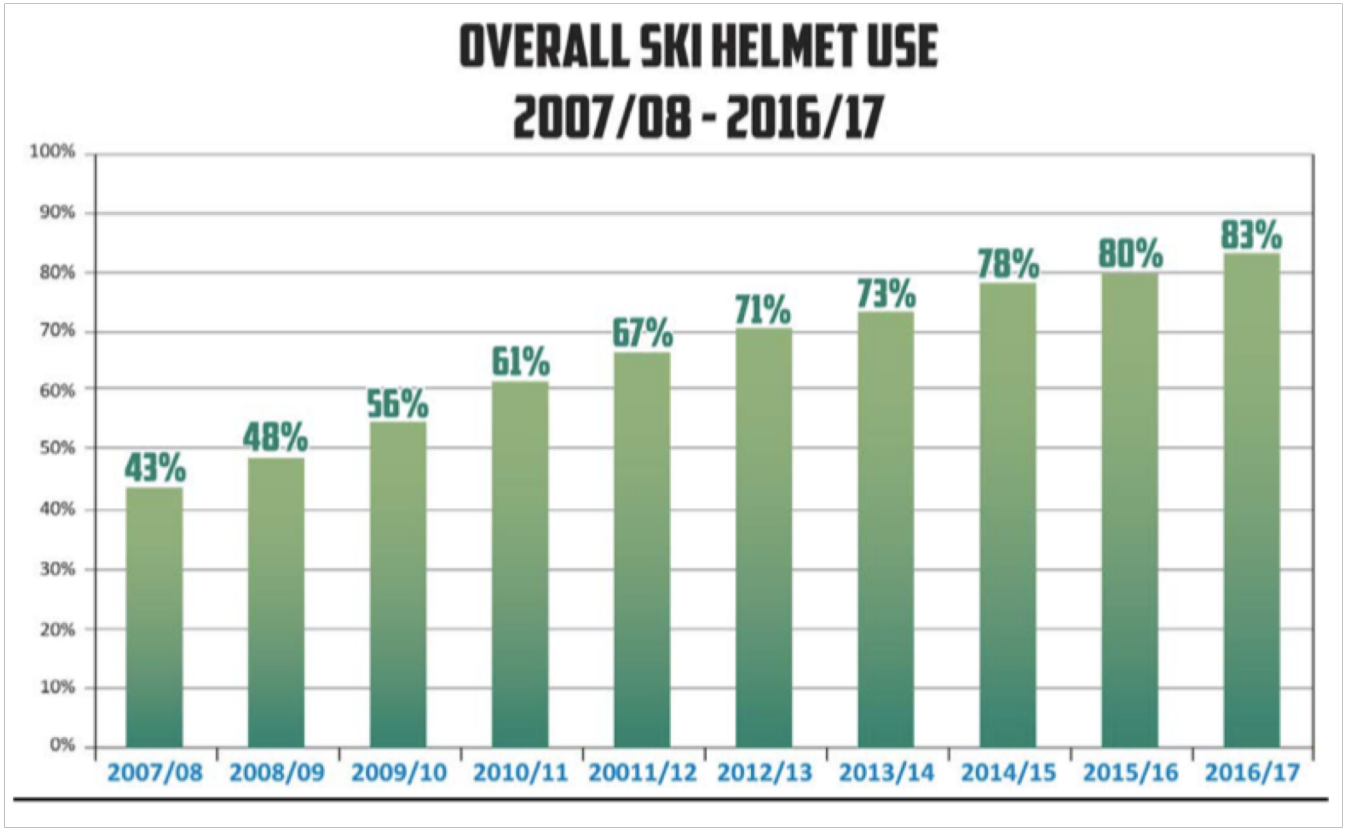
- Across all ages, most frequently TBIs were caused by falls (54%), followed by collision between people (18%), and jumps (15%)

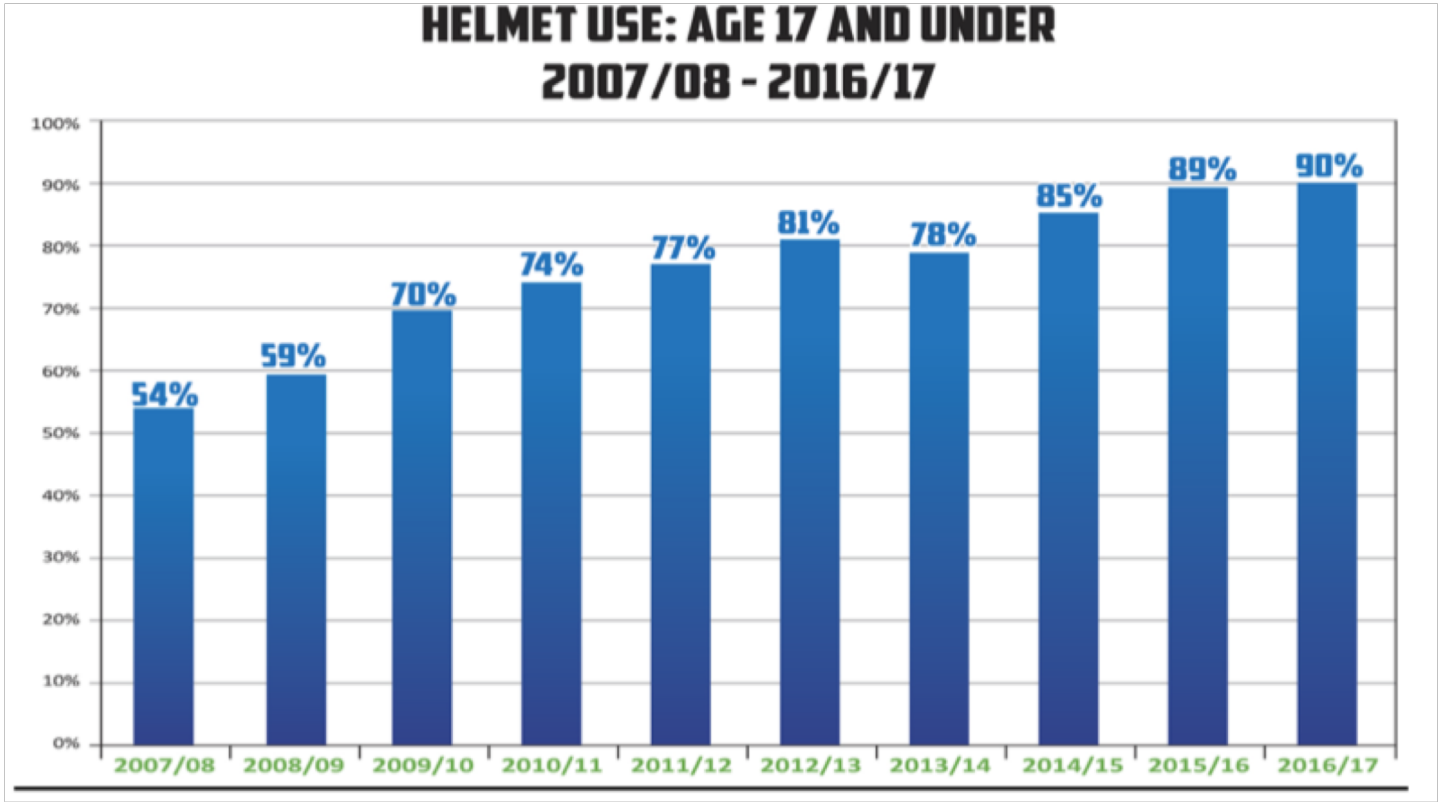
Injury prevention

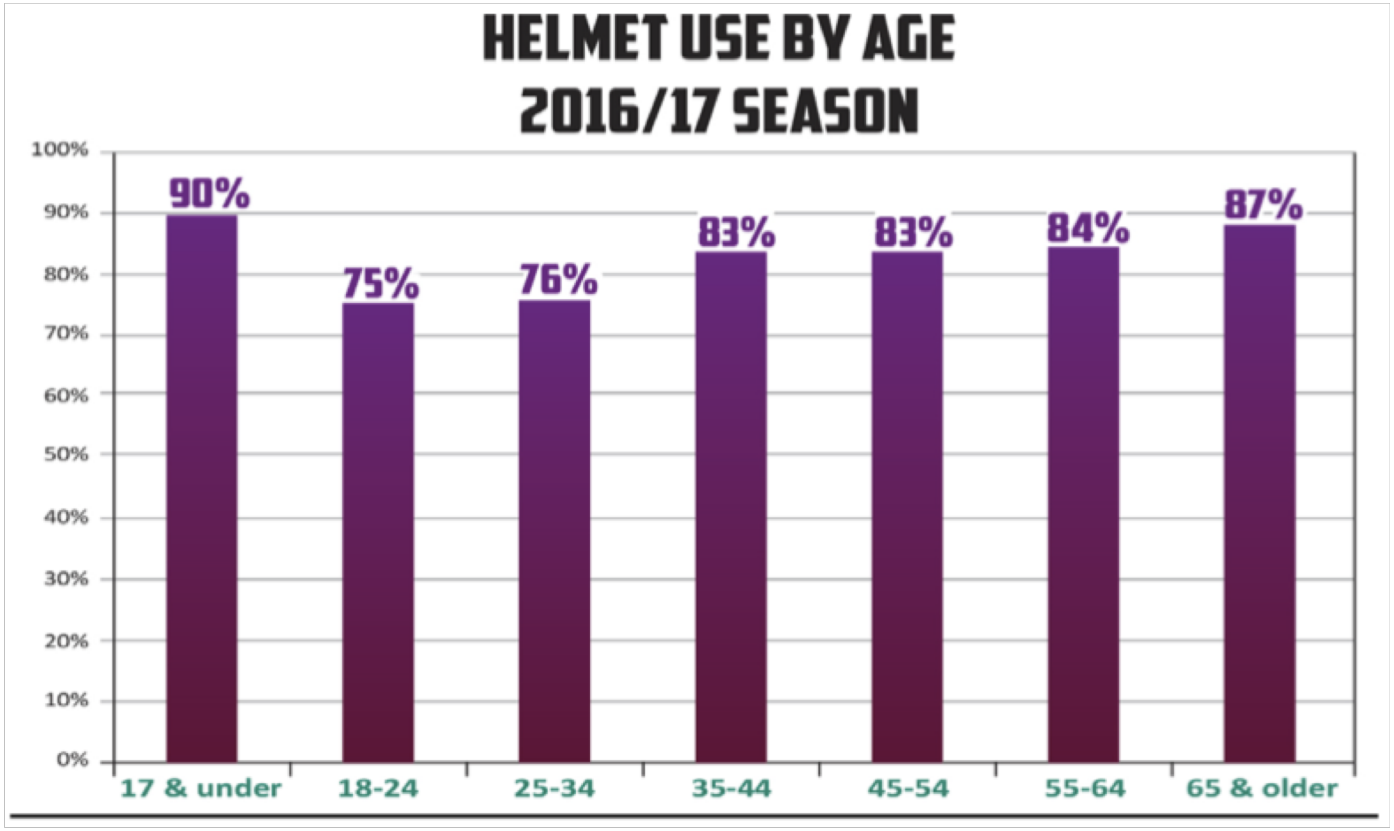
- There is a paucity of research designed to test preventive measures among child and adolescent skiers beyond helmet use

- Most injury prevention programs aim to change individual participants' knowledge and/or behavior, rather than extrinsic modifiable risk factors

- These studies have not been shown to decrease injury rates


OVERALL SKI HELMET USE
2007/08 - 2016/17
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
43%
48%
56%
61%
67%
71%
73%
78%
80%
83%
2007/08
2008/09
2009/10
2010/11
20011/12
2012/13
2013/14
2014/15
2015/16
2016/17


HELMET USE: AGE 17 AND UNDER
2007/08 - 2016/17
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
54%
59%
70%
74%
77%
81%
78%
85%
89%
90%
2007/08
2008/09
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
2016/17


HELMET USE BY AGE
2016/17 SEASON
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
90%
75%
76%
83%
83%
84%
87%
17 & under
18-24
25-34
35-44
45-54
55-64
65 & older

NSAA Skier/Snowboarder Helmet Use

- Helmet use among minors has also seen sizeable gains:
  - 32% of skiers and riders 17 and under wore helmets in the 2002-03 season
  - 90% of skiers and riders in this age group wore helmets in the 2016-17 season
- Both the Northeast region (CT, MA, ME, NH, NY, RI, and VT) and the Rocky Mountain region (CO, ID, MT, NM, UT, and WY) lead the country in terms of total helmet usage

NSAA Skier/Snowboarder Helmet Use

- New Jersey is still the only state that requires those under the age of 18 to wear a helmet while skiing or snowboarding
- 97% of children ages 9 and under wore helmets in the 2016-17 season

Should you wear a helmet?

- Current evidence strongly suggests that helmets may prevent or reduce the severity of many head injuries
- Even the best currently available helmet cannot protect you against all potential impacts
- If you are unlucky enough to hit a tree or other static object when travelling at the speed of an average intermediate skier or snowboarder, the forces will likely exceed the protective capabilities of any helmet

Summary of Data

- Helmets protect at lower speeds (<12 mph) and skiers or snowboarders are typically hitting trees at 25-40 mph
- More than 80% of CO ski deaths are male

Future research

- A study evaluating hamstring muscle eccentric force and activation during skiing may be a predictor of risk of ACL injury in young skiers

- A systematic review or meta-analysis with quantitative measurements, comparing skier and snowboarder severity of injury should be conducted to determine whether skiers or snowboarders are at greater risk for severe injury in the pediatric population

Future research

- Preventative studies should focus on risk reduction factors, which do not rely on individual behavior. Such as education of beginning skiers at time of equipment rental

- Biomechanical assessment during skiing is a growing focus for risk reduction in skiing and should consider the biomechanics of children as unique from adults

Consideration

In bounds:

- Average death in CO is a 37 year old experienced male skier wearing a helmet and loses control on an intermediate, groomed run and hits a tree
- 54% of deaths on blue groomed runs, 31% on expert trails


ALTA