

Prevention and Management of Pediatric Overuse Injuries



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Overview

- Pediatric sports participation and overuse injuries
- Position/Consensus Papers
- Recommendations
- Conclusions



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Sports Participation

- ~30 million children and adolescents participating in organized sports in the US (Hergenroder, 1998; NIH, 1992)
- 2009-2010 school year = 7,628,377 high school students participating in interscholastic athletics (NFHS, 2006, 2011)
 - 4,445,740 males and 3,172,637 females
 - Over half of all enrolled students are competing in high school activities

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Enhanced physical and psychosocial development

+ Cardio-respiratory fitness	+ Blood lipids	+ Selected psychological measures	+ Body comp	+ Bone mineral density
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Establish good health habits at an early age

The Pyramid of Sports Medicine and Child Health

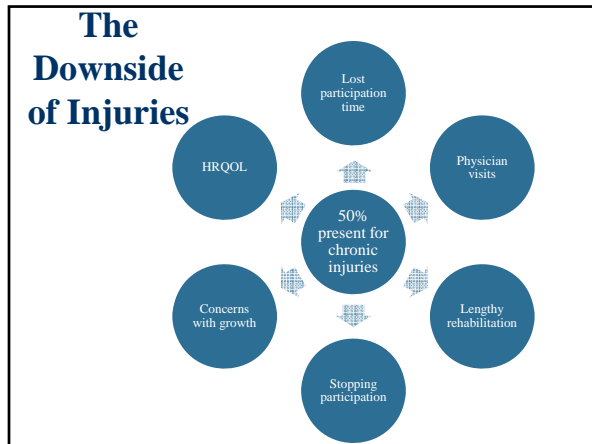


Stovitz, *BJSM*, 2010

Pediatric Sport-Related Injury

- >3 million injuries annually that cause time lost from organized sport (Hergenroder, 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

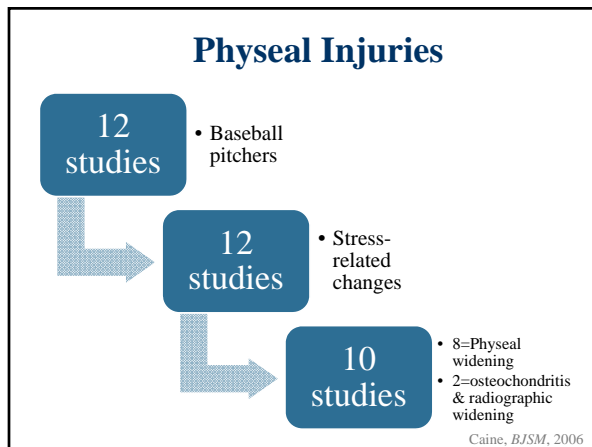
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Growth and Development

- 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

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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)

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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)

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Overtraining Syndrome

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 Epstein-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)

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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)

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)

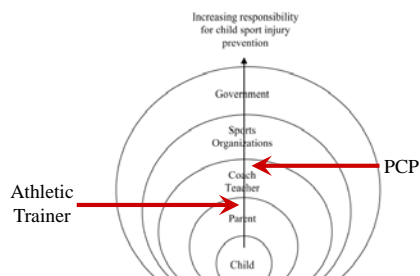


FIGURE 1. Responsibility hierarchy for child sport injury prevention based on potential influence.

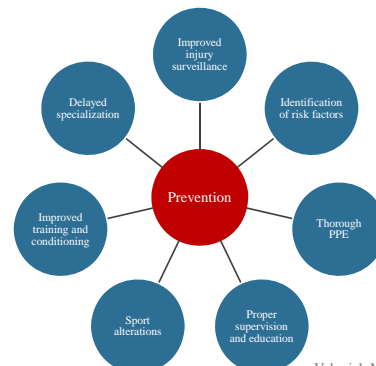
(Emery et al, 2006)

Overuse Injuries

- Growth-related
 - Apophyseal injuries
- Repeated microtrauma
 - Chronic submaximal loading of tissue
 - Stress fractures
 - Tendinopathies
- Combined mechanisms

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)



Valovich McLeod, *JAT*, 2011

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)

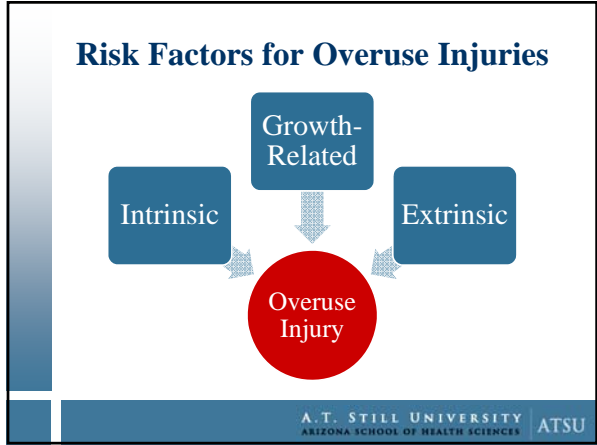
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Preparticipation Physical Examination

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

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

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Growth-Related Risk Factors

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

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Intrinsic Risk Factors

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

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Extrinsic Risk Factors

- Training and recovery
- Equipment
- Poor technique
- Environment

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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)

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)

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)

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.sportsafely.org/prepare
American Red Cross	www.redcross.org
National Federation of State High School Associations	www.nfhslearn.com

(Valovich McLeod, JAT 2011)

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)

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)

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

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

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

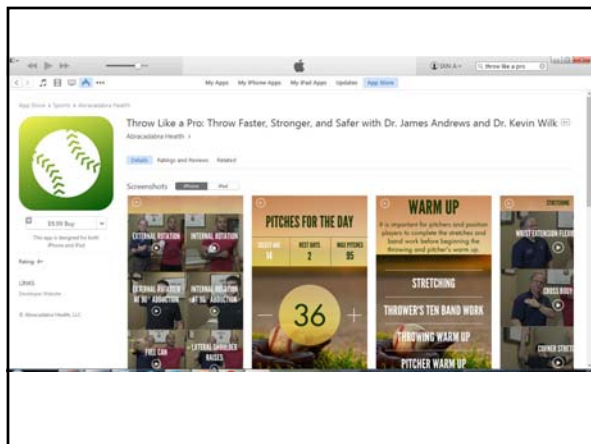
MLB Pitch Smart

<http://m.mlb.com/pitchsmart/>

Pitch Count Limits and Required Rest Recommendations

It is important for each league to set workload limits for their pitchers to limit the likelihood of pitching with fatigue. Research has shown that pitch counts are the most accurate and effective means of doing so.

AGE	DAILY MAX (PITCHES)	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+



Swimming

Level	Category	Skill Objective	Training Objective	Commitment
1	Sport Preparation (6-9 yrs)	<ul style="list-style-type: none"> • Stroke Technique • All four strokes 	<ul style="list-style-type: none"> • Aerobic development • Joy of participation 	<ul style="list-style-type: none"> • 2-3 sessions per week • 30-60 minutes
2	Basic Skill Development (10-11 yrs)	<ul style="list-style-type: none"> • Teaching fundamentals • Technique • Balance and coordination in the water • All strokes, all events • Develop athleticism 	<ul style="list-style-type: none"> • Continued progressive aerobic development • Emphasis on kicking • Swim practice skills • Self-management and independence 	<ul style="list-style-type: none"> • 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)	<ul style="list-style-type: none"> • Strong foundation in all four strokes • No specialization • Stretching, calisthenics, own body weight exercise • Develop athleticism 	<ul style="list-style-type: none"> • Aerobic endurance • Maintain good technique on low intensity interval work • Focus preparation on 200 IM and 200/500 free • Kicking emphasis • Learn to compete 	<ul style="list-style-type: none"> • 4-6 sessions per week • 60-90 minutes • Year round participation • Encourage other activities/sports while understanding need to meet attendance expectations

Swimming

Level	Category	Skill Objective	Training Objective	Commitment
4	Progressive Training (13-18 yrs)	<ul style="list-style-type: none"> Maintain and refine technique Core body conditioning Additional dryland such as medicine balls, free weights 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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)	<ul style="list-style-type: none"> Attention to detail Efficiency Technical precision Strength training 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 8-10 sessions per week 90-120 minutes Year round High commitment level Short breaks to minimize deterioration of aerobic base

Chapter 3: Organization and Administration Page 4 © 2007 USA Swimming. All rights reserved.

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)

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)

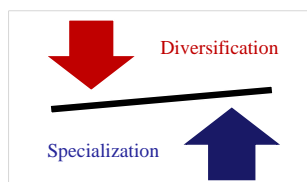
Prevention Programs

- 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)

Specialization

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



Malina, CSMR, 2010

Specialization

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.*

	Men's Sports					Women's Basketball
	Basketball	Football	Baseball	Ice Hockey	Soccer	
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	4900	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	25,700	3700	18,200	14,400
Seniors	3500	12,600	5700	800	4100	3200
Athletes drafted	44	250	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

*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

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)

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Evidence for Prevention

EC=A

- Sport alterations
- LE prevention programs

EC=B

- Risk factor identification
- Education/Supervision

EC=C

- Delayed specialization
- Injury surveillance
- PPE

Conclusions

- Little evidence specific to pediatric athletes
 - **23** Level C, **3** Level B, **4** Level A
- Too little is known about potential risk factors for overuse injury in pediatric athletes
- Need for improved injury surveillance in young athletes
 - Determination of associated risk factors
 - Provide a foundation for future studies of prevention and treatment efficacy

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Thank You



Clinical Outcomes Research Education for Athletic Trainers
CORE-AT
www.coreat.org

tmcleod@atsu.edu
480-219-6035



GUIDELINES FOR YOUTH AND ADOLESCENT PITCHERS

Each organization – whether it be a league, travel team, showcase or tournament – should establish rules for that league to ensure that players must follow the guidelines while playing in that league. Ultimately, it is the responsibility of the parent and the athlete to ensure that the player follows the guidelines for his age group over the course of a year – given that he will oftentimes play in multiple leagues with different affiliations covering different times of the year.

Pitch Count Limits and Required Rest Recommendations

It is important for each league to set workload limits for their pitchers to limit the likelihood of pitching with fatigue. Research has shown that pitch counts are the most accurate and effective means of doing so.

AGE	DAILY MAX (PITCHES)	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+
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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+

Ages 8 & Under

(Typically 46' Pitching Distance)

- Focus on athleticism, physical fitness, and fun
- Focus on learning baseball rules, general techniques, and teamwork
- Do not exceed 60 combined innings pitched in any 12 month period
- Take at least 4 months off from throwing every year, with at least 2-3 of those months being continuous
- Make sure to properly warm up before pitching
- Set and follow pitch-count limits and required rest periods
- Avoid throwing pitches other than fastballs and change-ups
- Avoid playing for multiple teams at the same time
- Avoid playing catcher while not pitching
- Avoid pitching in multiple games on the same day
- Play other sports during the course of the year
- Monitor for other signs of fatigue
- Pitchers once removed from the mound may not return as pitchers

AGE	DAILY MAX (PITCHES)	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

Ages 9 to 12

(Typically 46-50' Pitching Distance)

- Focus on athleticism, physical fitness, and fun
- Focus on learning baseball rules, general techniques, and teamwork
- Do not exceed 80 combined innings pitched in any 12 month period
- Take at least 4 months off from throwing every year, with at least 2-3 of those months being continuous
- Make sure to properly warm up before pitching
- Set and follow pitch-count limits and required rest periods
- Avoid throwing pitches other than fastballs and change-ups
- Avoid playing for multiple teams at the same time
- Avoid playing catcher while not pitching
- Avoid pitching in multiple games on the same day
- Play other sports during the course of the year
- Monitor for other signs of fatigue
- Pitchers once removed from the mound may not return as pitchers

AGE	DAILY MAX (PITCHES)	REQUIRED REST (PITCHES)				
		0 Days	1 Days	2 Days	3 Days	4 Days
9-10	75	1-20	21-35	36-50	51-65	66+
11-12	85	1-20	21-35	36-50	51-65	66+

Ages 13 to 14

(Typically 60' Pitching Distance)

- Players can begin using breaking pitches after developing consistent fastball and changeup
- Do not exceed 100 combined innings pitched in any 12 month period
- Take at least 4 months off from throwing every year, with at least 2-3 of those months being continuous
- Make sure to properly warm up before pitching
- Set and follow pitch-count limits and required rest periods
- Avoid playing for multiple teams at the same time
- Avoid playing catcher while not pitching
- Avoid pitching in multiple games on the same day
- Play other sports during the course of the year
- Monitor for other signs of fatigue
- A pitcher remaining in the game, but moving to a different position, can return as a pitcher anytime in the remainder of the game, but only once per game

AGE	DAILY MAX (PITCHES)	REQUIRED REST (PITCHES)				
		0 Days	1 Days	2 Days	3 Days	4 Days
13-14	95	1-20	21-35	36-50	51-65	66+

Ages 15 to 18

(Typically 60' Pitching Distance)

- Players can begin using breaking pitches after developing consistent fastball and changeup
- Do not exceed 100 combined innings pitched in any 12 month period
- Take at least 4 months off from competitive pitching every year, including at least 2-3 continuous months off from all overhead throwing
- Make sure to properly warm up before pitching
- Set and follow pitch-count limits and required rest periods
- Avoid playing for multiple teams at the same time
- Avoid playing catcher while not pitching
- Avoid pitching in multiple games on the same day
- Make sure to follow guidelines across leagues, tournaments and showcases
- Monitor for other signs of fatigue
- A pitcher remaining in the game, but moving to a different position, can return as a pitcher anytime in the remainder of the game, but only once per game

AGE	DAILY MAX (PITCHES)	REQUIRED REST (PITCHES)				
		0 Days	1 Days	2 Days	3 Days	4 Days
15-16	95	1-30	31-45	46-60	61-75	76+
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