Alabama AAP Fall Meeting Sept.19-20, 2009

EBM: Sports Injury Prevention in Children

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Quiz

- 1) All of the following are proven sports injury prevention strategies except:
  - a) Ankle Braces for ankle injuries
  - b) Knee Braces for knee injuries
  - c) Insoles for lower leg injuries
  - d) Mouth guards for concussions
  - e) Wrist guards for wrist injuries
- 2) True or False: Neuromuscular training programs have been proven to lower the rate of ACL tears in female soccer players.
- 3) True or False: Weight training programs have been proven to lower overall injury rates.
- 4) All of the following are recommendations from USA baseball for injury prevention in youth pitchers except:
  - a) Pitch counts should be monitored and regulated in youth baseball.
  - b) Throwing breaking pitches before physical maturity should be encouraged.
  - c) Pitchers should develop proper mechanics as early as possible and include more year-round physical conditioning.
  - d) Pitchers should be prohibited from returning to the mound in a game once he/she has been removed as the pitcher.
  - e) Pitchers are discouraged from pitching for more than one team in a given season.
- 5) True or False: Chest protectors and safety balls reduce the risk of Commotio Cordis.

Objectives

- Identify key resources for further information on sports injury prevention
- Understand the nature of sports injuries and strategies for prevention
- Provide parents with evidence based guidance on sports injury prevention

Injury Prevention Model

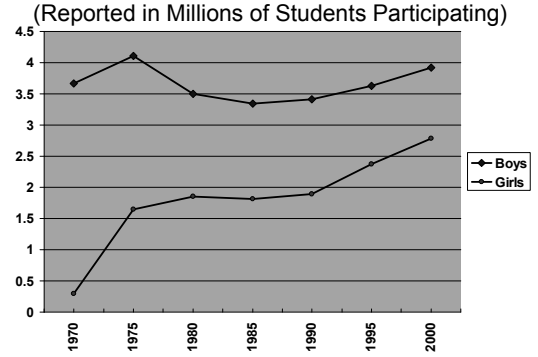
- Define the Problem
- Identify the Risk Factors
- Design an Intervention
- Test the Intervention
- Implementation of Intervention
- Evaluation

2008 World Congress on Sports Injury Prevention

- Tromso, Norway
- Land of the Midnight Sun
- Mack Beer – northern most Brewery in the world
- 3rd World Congress in Monaco April 7-9, 2011

- If you had a proven injury prevention technique what do you think is the best way to implement it?

Sports Participation by High School Students 1970-2000
(Reported in Millions of Students Participating)

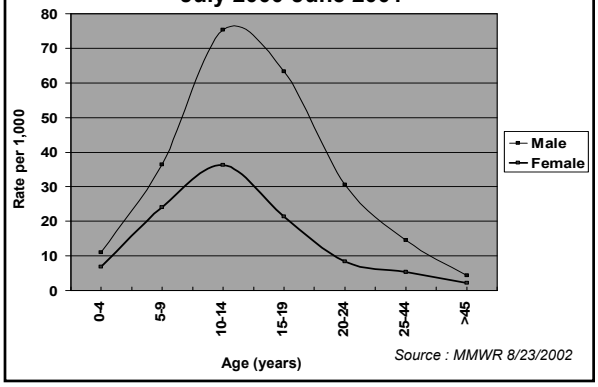


Source : www.nfshsa.org

Sports participation and injuries

- Estimated 30 million in organized sports
- July 2000-June 2001
  - ~4.3 million sports/recreational injuries in ER
    - 16% of all unintentional injury-related ER visits
  - About 3.5 million MVA visits per year
  - Boys age 10-14 most commonly injured
    - 51% of all unintentional injury-related visits

Sports/Recreational Injury Rates from ER visits, July 2000-June 2001



Source : MMWR 8/23/2002

Top 5 Sports/Recreational Injuries July 2000-June 2001, Ages 5-9

Boys	Girls
1. Bicycle (85k)	1. Playground (58k)
2. Playground (68k)	2. Bicycle (53k)
3. Football (25k)	3. Scooter (15k)
4. Scooter (21k)	4. Trampoline (14k)
5. Baseball (20k)	5. Swimming (9k)

Source : MMWR 8/23/2002

Top 5 Sports/Recreational Injuries July 2000-June 2001, Ages 10-14

Boys	Girls
1. Football (145k)	1. Basketball (53k)
2. Bicycle (124k)	2. Bicycle (39k)
3. Basketball (118k)	3. Soccer (28k)
4. Baseball (47k)	4. Gymnastics (23k)
5. Swimming (39k)	5. Softball (20k)

Source : MMWR 8/23/2002

Top 5 Sports/Recreational Injuries July 2000-June 2001, Ages 15-19

Boys	Girls
1. Basketball (169k)	1. Basketball (38k)
2. Football (139k)	2. Gymnastics (22k)
3. Bicycle (53k)	3. Soccer (20k)
4. Soccer (30k)	4. Softball (17k)
5. Combative* (29k)	5. Volleyball (12k)

* - Wrestling, Boxing, Martial Arts, Fencing

Source : MMWR 8/23/2002

Vanderbilt University Audience Response System (VUARS)

- The speaker will ask you a yes or no question
- If you believe the answer to be "Yes" raise your arm in a vertical fashion
- If you prefer the answer "No" simply rest your hand at your side
- The speaker will make a quick count of hands raised
- Indifference counts as a "No"

Q & A (1)

- Do orthotics (insoles) prevent leg injury?
- Do ankle braces prevent ankle injury?
- Do knee braces prevent knee injury?
- Do wrist braces prevent wrist injury?
- Do exercise programs prevent injury?

Sari Aaltonen, PT et al. Prevention of Sports Injuries Systematic Review of RCT's, *Arch Intern Med.* 2007;167(15):1585-1592.

- 32 trials (25k participants)
- evidence of a preventive effect in 3 types of interventions
- 5 trials (2500 participants) - insoles reduced leg injuries in military recruits (risk reduction 50%).
- 7 studies of external joint supports (10k participants) showed prevention of ankle, wrist, or knee injuries (risk reduction 50%).
- 6 training programs (2800 participants) were effective in preventing sports injuries (risk reduction 50%).
- Decrease risk of sports injuries was associated with the use of insoles, external joint supports, and multi-intervention training programs

Insoles

- 5 trials, 6 comparisons (2500 military recruits) effectiveness of different insoles to reduce leg injuries.
  - All showed preventive effects of insoles compared with controls.
  - All showed injury risk reduction of >30%, and in 4 the risk reduction was >50%.
  - Effectiveness of custom-made and prefabricated insoles similar
- 1 study compared 19 different types of orthoses we and no difference was found.

External Joint Supporters

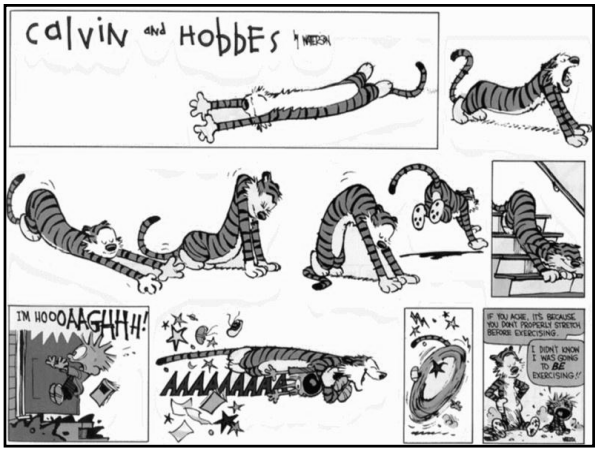
- 4 studies of ankle orthoses, stabilizers, and outside-the-boot braces reduced ankle injuries
  - Risk reduction >30% in one and >50% in 3.
- Knee supports worn by military cadets while playing football showed a preventive effect on knee injuries.
- 2 studies - Wrist protectors for snowboarding showed a similar effect in preventing wrist injuries (ORs, 0.12 and 0.27).
- 7 studies - external joint supports (10k participants) showed reduction of risk of injury compared with controls.
  - Injury risk was reduced by >30% in one and >50% in 6.

Training Programs

- 4 trials (1800 participants) - balance board training only - contradictory results
  - 2 studies - rate of injuries was significantly reduced by training
  - 2 studies - no difference
- 2 multi-intervention trials + balance board training (400 participants) - significant reduction in the number of injuries vs. controls
- 4 Multi-intervention programs – exercise and rehab, no balance board training (2400 participants)
  - All favored the use of multi-intervention programs.
- All 6 multi-intervention training programs (3000 participants) showed a reduction in the risk of injury in the intervention groups.
  - Injury risk was reduced by >30% in one and by >50% in 5.

Q & A (2)

- Does stretching prevent injury?
- Does warming up prevent injury?
- Do mouth-guards prevent concussion?
- Do high top sneakers prevent injury?
- Do Instructional videos prevent injury?



Other Interventions

- 3 trials on stretching and warm-up (3000 participants) - no preventive effects on leg injuries
- Mouth Guards
  - 650 university football/ rugby players did not change the number of concussions
  - prevented head injuries (including orofacial) in 300 Australian football players.
- Modified basketball shoes - no preventive effect on ankle sprains or other leg injuries.
- Instruction Videos - 2 studies (1000 individuals)
  - reduction in the number of downhill skiing injuries but not soccer injuries.

McGuine T. Sports injuries in high school athletes: a review of injury-risk and injury-prevention research. CJSM. 2006 Nov;16(6):488-99.

- HS athletes (ages 14 to 18), injury and exposure data for entire season or school year.
- 29 studies
- Risk factors for injury in soccer, American football, and basketball have been documented.
  - Other sports are less well represented.
- Risk factors for injuries to the ankle, head, and knee have been identified
  - UE injury risk factors are less well known.

Extrinsic Risk Factors

- Session (Competition/Practice)
- Playing Surface
- Protective Equipment
- Coaching Education and Training

- Q & A (3)

Session

- Studies report athletes being at greater risk of injury during competition versus practice
  - dramatically increased - basketball, football and soccer
  - smaller increases - females, male lacrosse players, and wrestlers.
- Study of 3200 cross-country runners
  - more injuries occurred during practice than during competition.
  - probably related to training volume

Playing Surface

- Not much information on surface conditions and risk of injury for HS athletes.
- Natural grass vs. FieldTurf in football (8 high schools over 5 years)
  - Grass - noncontact epidermal and muscle-related trauma
  - FieldTurf - injuries to the head and ligaments were more common

Protective Equipment

- Braces and protective padding are often prescribed for return to play
- Head and facial injuries in 1386 female lacrosse players lower in players wearing protective eyewear.
- Increased risk of injury in football players using ankle braces or tape
- Athletes with protective kneepads less likely to sustain a LE injury.

Coaching Education

- Risk of injury lower for cheerleaders with coaches with a college degree and more years of coaching experience
- Risk of concussion for athletes in multiple sports - no difference for athletes with coaches with and without a masters degree.

Intrinsic

- Gender
- Age/Grade/Experience
- Previous Injury
- Body Size
- Performance Measures
- Psychosocial Variables

- Q & A (4)

Gender

- Studies are contradictory
  - no difference in the risk of injury between male and female basketball players
  - male lacrosse players have a slightly higher injury rate than females
  - males had a higher risk of injury than females while playing soccer
  - no difference in the rate of injury between U18 and U16 male and female soccer players (317) in Canada.

Gender

- Specific injuries
  - risk of knee injury was higher for female than males in basketball and soccer
  - female athletes were more likely to be injured in high school cross country
  - no differences for the risk of sustaining ankle sprains, concussions, or leg injuries.

Age/ Grade/ Experience

- Older more experienced athletes at greater risk of injury than younger, less experienced.
  - 418 wrestlers - older experienced more injuries.
  - 717 football players - more experienced more likely to sustain an injury
  - 5100 football players - increased risk of injury with age and experience
- Concussion rates lowest for 9th grade vs. 10-12th
  - 9th graders less likely to have previous concussion.
- rate of injury lower for soccer players in U18 than for U16.

Previous Injury

- A high school athlete who has sustained an injury is at greater risk of subsequent injury.
  - previous injury doubled the risk of injury in competitive cheerleading and in football.
  - soccer players with previous injury had a 74% increased risk of injury.
  - football players were at an increased risk for ankle sprain if they had previously suffered one
  - football players who had previously sustained a concussion were 5x as likely to sustain another concussion.

Body Size

- Increased size and weight make athletes more susceptible to injury
  - 215 varsity and JV football lineman from 10 schools - higher %body fat/ BMI associated with an increased risk of leg injuries
  - Football players (normal BMI) with previous ankle sprain were 9x as likely to sustain another ankle sprain vs. overweight players 19x greater risk

Performance Measures

- no relationship between risk of injury in soccer players and VO2max/ vertical jump tests
- no relationship between hip strength and risk of ankle sprain.
- Athletes with increased dynamic valgus and high abduction loads were more likely to injure their ACL while participating in volleyball, basketball, and soccer.
- 3 studies have used preseason measures of balance (static and dynamic) to predict leg injury
  - Tilt board to measure balance did not detect a relationship with risk of ankle sprain.
  - Airex Balance Pad to measure balance - no relationship between baseline scoring and subsequent injury in soccer
  - Force plate measures of static balance (210 basketball players) - steady increase in the rate of ankle sprains from low sway (good balance) to high sway (poor balance).

Psychosocial Variables

- players with higher levels of preseason total and negative life changes more likely to sustain an injury during the season
- 86 high school hockey players - low vigor and high fatigue were associated with increased risk of injury.

Knee Injuries

- Hewett - neuromuscular training program on the risk of knee injury in females in basketball, soccer, and volleyball.
  - 3x/ week for 6 wks - 366 females (15 teams)
  - Exercises emphasized proper jumping and landing techniques, strength, power, and agility
  - Controls - 463 girls (15 teams), 434 males (13 teams)
  - Untrained females - 3.6x higher incidence of injury than trained females, 4.8x higher than untrained males
  - Trained females had significantly fewer noncontact ACL injuries

ACL Injuries

- PEP Program (Prevent Injury and Enhance Performance) - structured warm-up activities and emphasizes proper jump-landing techniques
  - 2-year study - players from 97 teams incorporated the intervention, 207 teams as controls.
  - Rate of ACL injury for players performing the intervention was 0.1/ 1000 exposures vs. 0.5/ 1000 exposures for controls (RR, 0.2).

All Injuries

- Performance-improvement program
- player education, structured warm-up/cool-down, and injury rehabilitation
  - 263 soccer players (14 to 18 yo)
  - 21% decrease in injury incidence for players on teams performing the interventions
  - Statistical significance for mild, overuse, noncontact, and groin injuries.

All Injuries (2)

- Structured warm-up program
  - Norwegian team handball players.
  - running exercises, jump-shot landings, balance training, and upper-leg exercises.
  - 958 players (15-17yo) from 61 teams randomized into the intervention group
  - 879 players from 59 teams as controls.
  - Risk of sustaining any injury was significantly lower (RR = 0.5) for players in the intervention group.
  - Reduced risk of injury for leg injuries (RR = 0.5) and acute knee injuries (RR = 0.5).

Ankle Sprains

- Balance-training program reduced the incidence of ankle sprain injuries in high school basketball and soccer players.
  - 27 teams (373 players) randomized to 5-phase balance-training program throughout the season
  - 28 teams (392 players) were assigned to the control group.
  - Athletes performing the balance-training program had a lower incidence of ankle sprains (risk ratio = 0.5).

Ankle Sprains (2)

- Combined balance training with muscle warm-up and training
- cohort of female team handball players in Denmark.
  - 111 players (11 teams) intervention
  - 126 players (11 teams) controls
  - Controls were 3x more likely to sustain an ankle sprain

Specific Studies

- Mouthpieces
- Warm-up
- Hamstring Injuries

Knapik JJ et al. Mouthguards in sport activities: history, physical properties and injury prevention effectiveness. Sports Med. 2007;37(2):117-44.

- 1920s - boxing first sport to require mouthguards.
- 1962 - mandated use in high school football
- NCAA requires use in ice and field hockey, lacrosse and football
- ADA recommends use in 29 sports
- Materials: polyvinylacetate-polyethylene or ethylene vinyl acetate (EVA) copolymer; polyvinylchloride; latex; acrylic resin; and polyurethane.
- None seems to stand out as superior (latex poor)
- Reduced number of fractured teeth and head acceleration.
- Meta-analysis - risk of an orofacial injury was 1.6-1.9 x without mouthguard
- Evidence that mouthguards protect against concussion inconsistent.

Fradkin AJ, Gabbe BJ, Cameron PA
Does warming up prevent injury in sport? The evidence from RCT's. J Sci Med Sport. 2006 Jun;9(3):214-20.

- Systematic review 1966-2005
- 5 studies, all of high quality
- 3 studies - warming-up prior to performance significantly reduced the injury risk
- 2 studies - warming up was not effective in significantly reducing the number of injuries.
- Insufficient evidence to endorse or discontinue routine warm-up prior to physical activity to prevent injury
- Weight of evidence is in favor of a decreased risk of injury.

Details

- Studies heterogeneous with respect to interventions, participants' characteristics and performance activities
- 3 studies showing an effect the participants were teenagers while in the other 2 studies they were older.
- 3 studies involved only male participants and 1 study involved only female participants.
- The total warm-up time varied from 3 to 40 min.

Warm Up - Reduced Risk

- The 3 studies showing reduced risk of injury were in handball and American football.
  - Handball study - controls were 6x more likely to sustain an injury than the players in the warm-up group.
  - Handball study - knee and ankle injuries
    - 0.5 injuries per 1000 player/h vs. 1 injuries per 1000 player/h for controls.
  - American football study - warm-up at half-time, sprains and strains in the 3rd quarter was significantly lower ($p < 0.05$) than controls

Warm Up - No Effect

- 2 studies - recreational runners and military recruits.
- Running study - 16-weeks (23 injuries in the controls and 26 in warm-up)
  - Injury incidence was 5 injuries/ 1000h for controls and 5.5 for warm up
  - attrition rate 22% and compliance - 46%.
- Military study - 333 lower limb injuries during the training period (214 soft tissue injuries).
  - 158 injuries (intervention) and 175 (controls)

Petersen J, Hölmich P. Evidence based prevention of hamstring injuries in sport. BJSM. 2005 Jun;39(6):319-23.

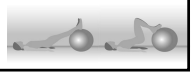
- Injuries are common in football and other sports involving sprinting and jumping
- High incidence of re-injury
- grouped into 3 categories according to severity
- A number of potential risk factors have been proposed but few are evidence based.
- Although the initial treatment of rest, ice, compression, and elevation is accepted for muscle strains, no consensus exists for their rehabilitation.
- 2 prospective studies on prevention
- There is a need for further research

Prevention - Stretching

- Hartig *et al* - military basic trainees 3 mth fitness program
  - 1 group followed the regular program
  - 2nd group added 3 hamstring stretching sessions each day
- Stretch – stand with the hip flexed to 90°
  - Flex trunk anterior tilt of pelvis, straight back and neutral head.
  - Should perceive a stretching sensation without pain.
  - 5 times for each side for 30 seconds each.
- Flexibility increased significantly
- Injuries were significantly lower (17% *vs.* 29%).

Prevention - Strengthening

- Askling *et al* - preseason strength training in 30 Swedish soccer players.
- Training group - (10 weeks preseason)
  - 16 sessions - q 5 days for 4 weeks, q 4 days for 6 weeks
- Both concentric and eccentric actions performed on an ergometer.
- Significant increase in concentric and eccentric strength in the training group
- 13 hamstring injuries total - 10 month season 10 (control)/ 3 (trained)



Activity/ Sports Specific Recommendations

- Baseball
- Football
- Basketball
- Soccer
- Gymnastics
- Skating
- Snowboarding
- Playground
- Bicycling
- Exercise
- Swimming
- Scooter
- Trampoline

Baseball

- Breakaway Bases
  - Reduce injury rate

- Safety Baseballs
  - Reduce injury rate
  - Same bounce characteristics as standard ball
  - Does not reduce risk of commotio cordis

Baseball Pitchers

USA BASEBALL

- **Pitch counts should be monitored and regulated in youth basebal**
Recommended limits for youth pitchers are as follows:
- **9-10 year old pitchers:**
50 pitches per game
75 pitches per week
1000 pitches per season
2000 pitches per year
- **11-12 year old pitchers:**
75 pitches per game
100 pitches per week
1000 pitches per season
3000 pitches per year
- **13-14 year old pitchers:**
75 pitches per game
125 pitches per week
1000 pitches per season
3000 pitches per year
- Pitch count limits pertain to pitches thrown in games only. These limits do not include throws from other positions, instructional pitching during practice sessions, and throwing drills, which are important for the development of technique and strength. Backyard pitching practice after a pitched game is strongly discouraged.
- http://www.asmi.org/asmiweb/usabaseball.htm

Baseball - Pitching

- The risk of throwing breaking pitches until physical maturity requires further research but throwing curves and sliders, particularly with poor mechanics appears to increase the risk of injury.
- Pitchers should develop proper mechanics as early as possible and include more year-round physical conditioning as their body develops.
- A Pitcher should be prohibited from returning to the mound in a game once he/she has been removed as the pitcher.
- Baseball players – especially pitchers - are discouraged from participating in showcases due to the risk of injury. The importance of "showcases" should be de-emphasized, and at the least, pitchers should be permitted time to appropriately prepare.
- Baseball pitchers are discouraged from pitching for more than one team in a given season.

Football - National Center For Catastrophic Sports Injury Research

- Suggestions to reduce head and neck injuries
  - Conditioning exercises to strengthen neck
    - Hold head erect when making contact
  - Strict enforcement of tackling rules
    - Practice and game
  - Continued teaching of proper blocking & tackling techniques
  - Respect helmet as protective device
    - Not to be used as weapon
  - Ensure equipment meets current standards and properly fitted

Prevention: New Riddell Football Helmets

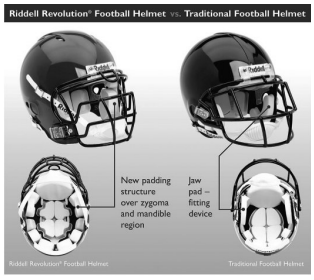


FIGURE 1. *Design features of the Revolution helmet.*

Riddell Revolution Helmet

- Collins et al. Neurosurg. 2006
- Prospective Cohort—Level 3
  - 2,141 HS football players in PA
  - 1,173 with Revolution, 968 standard
- Concussion statically less in Revolution group 5% vs. 7% (p=0.03)
- Small study (136 concussions), authors with COI, older helmets/ younger athletes in control group

Stingers / Burners: Prevention

- Properly fitted equipment
- Correct blocking & tackling techniques
- Neck roll/ Cowboy collar
  - Use remains controversial
  - No studies regarding efficacy in prevention of stingers




Skating

- Ice Skates
- Rollerskates
- Inline Skates
- Heelies
- Skateboard
- Scooter
- Ripstick

In-line Skating Injuries

- Frequent falls in beginners, skate parks, half pipes
- First timers should take lessons
- Head injuries, contusions and wrist fractures are common
- Helmets, knee & elbow pads & wrist guards prevent injuries

Skate Parks

- Rollerblading / Skateboarding
- 5 yr period
- Inc. relative risk by 8.35
  - Fractures requiring reduction
  - Surgery
- 5% use of limb/joint protective gear

Sheehan, et al J Ped Orthop 2003:23;440-2

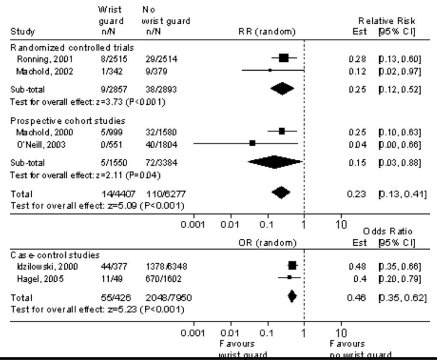
Snowboard

- There is sound evidence for the effectiveness of helmets for skiing and snowboarding Specific injuries
- 1st day is difficult but may be overall easier to improve skills than skiing
- Helmets, padded snowboard pants, gloves with wrist guards

Russell K, Hagel B, Francescutti LH
The effect of wrist guards on wrist and arm injuries among snowboarders: a systematic review. CJSM. 2007 Mar;17(2):145-50.

- 6 studies.
- RCT's/ cohorts - the risk of wrist injury (RR: 0.2), wrist fracture (RR: 0.3), and wrist sprain (RR: 0.2) was significantly reduced with the use of wrist guards.
- Case-control studies - wrist guards significantly lowered the odds of sustaining a wrist injury (OR: 0.5).
- 1 RCT suggests wrist guards also protect the shoulder (RR: 0.2).
- Nonexperimental data suggests that wrist guards may increase the risk of finger and elbow injuries.
- NNT - For every 50 snowboarders who wore a wrist guard, one wrist injury will be averted.

Wrist Guard vs. None



Trampoline

- AAP Policy - trampoline should not be used at home, physical education classes or outdoor playgrounds
- AAOS Recommendations:
  - Adult supervision
  - 1 person at a time
  - Net/ padding in place
  - No child under age 6
  - Jumping surface at ground level

Playground

- There is sound evidence for the effectiveness of implementing playground safety standards
- Playground safety handbook
- National Program for Playground Safety
  - Sand surfaces
  - Lower Monkeybars
  - Do not slide down with child sitting on lap

Bicycling

- There is sound evidence for the effectiveness of bicycle helmets, the promotion of bicycle helmets at a community level and through physician counseling, and legislation - Parkin PC, Curr Opin Pediatr. 2008 Dec;20(6):719-23
  - Community-wide interventions - mandating helmet wearing, education campaigns, distribution of free helmets all report success in influencing helmet wearing across communities

Resources

- National Youth Sports Safety Foundation – Parent Education
- National Center for Sports Safety – Coaching Education
- CDC Heads Up: Toolkit on Concussion
- ACSM – Active Nation website
- AAP text: Care of the Young Athlete – Patient Education Handouts

Quiz Answers

- 1) All of the following are proven sports injury prevention strategies except: (d)
  - a) Ankle Braces for ankle injuries
  - b) Knee Braces for knee injuries
  - c) Insoles for lower leg injuries
  - d) Mouth guards for concussions
  - e) Wrist guards for wrist injuries
- 2) True or False: Neuromuscular training programs have been proven to lower the rate of ACL tears in female soccer players. (True)
- 3) True or False: Weight training programs have been proven to lower overall injury rates. (False)
- 4) All of the following are recommendations from USA baseball for injury prevention in youth pitchers except: (b)
  - a) Pitch counts should be monitored and regulated in youth baseball.
  - b) Throwing breaking pitches before physical maturity should be encouraged.
  - c) Pitchers should develop proper mechanics as early as possible and include more year-round physical conditioning.
  - d) Pitchers should be prohibited from returning to the mound in a game once he/she has been removed as the pitcher.
  - e) Pitchers are discouraged from pitching for more than one team in a given season.
- 5) True or False: Chest protectors and safety balls reduce the risk of Commotio Cordis. (False)

Thank You!