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Prevention and Management of Pediatric Overuse Injuries

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Learning Objectives

- Describe at least three recommended means of preventing pediatric overuse injuries.
- Describe the rationale for pitch counts in youth baseball.
- Identify at least three merits of early specialization and sports sampling.
- List at least three of the best ways for managing common overuse injuries, as proven by the available evidence.

4

Overview

- Pediatric sports participation and overuse injuries
- Role of sports medicine professionals
- Position/Consensus Papers
- Recommendations
- Conclusions

5

Sports Participation

- ~30 million children and adolescents participating in organized sports in the US (Hergenroder, 1998; NIH, 1992)
- 2014-2015 school year = 7,807,047 high school students participating in interscholastic athletics (NFHS, 2006, 2011, 2015)
  - 4,519,312 males and 3,287,735 females
  - Over half of all enrolled students are competing in high school activities

6

Enhanced physical and psychosocial development

+	+	+	+	+
Cardio-respiratory fitness	Blood lipids	Selected psychological measures	Body comp	Bone mineral density

Establish good health habits at an early age

7

Bigger, faster, stronger: The rising cost of youth sports

Rob Carr/Getty Images

Costs for youth sports set to spiral ... again

Kelley Holland | @KKelleyHolland

SFGATE http://www.sfgate.com/sports/article/Paying-to-play-is-new-normal-for-youth-athletes-4902034.php

The New York Times | http://nyti.ms/1Cw02Bv

NOW PLAYING GET TICKETS

YOUR MONEY

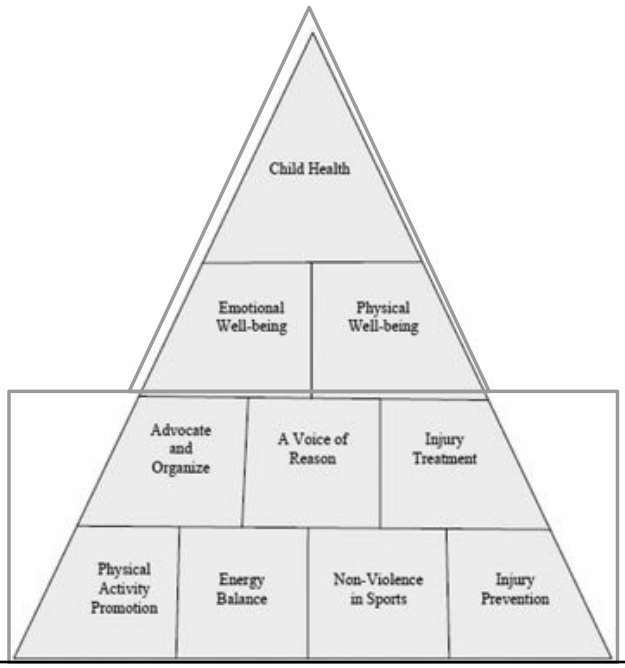
The Rising Costs of Youth Sports, in Money and Emotion

JAN. 16, 2015

Wealth Matters

By PAUL SULLIVAN

8



Stovitz, *BJSM*, 2010

9

Long-Term Athletic Development

Long-term athletic development pathways should accommodate for the highly individualized and non-linear nature of the growth and development of youth
Youth of all ages, abilities and aspirations should engage in long-term athletic development programs that promote both physical fitness and psychosocial wellbeing
All youth should be encouraged to enhance physical fitness from early childhood, with a primary focus on motor skill and muscular strength development
Long-term athletic development pathways should encourage an early sampling approach for youth that promotes and enhances a broad range of motor skills
Health and wellbeing of the child should always be the central tenet of long-term athletic development programs

10

Long-Term Athletic Development

Youth should participate in physical conditioning that helps reduce the risk of injury to ensure their on-going participation in long-term athletic development programs
Long-term athletic development programs should provide all youth with a range of training modes to enhance both health- and skill-related components of fitness
Practitioners should use relevant monitoring and assessment tools as part of a long-term physical development strategy
Practitioners working with youth should systematically progress and individualize training programs for successful long-term athletic development
Qualified professionals and sound pedagogical approaches are fundamental to the success of long-term athletic development programs

11

Pediatric Sport-Related Injury

- >3 million injuries annually that cause time lost from organized sport (Hergenroeder, 1998)
  - More than 35% of all medical visits in 5-17 year olds and
  - More than 20% of all emergency department visits in 5-24 year olds
  - Estimated cost (1996) of these visits was over **$1.3 billion** annually
- 12 million student athletes between the ages of 5-22 will suffer a sports related injury this year (Janda, 2004)
  - Resulting in **20 million** lost days of school

12

Overuse Injuries

- 52% of injuries presenting to a sports medicine center were overuse injuries
  - Tennis, swimming, soccer, dance, track, runner, gymnastics, and cheerleading
- Females higher rate (63% vs. 40%)
- Males on team sports 5.3x higher rate of overuse than non-team sports
- High-overuse sport = 10x male and 3.6x female risk for overuse

Stracciolini, CJSM, 2015 13

Overuse Injuries

	Overuse	Traumatic
Females	**62.5%**	37.5%
Males	41.9%	**58.2%**

	Upper Extremity	Spine	Lower Extremity
Females	15.1%	**11.3%**	**65.5%**
Males	29.8%	8.2%	53.7%

Stracciolini, AJSM, 2014

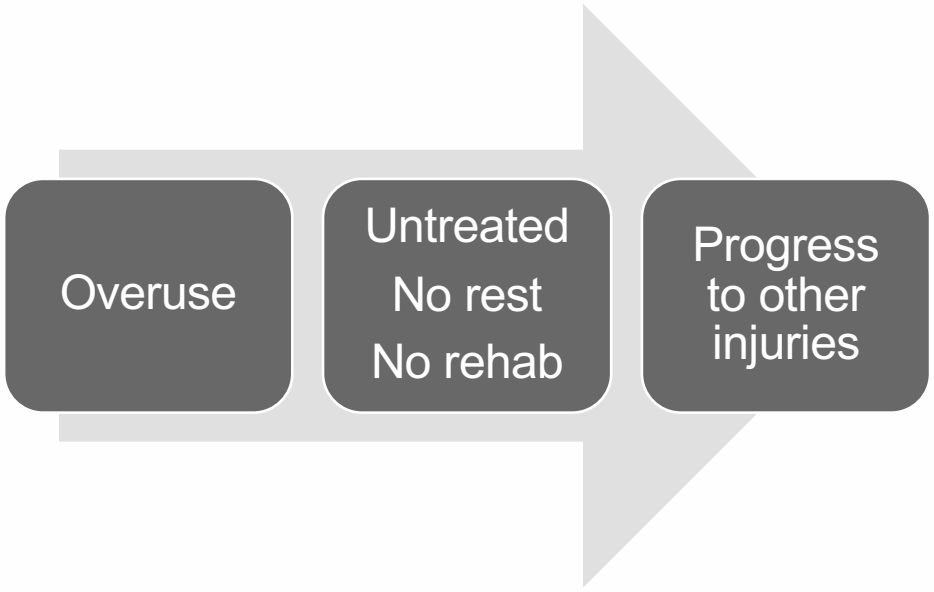
- Children (5-12) vs. Adolescents (13-17)
  - Children more traumatic (UE)
  - Adolescents more overuse (54.5% vs. 49.2%)

Stracciolini, AJSM, 2013 14

Overuse Injuries

- Overuse/chronic accounted for
  - 27.5% of boys and 36.2% of girls track and field injuries
  - Most often to lower extremity
- 1.5 per 10,000 AE
  - Girls greater risk than boys
  - Girls track/field and field hockey
  - 7.7% of all injuries (55.7% in boys swimming)
  - 7.6% resulted in time loss greater than 3 weeks

Schroeder, 2016; Pierpont, 2016 15



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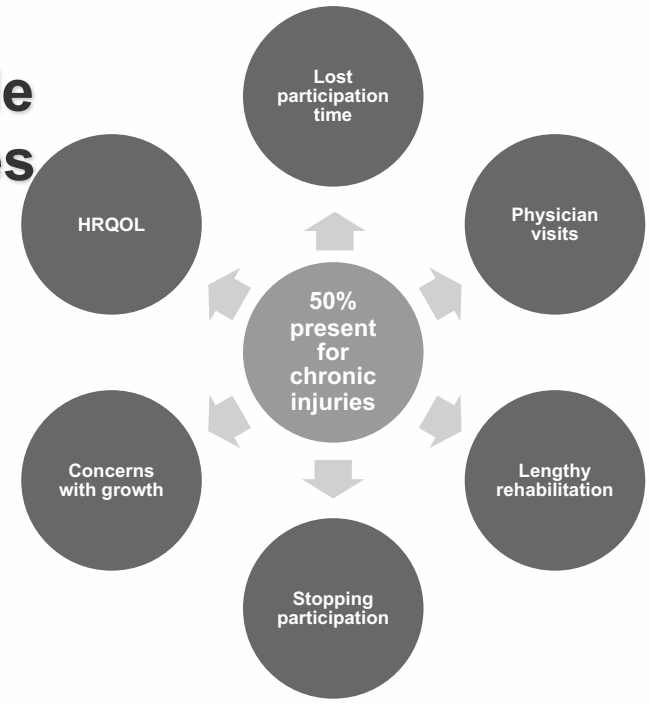
The Downside of Injuries



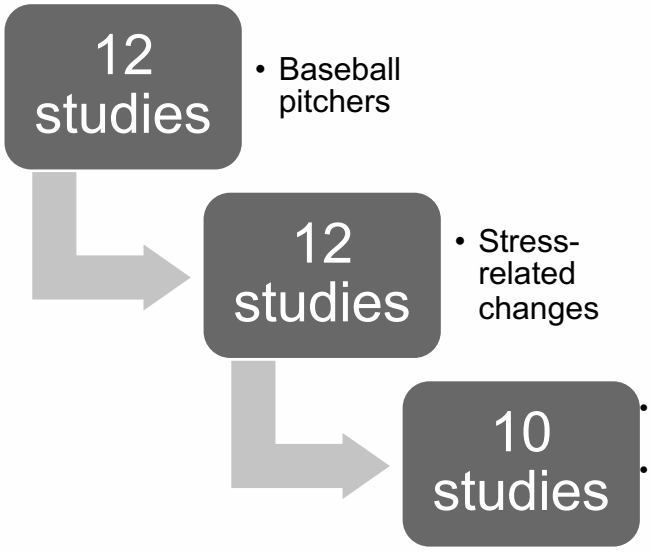
17

Growth and Development

- Children and adolescents physiologic status is defined by growth
  - Onset of puberty occurs at ~ 10.5 years for girls and ~ 12.5 years for boys
- Injuries in this age group occur in patterns distinct from adults
- Due to growth, may be susceptible to overuse injuries

18

Physeal Injuries



Caine, *BJSM*, 2006 19

Dropping Out

- 8% annual drop out rate from sports due to injuries in Australia (Grimmer, 2000)
- Elbow OCD in elite female gymnasts (Jackson, 1989)
  - Only one still participating after 3 yr follow-up
- Gymnasts with spine injury (Katz, 2003)
  - All ceased or reduced participation due to back pain
- Athletes with ACL injury retire from active participation at a higher rate than athletes without this injury (Thelin, 2006)

20

Overtraining - Burnout

TABLE 6. Symptoms of Overtraining Syndrome/ Burnout[180,187,188]

Fatigue	Insomnia	Loss of appetite
Depression	Irritability	Weight loss
Bradycardia or tachycardia	Agitation	Lack of mental concentration
Loss of motivation or interest	Decreased self-confidence	Heavy, sore, stiff muscles
Hypertension	Anxiety	Restlessness
Sleep disturbances	Nausea	Frequent illness

(DiFiori, *CJSM,* 2014) 21

TABLE 7. Diagnosis of Overtraining Syndrome/Burnout[180,192]

History
- Decreased performance persisting despite weeks to months of recovery
- Disturbances in mood
- Lack of signs/symptoms or diagnosis of other possible causes of underperformance
- Lack of enjoyment participating in sport
- Inadequate nutritional and hydration intake

Presence of potential triggers: (a) increased training load with adequate recovery, (b) monotony of training, (c) excessive number of competitions, (d) sleep disturbance, (e) stressors in family life (parental pressure), (f) stressors in sporting life (coaching pressure and travel demands), (g) previous illness.

Testing (if indicated by history)
- Consider laboratory studies: complete blood count, comprehensive metabolic panel, erythrocyte sedimentation rate, C-reactive protein, iron studies, creatine kinase, thyroid studies, cytomegalovirus and Ebstein-Barr virus titers.
- Profile of Mood States (POMS): A psychometric tool for a global measure of mood, tension, depression, anger, vigor, fatigue, and confusion.[189]

(DiFiori, *CJSM,* 2014) 22

How Does Recent Sport-Related Injury Affect HRQOL?

- Adolescents with a self-reported recent injury demonstrated lower HRQOL compared to their uninjured peers
  - Physical functioning
  - Pain
  - Social functioning
  - Global HRQOL
- Indicate injuries affect areas outside the expected physical component of health

(Valovich McLeod, *J Athl Train.* 2009) 23

YOUTH SPORTS SAFETY ALLIANCE

STOP SPORTS INJURIES

THE ASPEN INSTITUTE

YOUTH SPORTS NATIONAL SAFETY FOUNDATION

National Youth Sports Health & Safety Institute

AMERICAN COLLEGE OF SPORTS MEDICINE SANFORD

SAFE KIDS WORLDWIDE

24

Journal of Athletic Training 2011;46(2):206–220
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www.nata.org/jat

position statement

National Athletic Trainers' Association Position Statement: Prevention of Pediatric Overuse Injuries

Tamara C. Valovich McLeod, PhD, ATC*; Laura C. Decoster, ATC†; Keith J. Loud, MDCM, MSc‡; Lyle J. Micheli, MD§; J. Terry Parker, PhD, ATC‖; Michelle A. Sandrey, PhD, ATC¶; Christopher White, MS, ATC#

POSITION STATEMENT

Overuse Injuries and Burnout in Youth Sports: A Position Statement from the American Medical Society for Sports Medicine

John P. DiFiori, MD, Holly J. Benjamin, MD,† Joel Brenner, MD, MPH,‡ Andrew Gregory, MD,§ Neeru Jayanthi, MD,¶ Greg L. Landry, MD,‖ and Anthony Luke, MD, MPH***

(*Clin J Sport Med* 2014;24:3–20)

25

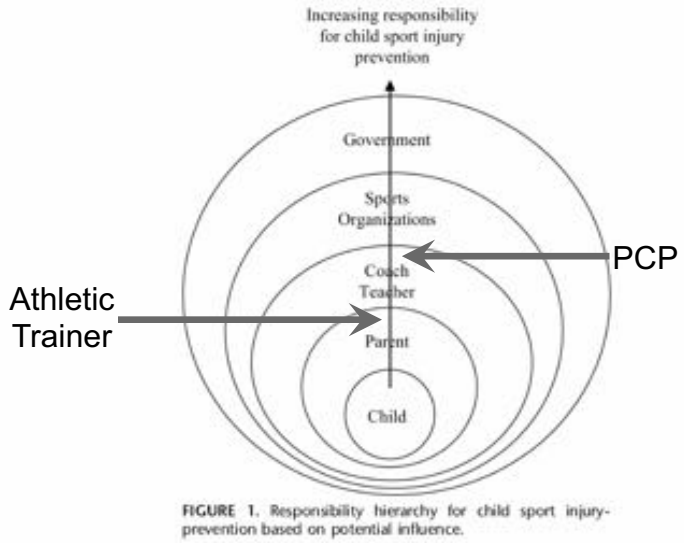


FIGURE 1. Responsibility hierarchy for child sport injury-prevention based on potential influence.

(Emery et al, 2006) 26

Overuse Injuries

- Growth-related
  - Apophyseal injuries
- Repeated microtrauma
  - Chronic submaximal loading of tissue
  - Stress fractures
  - Tendinopathies
- Combined mechanisms
- Repetitive submaximal loading when rest is not adequate for adaptation to take place
- Muscle-tendon unit, bone, bursa, NV, physis
- Apophyseal and physeal stress injuries unique to youth athlete

Valovich McLeod, JAT, 2011 DiFiori, CJSM, 2013 27

High Vs. Low Risk

- High Risk
  - Can result in significant time loss
  - Stress fx
  - Physeal stress injuries
  - OCD
  - Apophyseal injuries
  - Effort thrombosis (TOC)

TABLE 3. High-Risk versus Low-Risk Overuse Injuries

Location	High Risk	Low Risk
Hip/Pelvis	Femoral neck (tension-sided)	Femoral shaft stress fracture
Back (lumbar spine)	Pars interarticularis stress fracture	Congenital spondylolysis, pedicle stress fracture
Leg	Anterior cortical tibial stress fracture	Medial tibial stress fracture, fibular shaft stress fracture
Ankle	Medial malleollar stress fracture, talar dome osteochondral defect, talar neck stress fracture	Distal fibular stress fracture
Foot	Tarsal navicular stress fracture, fifth metatarsal proximal diaphyseal stress fracture, sesamoid stress fracture	Second, third, fourth metatarsal stress fractures, cuboid
Knee	Patellar stress fracture, osteochondritis dissecans of femoral condyle or patella	Tibial tubercle and inferior patellar pole apophysitis
Shoulder/arm	Effort thrombosis	Proximal humeral physeal stress fracture
Elbow	Osteochondral dissecans capitellum, apophyseal non-union of medial epicondyle	Medial epicondyle apophysitis
Wrist	Distal radial physeal stress injury	

DiFiori, CJSM, 2013 28

Preventative Approach

- Advocated by several prominent sports and healthcare organizations
  - American College of Sports Medicine (1993)
  - World Health Organization, International Federation of Sports (1998)
  - American Academy of Pediatrics (2007)
  - International Olympic Committee (2008)
    - **50%** of overuse injuries in active children and adolescents are ***preventable*** (Smith et al, 1993)

29

Valovich McLeod, JAT, 2011

30

Injury Surveillance

- Improved understanding of prevalence, incidence and economic cost
- Increased funding and support
- Participation in surveillance efforts by all athletic healthcare providers
- Development of resources and training improved surveillance

EC= C

(Mountjoy, 2008; FIMS, 1998; Almquist, 2008; DiFiori, 2013) 31

Preparticipation Physical Examination

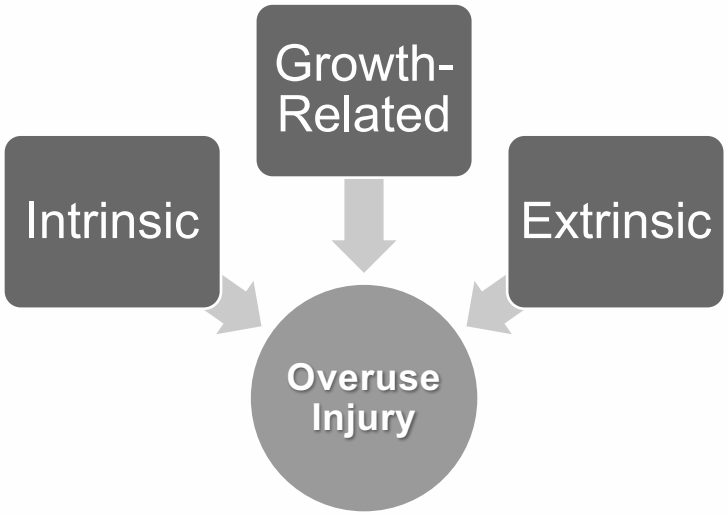
- Screening process
  - Injury history
  - Risk factors
  - Stature/maturity
  - Joint stability
  - Strength
  - Flexibility

Identification of Risk Factors

EC= C

(ACSM, 1993; Dalton, 1992; Hergenroeder, 1998; Caine, 2006; PPE Working Group, 2005) 32

Risk Factors for Overuse Injuries



33

Growth-Related Risk Factors

- Growth plate cartilage
- Growth spurt
- Age
- Height
- Tanner stage

34

Intrinsic Risk Factors

- History of previous injury
- Anatomical alignment
- Muscle imbalances
- Inflexibility
- Muscle weakness
- Instability / laxity

35

Extrinsic Risk Factors

- Training and recovery
- Equipment
- Poor technique
- Environment

36

Overuse-Prone Profiles

Males	Females
Tall stature	Tall stature
Endomorph body structure	Decreased upper extremity strength
Less static strength	Less static strength
More explosive strength	More explosive strength
Decreased muscle flexibility	High limb speed
High degree of ligamentous laxity	Increased muscle tightness
Large Q-angle	Increased ligamentous laxity
	Greater leg length discrepancy
	Pronation
	Large Q-angle

(Lysens, 1989)

37

Risk Factor Identification

- Arm pain and fatigue *EC=A* (Lyman 2001, Olsen, 2006)
- Decreased throwing performance *EC=A* (Lyman, 2001)
- Volume of pitches *EC=A* (Lyman 2001, 2002; Olsen, 2006)
  - 9-14 year olds: 75 pitches in a game, 600 pitches in a season, and 2000-3000 pitches in a year
  - 15-18 year olds: 90 pitches per game; no more than 2 games per week
- Anatomical factors *EC=C* (DiFiori, 2002; Lysens, 1989)

38

Risk Factors for Lower Extremity Injury

- Multi-directional balance
  - Predictive of overall injury risk
  - OR 3.0 (95% CI: 1.5-6.1)
- Physical maturation
  - Boys <14 y/o more likely to sustain LE overuse injury

Onate, CJSM, 2015 39

Suggested Assessment for Runners

Intrinsic	Extrinsic
• Standing Q angle • BMI • Navicular Drop • Hip abduction, extension and ER strength • Menstrual cycle	• Preseason activity level • Modify training volumes • Early and continued participation in ball sports with 360° playing field

Paterno, 2013 40

Education and Supervision

- Athletes for S&S of overuse *EC=A* (Lyman 2001, Olsen, 2006)
- Coach certifications *EC=B* (FIMS, 1998; Caine, 2006; Ransone, 1999; Valovich McLeod, 2008)
  - Sport safety, techniques, psychosocial, health/medical concerns
- Adequate supervision *EC=C* (FIMS, 1998; ACSM, 1993)
- General knowledge of S&S of overuse *EC=C* (Hodson, 1999)

41

Coaching Education Programs

Organization	Web Address
National Athletic Trainers' Association: Sports Safety for Youth Coaches	www.nata.org
National Youth Sports Coaches Association	www.nays.org
American Sports Education Program	www.asep.com
National Center for Sports Safety	www.sportssafetly.org/prepare
American Red Cross	www.redcross.org
National Federation of State High School Associations	www.nfhslearn.com

(Valovich McLeod, *JAT* 2011) 42

Sport Alterations

- Limit total volume of physical activity *EC=A* (Lyman, 2001, 2002; Olsen 2006; Loud, 2005)
- Young pitchers avoid curves & sliders *EC=A* (Lyman, 2002)
- Pitching limits *EC=A*
  - 9-14 y/o = 75/game and 600/season (Olsen, 2006)
  - HS = 90/game (Andrews, 1996)

43

Sport Alterations

- 16-20 hours/week of vigorous physical activity *EC=A* (Loud, 2005)
- Only play one overhead throwing sport at a time *EC=C* (Cassas, 2006; Benjamin 2005; Carson, 1998)
- Avoid playing the same sport year round *EC=C* (Cassas, 2006; Benjamin 2005; Carson, 1998)

44

Throwing

- Avoid pitching with arm fatigue
- Avoid pitching with arm pain
- Avoid pitching too much – future research needed, but the following general limits are:
  - Avoid pitching more than 80 pitches per game
  - Avoid competitive pitching more than 8 months of the year
  - Avoid pitching more than 2500 pitches in competition per year

Olsen et al, 2006 45

Throwing

- Monitor pitchers with the following characteristics closely for injury
  - Those who regularly use anti-inflammatories to "prevent" injuries
  - Regularly starting pitchers
  - Pitchers who throw >85mph
  - Taller and heavier pitchers
  - Pitchers who warm up excessively
  - Pitchers who participate in showcases

Olsen et al, 2006 46

Throwing

- 10-year prospective study
  - 9-14 years of age
  - Interviewed annually
- 5% cumulative injury rate
- Pitch >100 innings per year were 3.5x more likely to be injured
- Pitchers who also played catcher had a trend towards increased risk of injury

Fleisig, *AJSM*, 2011 47

Throwing

- High school baseball players account for 13% of patients undergoing UCL reconstruction (Petty, 2004)
- Survey of healthy youth baseball players (Makhni, 2014)
  - 26.6% report prior injury to arm
  - 11% reported playing with pain
  - 44% had arm fatigue sometimes, often or always
  - 53% felt arm pain limited how hard they could throw sometimes, often or always

48

MLB Pitch Smart

AGE	DAILY MAX (PITCHES IN GAME)	REQUIRED REST (PITCHES)				
		0 Days	1 Days	2 Days	3 Days	4 Days
7-8	50	1-20	21-35	36-50	N/A	N/A
9-10	75	1-20	21-35	36-50	51-65	66+
11-12	85	1-20	21-35	36-50	51-65	66+
13-14	95	1-20	21-35	36-50	51-65	66+
15-16	95	1-30	31-45	46-60	61-75	76+
17-18	105	1-30	31-45	46-60	61-75	76+
19-22	120	1-30	31-45	46-60	61-75	76+

http://m.mlb.com/pitchsmart/pitching-guidelines/

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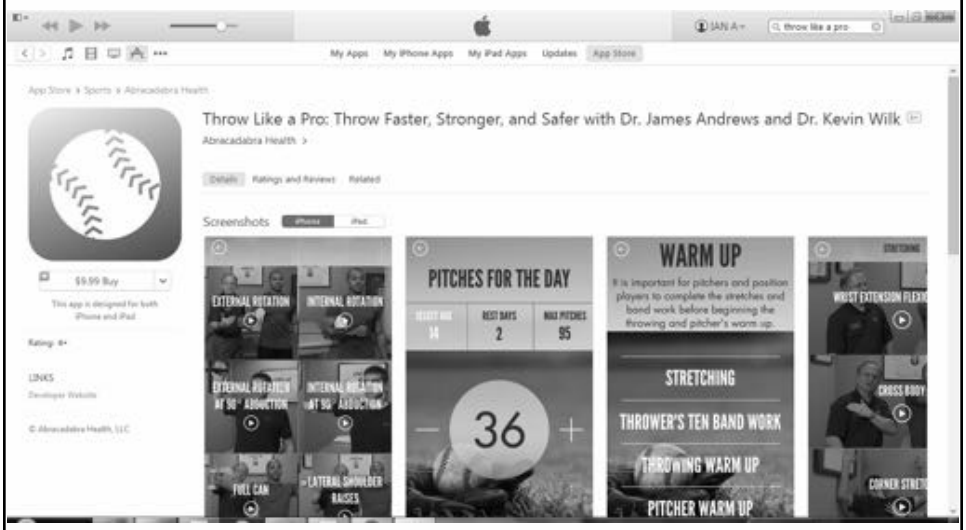

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Swimming

Level	Category	Skill Objective	Training Objective	Commitment
1	Sport Preparation (6-9 yrs)	• Stroke Technique • All four strokes	• Aerobic development • Joy of participation	• 2-3 sessions per week • 30-60 minutes
2	Basic Skill Development (8-11 yrs)	• Teaching fundamentals • Technique • Balance and coordination in the water • All strokes, all events • Develop athleticism	• Continued progressive aerobic development • Emphasis on kicking • Swim practice skills • Self-management and independence	• 2-4 sessions per week • 30-60 minutes • Encourage other activities/sports • Intra-squad competition or low pressure competition
3	Basic Training Development (11-14 yrs)	• Strong foundation in all four strokes • No specialization • Stretching, calisthenics, own body weight exercise • Develop athleticism	• Aerobic endurance • Maintain good technique on low intensity interval work • Focus preparation on 200 IM and 200/500 free • Kicking emphasis • Learn to compete	• 4-6 sessions per week • 60-90 minutes • Year round participation • Encourage other activities/sports while understanding need to meet attendance expectations

51

Swimming

Level	Category	Skill Objective	Training Objective	Commitment
4	Progressive Training (13-18 yrs)	• Maintain and refine technique • Core body conditioning • Additional dryland such as medicine balls, free weights	• Focus switches to training rather than fundamentals • Aerobic/Increased yardage • Introduction to anaerobic threshold work and speed development • Focus on 400 IM and mid-distance freestyle	• 6-10 sessions per week • 90-120 minutes • Year round including LC competition • Commit to swimming • Shorter breaks to minimize deterioration of aerobic base
5	Advanced Training (14 and over)	• Attention to detail • Efficiency • Technical precision • Strength training	• Distance based physiological training • All energy systems with heavy aerobic emphasis • Specificity of training for stroke and distance • Still train for and compete in wide variety of events	• 8-10 sessions per week • 90-120 minutes • Year round • High commitment level • Short breaks to minimize deterioration of aerobic base

52

Training and Conditioning

- Preventative program *EC=A* (Emery, 2005; Junge, 2002; Olsen, 2005)
  - NM control, balance, coordination, flexibility, strengthening
  - Especially those with history of LE injury
- General fitness program *EC=C* (ACSM, 1993; DiFiori, 2002; Flynn, 2002; Faignebaum, 2000)
- 1-2 days off per week *EC=C* (Mountjoy, 2008; Brenner, 2007)
- 10% rule *EC=C* (ACSM, 1993; Brenner, 2007)

53

Prevention Programs

- 19% of injuries were overuse injuries to the knee
- Significant ↓ in players injured in the intervention group compared to controls for overall injuries, lower limb injuries, as well as acute knee and ankle injuries

	Intervention	Control
Anterior leg pain	5 (27.8%)	20 (51.3%)
Knee pain	5 (27.8%)	6 (15.4%)
Low Back pain	3 (16.7%)	5 (13.8%)

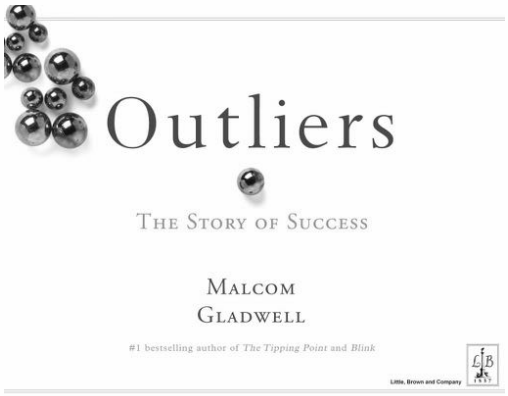
(Olsen) 54

Prevention Programs

- Soccer injuries in youth
  - 37% were overuse
- Total injuries (per player per year)
  - Intervention = .76 (±.89) *sig lower than control (p<.01),
  - Control = 1.18 (±1.04)
- Overuse injuries –
  - Intervention = .26 (±.48) *sig lower than control (p<.05),
  - Control = 0.44 (±.65)

(Junge et al, 2002) 55

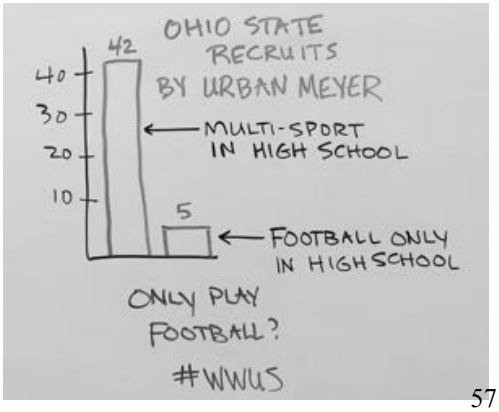
Early Specialization vs. Sports Sampling



10,000 hours of "deliberate practice" are needed to become world-class in any field

56

Early Specialization vs. Sports Sampling



57

Typical Aspects of Early Sports Specialization

58

Going Pro?

TABLE 2. Estimated percentages of athletes moving from high school to college, high school to professional, and college to professional in several sports in the United States.[a]

	Men's Sports					
	Basketball	Football	Baseball	Ice Hockey	Soccer	Women's Basketball
High school athletes						
Total	549,500	983,600	455,300	29,900	321,400	456,900
Seniors	157,000	281,000	130,100	8500	91,800	130,500
College freshman athletes	4500	16,200	7300	1100	5200	4100
High school to college, %	2.9	5.8	5.6	12.9	5.7	3.1
College athletes						
Total	15,700	56,500	25,300	3300	18,200	14,400
Seniors	3500	12,600	5700	800	4100	3200
Athletes drafted	44	252	600	33	76	32
College to professional, %	1.3	2.0	10.5	4.1	1.9	1.0
High school to professional, %	0.03	0.09	0.46	0.39	0.08	0.02

[a]Adapted from the National Collegiate Athletic Association (47), percentages are based on estimated data and thus are approximations. Estimates for the professional level are based on athletes drafted; there is no guarantee that they qualified for the playing roster.

Malina, CSMR, 2010 59

TABLE 1
Evidence Regarding Early Sport Specialization to Achieve Elite Status[a]

Study	Sport	Athletes	Study Conclusions
Barynina and Vaitsekhovskii[5]	Swimming	Elite Russian swimmers	Swimmers who specialized before 11 years of age spent less time on a national team and retired earlier than late specializers.
Carlson[9]	Tennis	10 elite, 10 near-elite	Elite players began intense training and specialized later than near-elites (after 13 years vs 11 years).
Lidor and Lavyan[30]	Multiple sports	63 elite, 78 near-elite	Elite athletes were more likely than near-elites to begin intense training after age 12 and were more likely to have played more than 1 sport in their developmental years.
Moesch et al[38]	Multiple sports	148 elite, 95 near elite	Elite athletes began intense training at a later age vs near-elites. Near-elites has more hours of training at a young age (9-15 years).
Gullich and Emrich[20]	Olympic sports	1558 German athletes, elite and near-elite	Elite athletes began intense training and competition in their sport later than did near-elites. More elites participated in more than 1 sport from age 11 years than did near-elites.

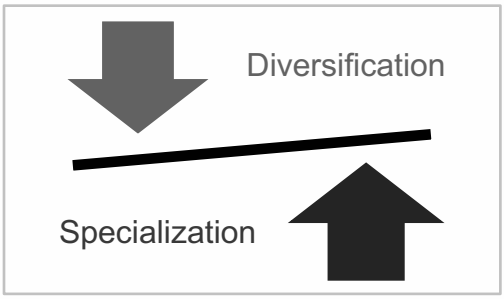
60

Against Early Specialization	For Early Specialization
• Avoid overuse injury • Allow proper rest • Cross sport skill development • Maintain interest in sport • Prevent social isolation • Prevent burnout • Prevent overdependence	• Gain competitive edge • Develop and hone skills faster • Early talent recognition • Increase opportunity for scholarships or professional contracts

Ferguson, 2014 61

Specialization

- Potential risks
  - Social isolation
  - Burnout
  - Overdependence
  - Manipulation
  - **Injury**
  - Compromised growth and maturation



Malina, CSMR, 2010 62

Specialization Among D1 Athletes

- Specialization increased throughout high school
  - No differences between sexes
  - Football tended to be more highly specialized
- Reasons for specialization
  - Enjoyed the one sport the most
  - Opportunity to earn scholarship
  - Being the best at that one sport

Post, 2016 63

Specialization & Injury Theory

- Growing physeal cartilage has decreased strength
  - Demands of growth exceed blood supply to region
- Apophysis is structurally weakest part of joint before ossification
  - More prone to injury with excessive force

Tisano, 2016 64

Specialization & Injury Risk

Table 1. Degree of sports specialization and risk of all-cause injuries[a]

Degree of Specialization	Risk of Injury	Risk of Serious Overuse Injury	Risk of Acute Injury
Low specialization (0 or 1 of the following): Year-round training (>8 months per year) Chooses a single main sport Quit all sports to focus on 1 sport	Low	Low	Moderate
Moderately specialized (2 of the following): Year-round training (>8 months per year) Chooses a single main sport Quit all sports to focus on 1 sport	Moderate	Moderate	Low
Highly specialized (3/3 of the following): Year round training (>8 months per year) Chooses a single main sport Quit all sports to focus on 1 sport	High	High	Low

[a]Reproduced with permission from Jayanthi et al.[40]

Meyer, 2015 65

Specialization & Injury Risk

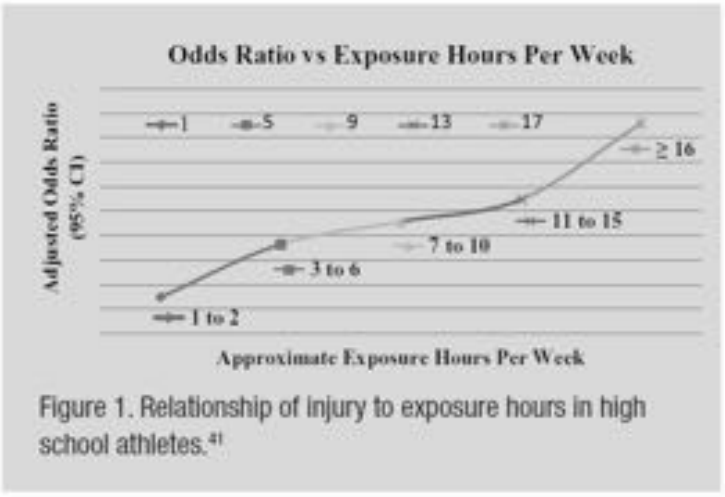


Figure 1. Relationship of injury to exposure hours in high school athletes.[41]

Meyer, 2015 66

Specialization & Injury Risk

- Single-sport athletes (Hall, 2015)
  - 4x greater risk of Osgood Schlatter, SLJ, patellar tendinopathy
  - 1.5x greater risk of PFPS
- Sports-specialized training (Jayanthi, 2015)
  - Independent risk for injury (odds ratio [OR], 1.27; 95% CI, 1.07-1.52; P<.01)
  - Serious overuse injury (OR, 1.36; 95% CI, 1.08-1.72; P<.01)

67

Specialization & Injury Risk

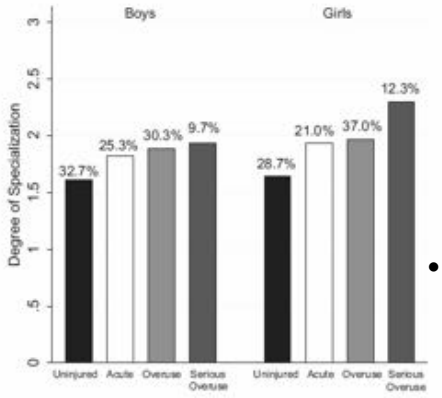


Figure 2. Degree of sports specialization by injury type and sex.

- ↑ risk of injury and serious overuse injury among young athletes who specialize in 1 sport
  - Independent of training volume and age
- Risk of injury, overuse injury, and serious overuse injury
  - Increases as the degree of specialization increases

68

Table 1. Seven postulates associated with the Developmental Model of Sport Participation[a]

Postulate 1	Early diversification (sampling) does not hinder elite sport participation in sports where peak performance is reached after maturation
Postulate 2	Early diversification (sampling) is linked to a longer sport career and has positive implications for long-term sport involvement
Postulate 3	Early diversification (sampling) allows participation in a range of contexts that most favorably affects positive youth development
Postulate 4	High amounts of deliberate play during the sampling years build a solid foundation of intrinsic motivation through involvement in activities that are enjoyable and promote intrinsic regulation
Postulate 5	A high amount of deliberate play during the sampling years establishes a range of motor and cognitive experiences that children can ultimately bring to their principal sport of interest
Postulate 6	Around the end of primary school (around age 13 years), children should have the opportunity to either choose to specialize in their favorite sport or to continue in sport at a recreational level
Postulate 7	Late adolescents (around age 16 years) have developed the physical, cognitive, social, emotional, and motor skills needed to invest their effort into highly specialized training in 1 sport

[a]Reproduced with permission from Côté et al.[3]

Meyer, 2015 69

Table 2. Recommendations for stage of specialization and sport[a]

Type of Sport	Recommended Stage of Specialization
Gymnastics, diving, figure skating	Early adolescence
Team sports, tennis, golf	Middle adolescence
Endurance sports, track, distance events	Late adolescence

[a]Adapted from Jayanthi et al.[27]

Meyer, 2015 70

Specialization and Injury

- SR of association between specialization and injury
- 3 studies included (Hall, 2015; Jayanthi, 2015; Jayanthi 2011)
  - 2 studies reported a statistical effect of early specialization on development of overuse injury
  - 1 study reported association of specialization in tennis with injury that resulted in withdrawal
- SOR=B that early specialization is associated with injury

Fabricant, 2016

71

Delayed Specialization

- Encourage multiple sports and activities *EC=C* (ACSM, 1993; FIMS, 1998)
- Discourage specialization <10 years old *EC=C* (ACSM, 1993; FIMS, 1998)
- Time off *EC=C* (Brenner, 2007)

72

Organizations Against Early Sports Specialization

- National Athletic Trainers' Association
- American Medical Society for Sports Medicine
- American Academy of Pediatrics
- International Society for Sports Psychology
- World Health Organization
- International Federation of Sports Medicine
- National Association for Sports and Physical Education

Ferguson, 2014 73

Management of Common Overuse Injuries

74

Pars interartcularis

Sacral stress fracture

Pelvic avulsion

OCD

Osgood Schlatter

Sinding-Larsen-Johansson

PFPS

Sever's

Little League Shoulder

Little League Elbow

Panner's

OCD

Tendinitis

75

Osgood Schlatter Disease

- Most often seen in 10-15 y/o males
- Repetitive microtrauma resulting in a traction apophysitis of the tibia tuberosity
  - May have associated distal patellar tendonitis
- Sports with jumping, squatting, kicking
- Conservative treatment
  - Ice, analgesic, NSAID, avoidance of exacerbating activities

Chang, 2013

76

Sinding-Larsen-Johansson

- Secondary to microtrauma from chronic repetitive traction of the proximal attachment of the inferior pole of the patella
- Conservative treatment
  - Rest, knee extensor mechanism training

Chang, 2013

77

Patellofemoral Pain

- Frequent complaint among adolescent females
- Insidious onset of anterior knee pain exacerbated by activity, including, jumping, stairs, and prolonged sitting
- Conservative treatment
  - Rehabilitation, hip strengthening,

Chang, 2013

78

Medial Tibial Stress Syndrome

- Focal tenderness in the middle to distal tibia
- Most often in distance runners
- More prevalent in females
- Non-operative treatment
  - Reduction in running and other activity restrictions
  - Gait / movement evaluation and correction

Chang, 2013

79

Little League Shoulder

- Overuse injury to the proximal humeral physis of the throwing arm of skeletally immature youth
- Chronic repetitive microtraumatic shear, torque or traction on the unossified cartilage
- Occurring with increasing frequency (Heyworth, 2016)
  - Greater number of youths participating and starting at a younger age
  - Most common age affected = 13
  - Treatment of rest (average 4.2 months), activity modification and physical therapy

80

Little League Elbow

- Apophysitis of medial epicondyle
- Can present with fracture or avulsion in same area
- Highest incidence among 9-10 years
- In absence of fracture, often treated non-operatively with cessation of throwing for 4-6 weeks
- RTP with supervised gradual throwing programs average 12 weeks after non-op and 7-8 months after operative

81

Lateral Elbow Conditions

- Panner's Disease
  - Most common cause of lateral elbow pain in patents younger than 10
  - Benign, self-limiting condition
  - Vague, generalized pain
- OCD
  - More common in adolescents
  - Compression injury associated with throwing
  - Associated with pain, decreased ROM, and mechanical symptoms

82

Differential for Panner's and OCD

Characteristic	Panner's disease	OCD
Lateral elbow pain	Yes	Yes
Throwing activity	Nearly always	Usually
Age (y)	7-12	13-16
Locking, catching	No	Yes
Loss of extension	Yes	Yes
X-ray appearance	Entire capitellum fragment, lytic, irregular	Island of bone demarcated from capitellum
Treatment	Non-operative	May require surgery
Prognosis	Good	Guarded – may have loss of function

83

Case Scenario

84

Case Presentation

- 16 year old elite baseball pitcher
- Grew up in Dominican Republic
- Began baseball at age 5
- Played year round baseball
- 2-3 times per week, mainly structured practice
- Significant pitching role
  - No pitch counts or limits

Ferguson & Stern, 2014

85

Case Presentation

- Moved to Canada at age 10
- Summer league only
  - Reduced volume of pitching
- Noticed intermittent pain
  - Low back and left hip
- Played through pain

Ferguson & Stern, 2014

86

Case Presentation

- Joined travel team at age 14
- High intensity throwing programs in off season
- Baseball 10+ months / year
- Noticed medial elbow pain
  - Continued with training
- In playoffs medial elbow pain increased to where he could not throw
- Sought medical care and rested several months

Ferguson & Stern, 2014

87

Case Presentation

- Beginning of next season pain had decreased
- Noted not feeling up to full potential
- Began to feel onset of gradual shoulder pain
- Continued to pitch but reported *throwing his shoulder out* during a tournament
- Diagnosed with Type II SLAP lesion

88

Case Presentation

- Current Complaints
  - Right shoulder pain
  - Right elbow pain
  - Left hip pain
  - Low back pain

Risk of Developing Elbow or Shoulder Pain	
Risk Factor	**Odds Ratio**
Regularly Throwing with Arm Fatigue	6 (3.5-10.1)
Throwing >600 pitches/year	3.4 (0.84-14.12)
Throwing > 75 pitches/game	3.2 (1.84-5.61)
Playing for a second team	2.8 (1.26-4.38)

Risk of Elbow/Shoulder Surgery or Retirement	
Risk Factor	**Odds Ratio (95% CI)**
Regularly Throwing with Arm Fatigue	36 (5.92-221.22)
Throwing >8 months/year	5 (1.39-18.32)
Throwing > 80 pitches/game	3.8 (1.36-10.77)
Throwing > 100 innings/year	3.5 (1.16-10.44)
Playing catcher and pitcher	2.7 (0.93-4.47)
Pitch velocity > 85 mph	2.5 (0.94-7.02)

Ferguson & Stern, 2014

89

Summary of the State of Evidence Regarding Overuse Injuries

90

Evidence for Prevention

EC=A	• Sport alterations • LE prevention programs
EC=B	• Risk factor identification • Education/Supervision
EC=C	• Delayed specialization (now B) • Injury surveillance • PPE

Valovich McLeod, *JAT* 2011

91

Evidence for Prevention

EC=B	• Limiting participation time • Monitoring of training workload • Pre-season conditioning programs • Neuromuscular training programs
EC=C	• Proper sizing of equipment • Emphasis on skill development rather than competition • Individual modifications to participation time

DiFiori, *CJSM*, 2013

92

Summary Findings

EC=A

- All overuse injuries are not benign
- History of injury is risk factor

EC=B

- Underreported in the literature
- Adolescent females should be assessed for menstrual dysfunction

EC=C

- PPE
- Parent and coach education for sport readiness
- Sport specialization (Now B)
- Address underlying causes of overuse injuries

DiFiori, *CJSM*, 2013

93

"Number one is just to gain a passion for running. To love the morning, to love the trail, to love the pace on the track. And if some kid gets really good at it, that's cool too." – Pat Tyson, award-winning high school and college cross-country coach*

"Somewhere behind the athlete you've become and the hours of practice and the coaches who have pushed you is a little girl who fell in love with the game and never looked back... play for her." –Mia Hamm, member of United States women's national soccer team*

"Before kids can play like a pro, they must enjoy playing the game like a kid." –Steve Locker, national and international soccer player, coach, and author**

94

Thank You

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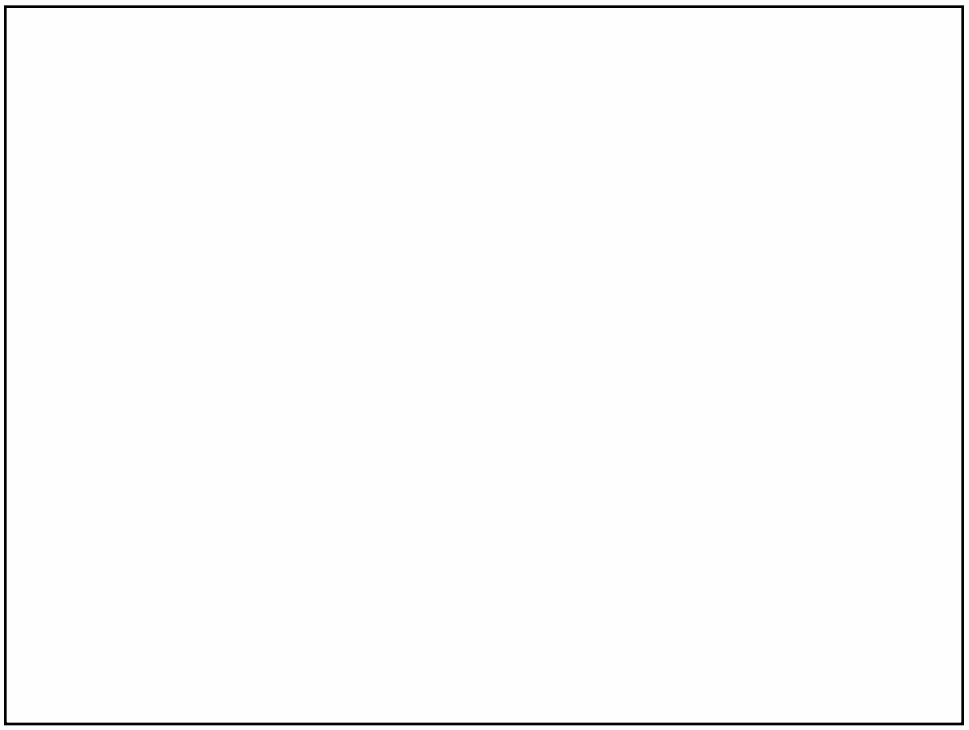
95

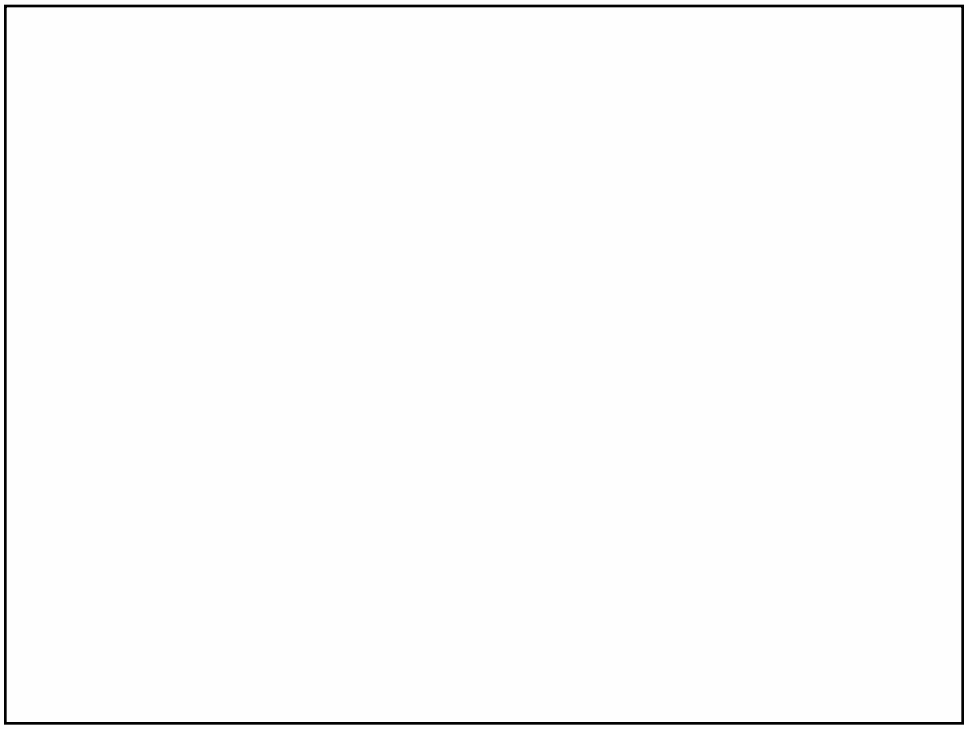
TABLE 3. Adjusted Odds Ratios, 95% CIs, and *P* Values From Logistic Regressions Predicting Injury Type (Reference = Traumatic) by Sex

	Overuse Injuries					
	Males			Females		
	Odds Ratio	95% CI	*P*	Odds Ratio	95% CI	*P*
Background characteristics						
Age, y	1.098	1.022-1.180	0.011	1.037	0.973-1.107	0.262
BMI z-score	0.856	0.727-1.009	0.063	0.918	0.778-1.084	0.313
History of chronic injury	1.119	0.751-1.665	0.581	1.408	1.030-1.926	0.032
Activity characteristics						
Participates in at least 1						
Team sport	5.329	3.026-9.383	0.000	1.277	0.824-1.979	0.274
Contact/collision sport	0.498	0.335-0.741	0.001	1.001	0.639-1.567	0.998
Total no. sports	1.069	0.947-1.206	0.280	1.132	1.005-1.274	0.040
High-overuse sport	10.310	4.429-24.000	0.000	3.641	2.303-5.758	0.000
Constant	0.0580	0.017-0.194	0.000	0.376	0.131-1.078	0.069
N	741			873		
Log likelihood	75.81			72.28		
Pseudo R2	0.076			0.063		

CI, confidence interval.

Stracciolini, CJSM, 2015





in that sport are key. An excellent resource from Canada Sport for Life highlights the appropriate training habits of Canadian youth. It is called the Long Term Athlete Development (LTAD) model.[24] This model is based off six stages of athletic development:

1. FUNdamental stage
2. Learning to train
3. Training to train
4. Training to compete
5. Training to win
6. Retirement/retainment

The focus of the early stages of the model is encouraging activity in many sports in a fun and engaging manner. While the later stages focus on sport specific skills, intense training and high level competition. The stages

Russell 2013