# Adolescent Sports Injuries

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POFPS
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## Disclosures

- Dr. Leary has provided no disclosures.

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## National Scholarly Work

- AAOM Prolotherapy Annual
- ACOFP Annual
- AOASM Annual
- ACSM Annual
- NATA Annual
- LECOM Health Web.com Challenge CME "Par For the Course"
- USGA Mid Am
- Edit PPE 5th Monograph
- ACSM Team Physician Consensus Panel
- NCAA Cardiovascular Risk Panel
- PIAA Sports Medicine Advisory Panel

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## Spectrum of Concern

- Mental Health
- Concussion
- PPE
- ACL Prevention
- Sudden Death
- **FEMALE TRIAD**
- ACL RTP
- Shoulder Instability
- Medical Illness
- Nutrition/ Supplements
- Regenerative Injections
- Snake Oil
- Overuse/Burnout
- Athletic Pubalgia
- Stress Fractures
- Facial Injuries
- Event Coverage
- Return to Play
- Ultrasound
- OMM

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## Objectives

- Identify and Treat Growth Injuries
- Diagnose and Treat Back Pain
- Differentiate Knee Pain
- New Treatment options for Shin Splints
- Discuss Burnout, Bullying, and Mental Health
- Incorporate nutrition (Obesity) hydration and sleep
- Discuss Diagnostics and Treatment
- Prevention of Overuse Injuries

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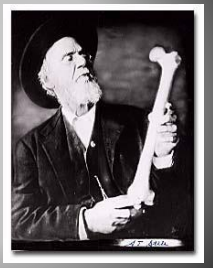
## Osteopathic Medicine

1. The body is a unit.
2. The body possesses self regulatory mechanisms.
3. Structure and function are reciprocally interrelated.
4. Rational therapy is based upon an understanding of body unity, self regulatory mechanisms, and the inter-relationship of structure and function.



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## Issues

- Osteochondrosis (Apophysitis) (hip, knee, foot elbow, back shoulder)
- ACL Injury
- Concussion
- Alignment/Posture
- Neuro muscular imbalance
- Patella Femoral Pain
- Stress Fractures
- Female Tetrad
- Low Back Pain
- Osgood Schlatter, SLJ
- MTSS/shin splints
- Ankle Sprains
- Over usage, Coach & Parental Abuse
- Substance Abuse
- Sleep and Rest
- Bullying
- Suicide
- Obesity
- State of Mind

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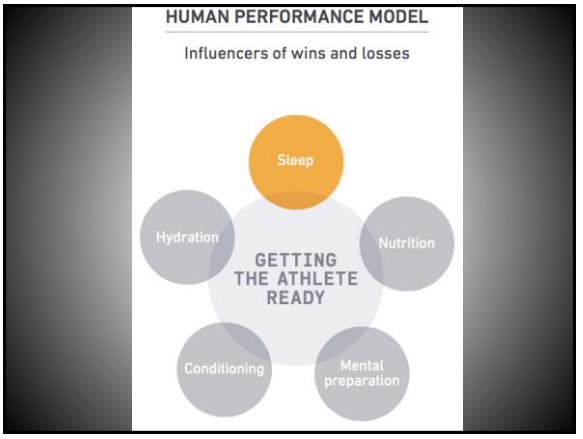
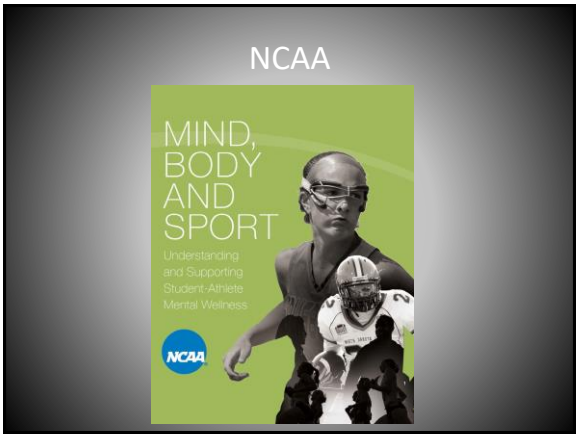
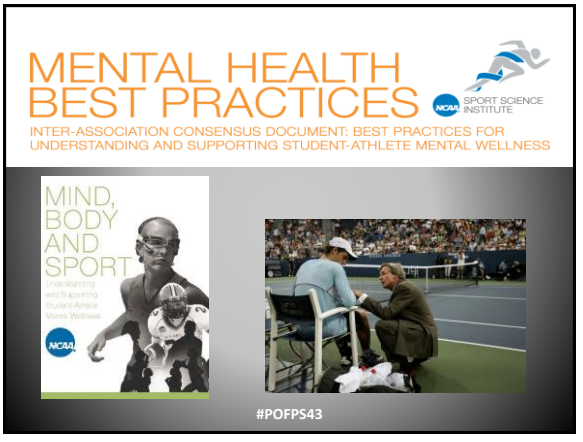

HUMAN PERFORMANCE MODEL
Influencers of wins and losses
Sleep
Hydration
Nutrition
GETTING THE ATHLETE READY
Conditioning
Mental preparation


NCAA
MIND, BODY AND SPORT
Understanding and Supporting Student-Athlete Mental Wellness
NCAA


MENTAL HEALTH BEST PRACTICES
SPORT SCIENCE INSTITUTE
INTER-ASSOCIATION CONSENSUS DOCUMENT: BEST PRACTICES FOR UNDERSTANDING AND SUPPORTING STUDENT-ATHLETE MENTAL WELLNESS
MIND, BODY AND SPORT
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## Suicide

- 1965-1987 tripled in teens
- 1980-1996 >105% AA 15-19

3rd leading cause of death 15-24

- SYMPTOMS:
  EXTREME PERSONALITY CHANGES
- Loss of interest in activities that used to be enjoyable
- Significant loss or gain in appetite
- Difficulty falling asleep or wanting to sleep all day
- Fatigue or loss of energy
- Feelings of worthlessness or guilt
- Withdrawal from family and friends
- Neglect of personal appearance or hygiene
- Sadness, irritability, or indifference

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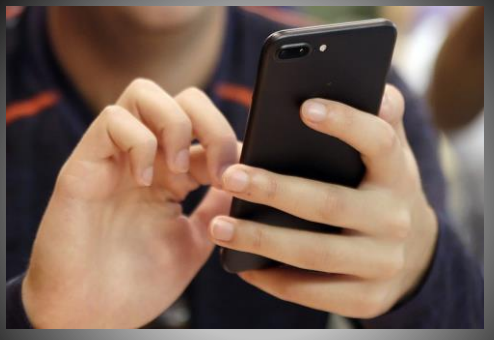

**Rise in teen suicide, social media coincide; is there link?**

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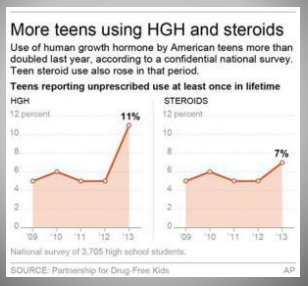
## Drug Use

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## Epidemiology of Children in Sports

- 20-30 million kids in organized sports today
- >3 million will be injured this year
- 750,000 will need to go to the E.R.
- 21% of traumatic brain injuries in children related to sports

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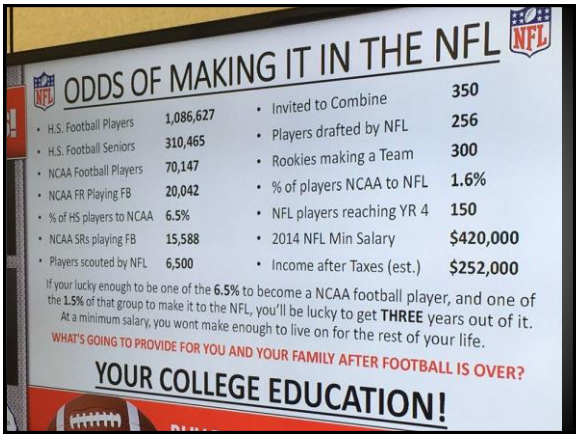

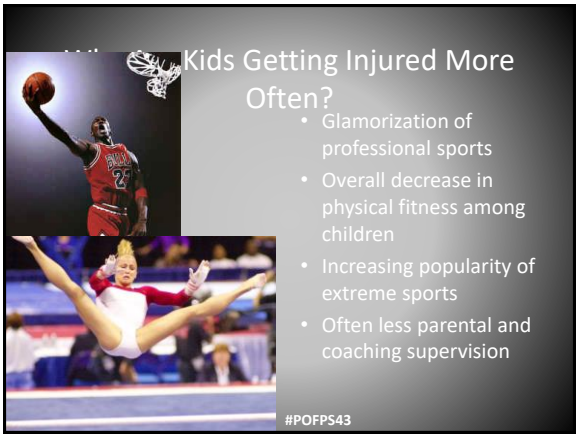
Kids Getting Injured More Often?
• Glamorization of professional sports
• Overall decrease in physical fitness among children
• Increasing popularity of extreme sports
• Often less parental and coaching supervision
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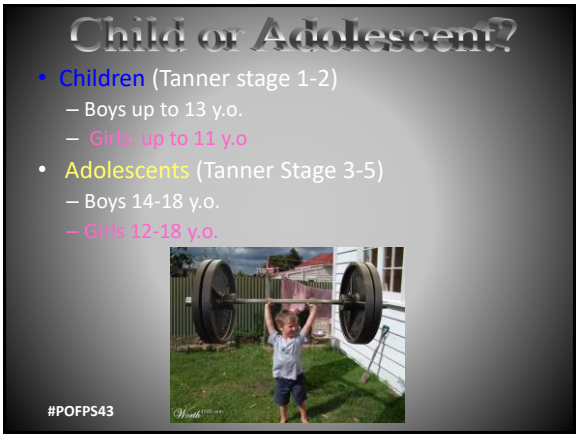
Child or Adolescent?
• Children (Tanner stage 1-2)
– Boys up to 13 y.o.
– Girls: up to 11 y.o
• Adolescents (Tanner Stage 3-5)
– Boys 14-18 y.o.
– Girls 12-18 y.o.
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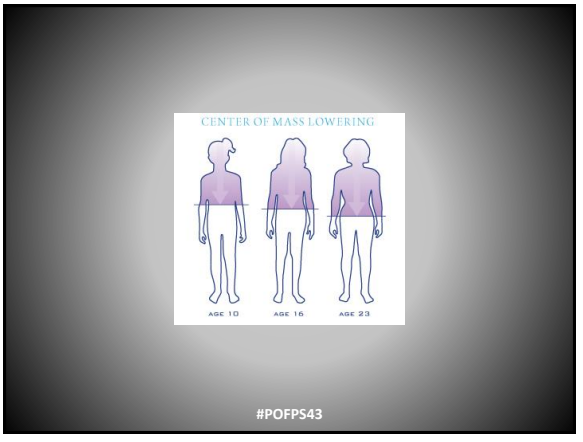
CENTER OF MASS LOWERING
AGE 10
AGE 16
AGE 23
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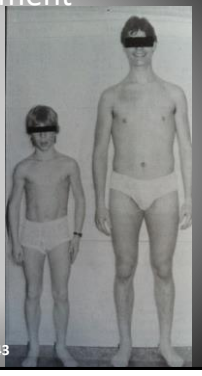
## Development

- Equal playing field
- Tanner Staging



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## Kids Are Not Miniature Adults

- Physical Differences
  - less coordinated
  - slower reaction times
  - kids mature at different rates
  - growth plates (physes) are susceptible to stress

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| | STAGE 1 | STAGE 2 | STAGE 3 | STAGE 4 | STAGE 5 |
|---|---|---|---|---|---|
| BOYS | | | | | |
| Growth | 5-6 cm/y | 5-6 cm/y | 7-8 cm/y | 10 cm/y | None |
| Testes, penis | Testes < 4mL or 2.5 cm | Testes < 4 mL or 2.5-3.5 cm penis usually not yet enlarged | Testes 12 mL or 3.6 cm, enlargement, lengthening of penis | Testes 3.1-4.5 cm, increased size and breadth of penis | Testes fully mature in shape and size |
| Pubic hair | None | Sparse, at base of penis | Pubic hair over pubis, darker, coarser and more curled | Adult like but over a smaller area | Fully mature in shape and quantity, extending into thighs |
| GIRLS | | | | | |
| Growth | 5-6 cm/y | 7-8 cm/y | 8 cm/y | 7 cm/y | None |
| Breasts | No development | Buds | Elevation and Areolar enlargement | Areolae and papillae form secondary mound | Mature |
| Pubic hair | None | Sparse, on labia, slightly pigmented | On mons pubis, darker, coarser, and more curled | Adult-like , but over a smaller area | Fully mature in shape and quantity, extending into thighs |

Tanner Stages of Physiologic Maturity

join the conversation

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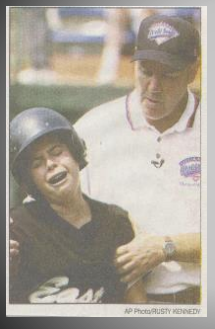
## Psychological Differences



- Still developing self-esteem, identity, and relationships
- Motivation may come from others
- "Losing" vs "Loser"
- "Winning isn't everything"

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## Will it damage growth plates?

"Total of 1109 children and adolescents lifting at national meets over a 4 year period showed:

A) No growth plates injuries

B) No serious injuries requiring hospitalization or surgery."*

Minor injuries such as muscle strains are common among children and adolescents as in their adult counter-part that do strength training.+

13 yo girl C&J 40kg

12 yo boy: snatch 37.5 kg

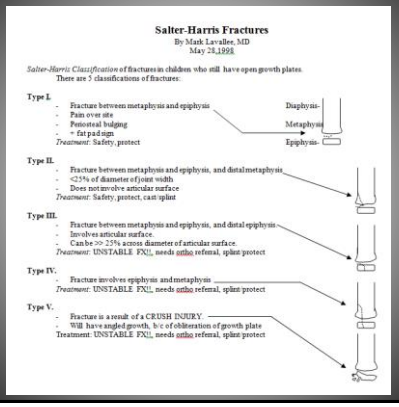
*Reed, MP. Injury patterns of preadolescent and adolescent weightlifters: a five-year retrospective study. Masters of Science thesis Royal Melbourne Institute of Technology, Bondoora, Victoria, Australia March 2002

+Lavallee, M: Amer Coll Sports Med, Current AASM Advs, Current Concepts, 2002

## Will it damage growth plates?

-A few growth plate fractures have been reported in children who lifted weights, but further investigation of these cases resulted in findings of excessive loading and improper supervision.


Benjamin, Holly J., MD; Glow, Kimberly M., MD, MPH "Strength Training for Children and Adolescents," The Physician and Sportsmedicine – Vol 31 – No. 9 Sept. 2003



**Salter-Harris Fractures**

By Mark Lavallee, MD
May 28,1998

*Salter-Harris Classification* of fractures in children who still have open growth plates.
There are 5 classifications of fractures:

**Type I.**
- Fracture between metaphysis and epiphysis
- Pain over site
- Periosteal bulging
- + fat pad sign

*Treatment:* Safety, protect

Diaphysis
Metaphysis
Epiphysis

**Type II.**
- Fracture between metaphysis and epiphysis, and distal metaphysis
- <25% of diameter of joint width
- Does not involve articular surface

*Treatment:* Safety, protect, cast/splint

**Type III.**
- Fracture between metaphysis and epiphysis, and distal epiphysis
- Involves articular surface.
- Can be >= 25% across diameter of articular surface.

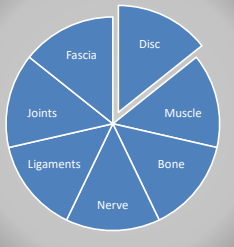
*Treatment:* UNSTABLE FX!!, needs ortho referral, splint/protect

**Type IV.**
- Fracture involves epiphysis and metaphysis

*Treatment:* UNSTABLE FX!!, needs ortho referral, splint/protect

**Type V.**
- Fracture is a result of a CRUSH INJURY.
- Will have angled growth, b/c of obliteration of growth plate

Treatment: UNSTABLE FX!!, needs ortho referral, splint/protect

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## Chronic Conditions
## Repetitive Microtrauma Overuse 60%

- Shin Splints (MTSS)
- Sever's Disease
- Osgood-Schlatter, SLJ
- Patellofemoral Pain Syndrome
- Little League Elbow and Shoulder
- Stress Fractures
- Low Back pain, Spondylolisthesis
- Burn Out, State of Mind

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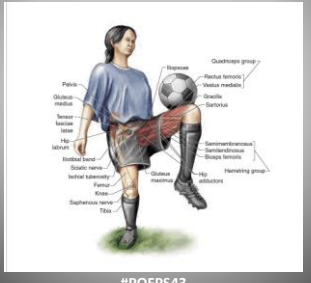


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## "A fit player is better than an injured star"

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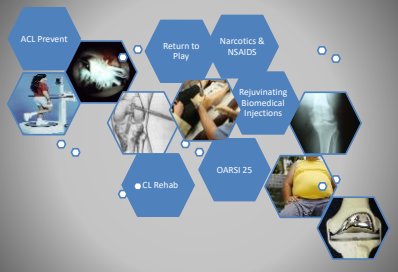
## Age 17-68

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## Reduction Programs

- FIFA 11
- Sportsmetrics Hewitt
- PEP Mendelbaum
- ACL Jump Movement Patterns Beutler
- 10 minute injury prevention

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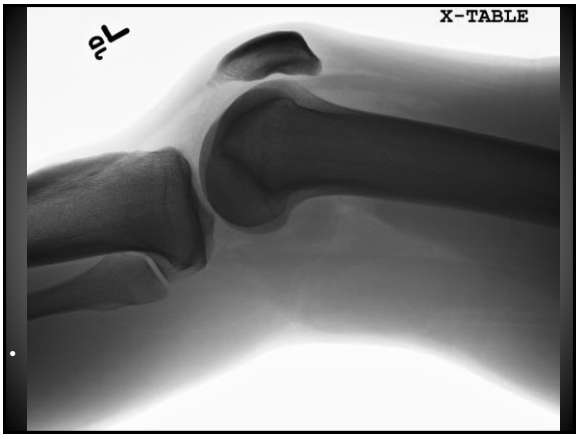



## ACL Injury

- Pivot and twisting movement at less than 21Degrees of flexion.
  - 66-93% non contact
- Anterior Cruciate Ligament prevents anterior translation and rotation of tibia and prevents hyperextension
- Lateral meniscus= acute ACL
- Medial meniscus =chronic ACL
- 250,000 per year in USA
- 100,000 ACL repairs
- 38,000 Female repairs
- Sixth most common orthopedic surgery
- 25,000$
- Muscle Imbalance Quadriceps> Hamstrings
- Rapid growth in skeletal immaturity
- Neuromuscular Imbalance
- Side to side disparity

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## CONCUSSION

Journal of Pediatrics
ER Concussion Study August 2010

- 14-19 yoa 3x 7,000-22,000 1997-2007
- 8-13 yoa 2x 3800-8,000 1997-2007

- 3 million pre high school participants
- 1.5 million high school participants
- 64,000 NCAA
  - 1200 schools
  - 19000 teams
  - 490,000 student athletes
- 1592 Pro Football

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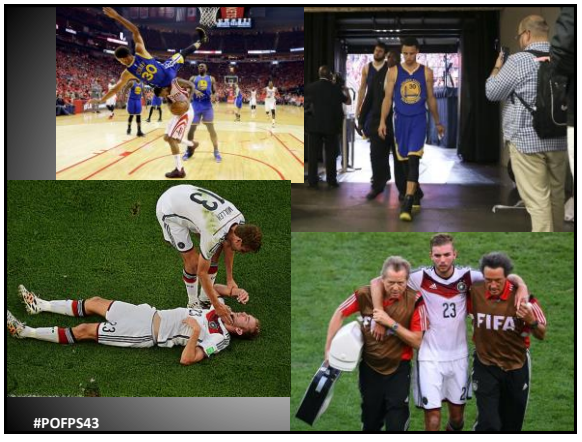

## Zak Lystetd Law

- Education
- Symptomatic – NO RETURN
- Qualified Physicians??
  - Primary Care Sports Medicine
  - Orthopedic Surgeons
  - Neurologists
  - Psychologists

HB301 Briggs of Pennsylvania

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## Sentinel Issues

- More Concussions than we know about
- Under Reporting and Over Diagnosing
- Anecdotal and Unreliable Literature
- Women and Children Suffer
- Multiple concussions have consequences
- Early RTP can be catastrophic
- Ocular and Vestibular Involvement
- Long term deficits can result from repetitive head injury
- Holistic treatments may help

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## RTP per Physician

- Serial Physical Exams
  - Visual Acuity
- Concussion History
  - Diagnostics CT/MRI
- NeuroPysch Testing
  - SAC, SCAT 5, Computer
- Balance Testing
- Family Observations
- School Work
- Social
- Sleep
- Appetite
- Exertion Testing/Graded Aerobic Protocol
- Enthusiasm to Return
- ATC/ Coaches Opinion
- Age/Gender/Tanner /Sport/ Position
- Parents Expectations
- Prevention Counseling
- Equipment / helmet fit/ mouthguard
- EDUCATION
- Strength and Fitness

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## Future

- Better Education
- Accurate and Honest Reporting
- Better Fitting Equipment
- Better Enforcement "recidivist violators"
- Less Contact during practice
- Fewer practices
- Shorter Field
- PPE with neuropsych/vestibular/ocular base line testing
- Systemic Markers
- No RTP with symptoms at rest or exertion
- Age and Gender Considerations
- Intelligent Sports options based upon access, physique, talent and desire.
- Zak Lystetd Laws
- Liability

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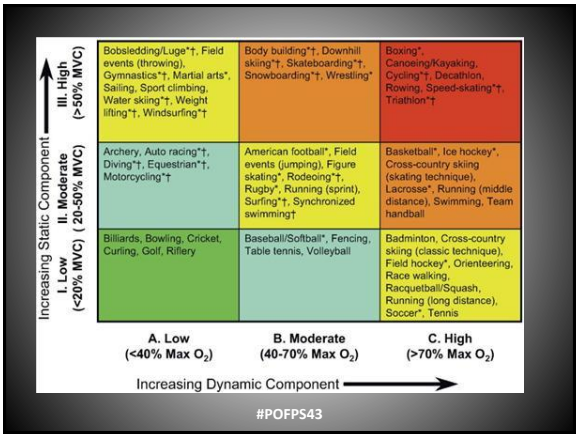


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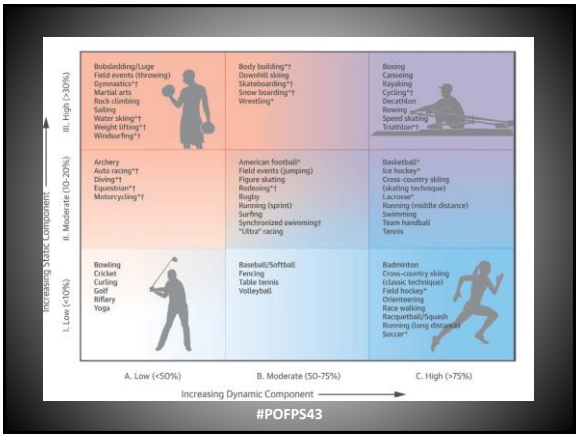


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## *Case 1*

17 y/o Caucasian male presents to your office

- concerns of 'the flu'
- nausea, headache, and dizziness for the past three days.
- Football teammates with similar symptoms
- Further questioning indicates 'bell rung' at practice
- Played through it, felt fine, and ran back an interception

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## Supervised RTP Protocol (Return to Learn)

| Rehabilitation stage | Functional exercise at each stage of rehabilitation | Objective of each stage |
|---|---|---|
| No activity | Physical and cognitive rest | Recovery |
| Light aerobic exercise | Walking, swimming or stationary cycling keeping intensity, 70 % maximum predicted heart rate. No resistance training | Increase heart rate |
| Sport-specific exercise | Skating drills in ice hockey, running drills in soccer. No head impact activities | Add movement |
| Non-contact training drills | Progression to more complex training drills, eg passing drills in football and ice hockey. May start progressive resistance training | Exercise, coordination, and cognitive load |
| Full contact practice | Following medical clearance participate in normal training activities | Restore confidence and assess functional skills by coaching staff |
| Return to play | Normal game play | |

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## Education

STOP SPORTS INJURIES

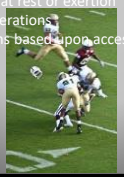
SAFE KIDS ERIE AREA

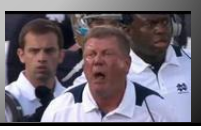
CDC SAFER · HEALTHIER · PEOPLE

Heads Up
Facts for Physicians About Mild Traumatic Brain Injury (MTBI)

## Future

- Better Education
- Better Fitting Equipment
- Better Enforcement "recidivist violators"
- Less Contact during practice
- Fewer practices
- Shorter Field
- PPE with neuropsych/balance/visual base-line testing
- When in doubt hold them out
- No RTP with symptoms at rest or exertion
- Age and Gender Considerations
- Intelligent Sports options based upon access, physique, talent and desire.
- Zak Lystetd
- Liability





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## Anterior Knee Pain

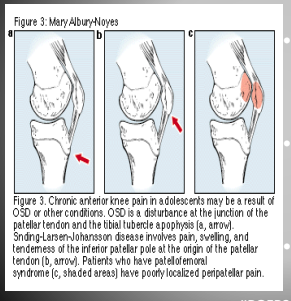

Figure 3: Mary Albury-Noyes

Figure 3. Chronic anterior knee pain in adolescents may be a result of OSD or other conditions. OSD is a disturbance at the junction of the patellar tendon and the tibial tubercle apophysis (a, arrow). Sinding-Larsen-Johansson disease involves pain, swelling, and tenderness of the inferior patellar pole at the origin of the patellar tendon (b, arrow). Patients who have patellofemoral syndrome (c, shaded areas) have poorly localized peripatellar pain.

- Tibial tubercle-OSD
- Inferior pole-SLJ
- Peri-patellar pain PFS

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## Osgood Schlatter

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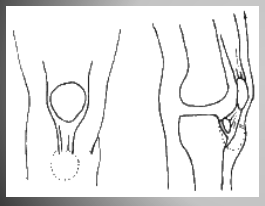
## Osgood-Schlatter Disease



- Common in ages 10-14
- Occurs after repeated strenuous activities
- Causes pain over ant. Tibial tubercle
- Treated with "relative rest," knee strap, ice
- Most have no long term problems

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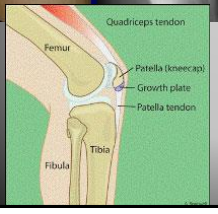
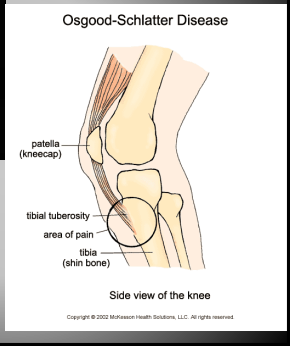
## Osgood Schlatter

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## Frieberg's Infraction

- Osteochondrosis of 2nd Met head (3rd met)
  - D/t- avascular necrosis of 2nd met. epiphysis
  - Suspect- Morton's foot shape w/ poor shoe fit
- Seen in adolescents, 3:1 female/male ratio
- Sx/ Signs- Pain under met head w/ activity
  - X-ray-Early- osteosclerosis (2-3wk process)
  - Late- Osteolysis and met head collapse
  - Bone scan- see osteochondrosis early

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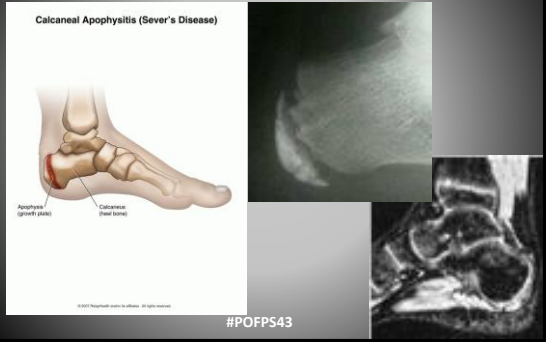
## Sever's Disease

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Achilles Tendon
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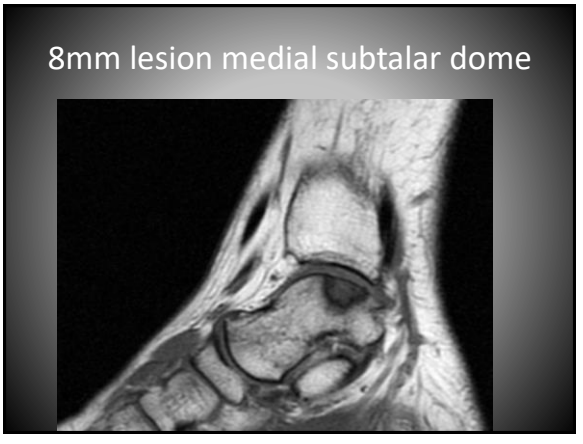
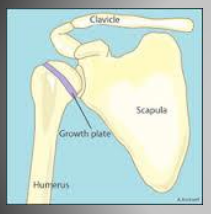

8mm lesion medial subtalar dome

## Little League Shoulder

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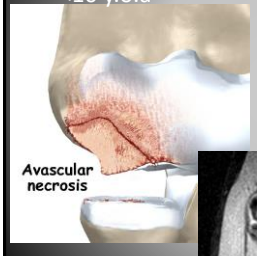
## Panner's

- <10 y.o.a

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## 13 yo Female Gymnast

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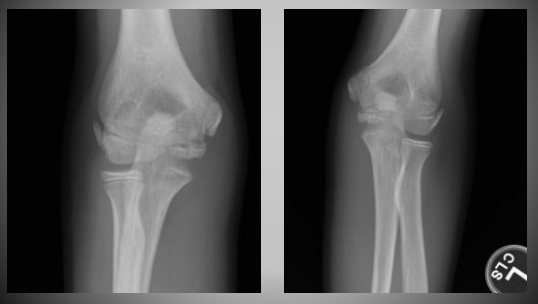
## 13 yo Pitcher



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## Pitch Counts

- Sliders 86% increased risk of elbow injury
- Curveballs 52% increased risk of shoulder injury
- 5 x Age
- 75 pitches/game
- 600 pitches/season

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## Case # 1

- 15 year old white male three sport athlete from Florida three weeks of exertional lower leg pain
- Compartment Syndrome?
- Stress Fracture?
- Medial Tibial Stress Syndrome?

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## Shin Splints

- MTSS
- ATSS
- PTSS


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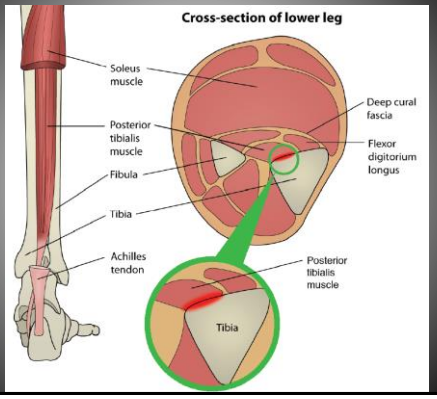
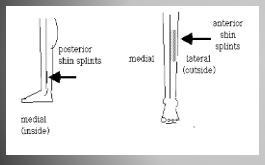



## Shin Splints (MTSS)




- An overuse injury, often in untrained athletes
- Causes pain along medial aspect of lower leg (tibia)
- Treated with "relative rest", stretching, PT, Foam Roller
- Biomechanical exam
- Prolotherapy

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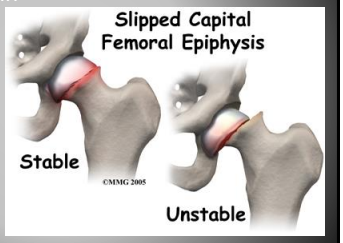
- Referred knee pain
- @13yoa
- Surgery
- Bilateral

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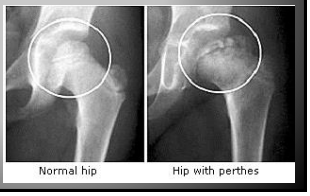
## Legg-Calve-Perthes Disease

- Boys 4-8
- 4x more likely than girls
- Atraumatic limp
- Referred knee pain
- Leg length
- Abnormal birthing

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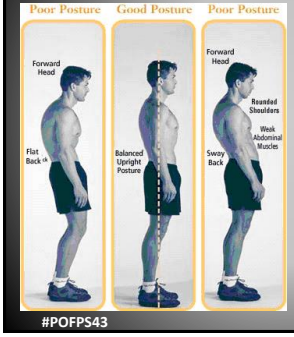
## Tensegrity // Postural Decompensation

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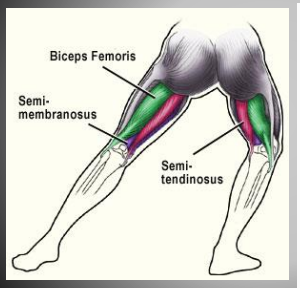
## Muscle Imbalance

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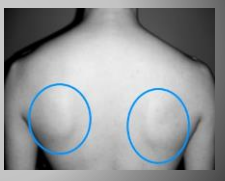
## Scapulothoracic Dysfunction



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## FMS Functional Movement Systems

- Deep Squat.
- Hurdle Step
- In-line Lunge :
- Shoulder Mobility
- Active Straight Leg Raise
- Trunk Stability Push-up
- Rotary Stability

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## Stress Fracture

- Too Much
- Too Often
- Too Hard
- Too Fast
- Too Soon

- Grow
- Repair
- Play

#POFPS43

- Grow
- Repair
- Play

- Tanner Stage
- Nutrition
- Overuse

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## Posterior Proximal Tibial Compression

## Incidence

- Track and field 31%
- Crew 8%
- Basketball 4%
- Lacrosse 3%
- Soccer 3%
- 15% of athletic injuries

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## Stress Fractures

- Year around athlete with repetitive mechanical loading
- California, Florida
- 3.5 times women>men
- White > black 2x
- Age???

- Tibia 50%
- Metatarsals 14%
- Fibula 7%
- Tarsal 3%
- 1/4 exercise induced leg pain.

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## Stress Fractures Pathophysiology

- Histological changes resulting from bone stress occur along a continuum, beginning with vascular congestion and thrombosis
- This is followed by osteoclastic and osteoblastic activity, leading to rarefaction, weakened trabeculae and microfracture
- Ends in complete fracture

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## Stress Fractures

- Tibia
- Pars
- Navicular
- Jones
- 5th metatarsal
- Insufficiency vs. fatigue
- Too much!
- Too often!
- Too soon!

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## Metatarsal Stress Fractures

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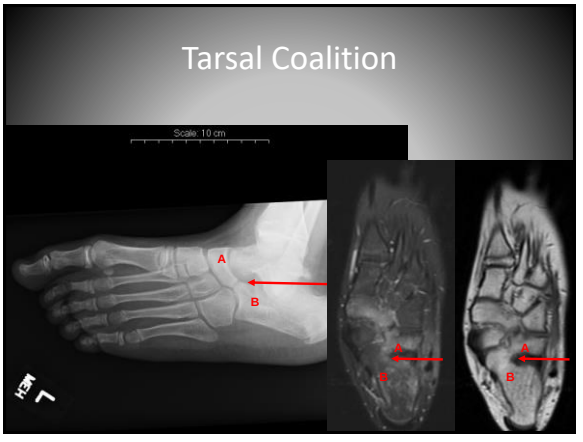
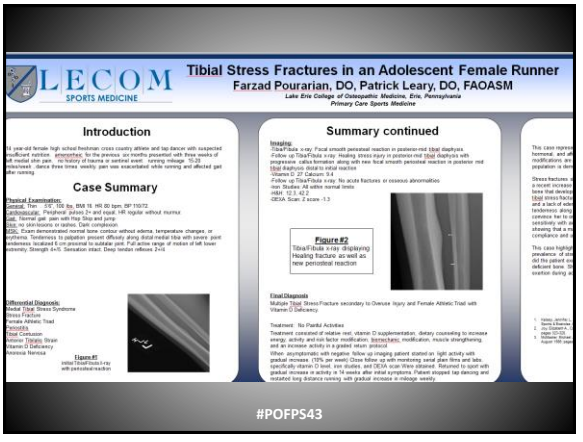

Tarsal Coalition
Scale: 10 cm
A
B
A
B
A
B


LECOM
SPORTS MEDICINE
Tibial Stress Fractures in an Adolescent Female Runner
Farzad Pourarian, DO, Patrick Leary, DO, FAOASM
Lake Erie College of Osteopathic Medicine, Erie, Pennsylvania
Primary Care Sports Medicine
Introduction
Case Summary
Summary continued
Figure #2
#POFPS43

## *Case 2*

13 y/o female gymnast

- Low back discomfort and spasm for past 7 months
  - Intermittent without injury or mechanism
- Plays volleyball, basketball, and track for school
- Ankle injury two years ago and otherwise healthy
  - Functional Low Back Strain
    - Pars Interarticularis
    - Idiopathic Scoliosis

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## Low Back Pain

| AGE GROUP: | ETIOLOGY: |
|---|---|
| • Prebubescent | trauma, infection |
| • Adolescent | spondylolysis 48% |
| • Adult | OA, HNP |
| • Elderly | OA, Stenosis |

85-90% Lifetime Incidence

"Evaluation of Low Back Pain" Clinical Journal of Sports Med August 2011

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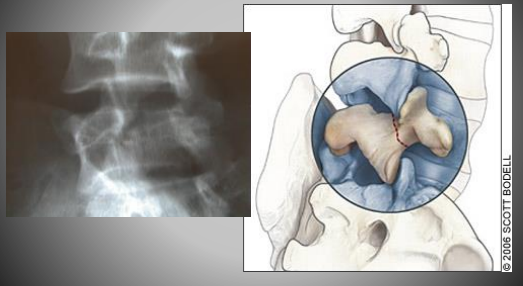
## Pars

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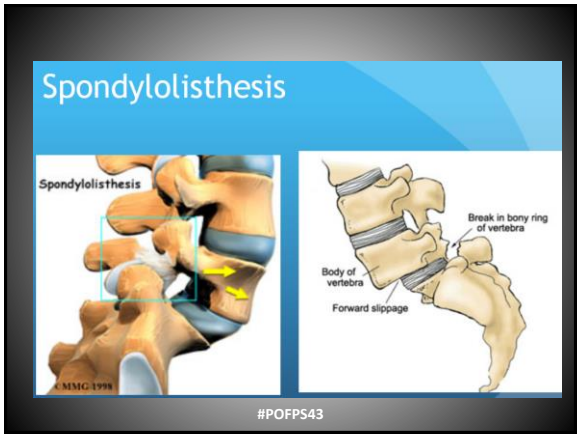


## Diagnostics

- Oblique plain films
- Spect scan
- MRI
- Reverse angle CAT Scan
- Vitamin D3
- Dexa

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## Recommendations

- Injury Surveillance
- PPE
- Risk Factors
- Coach Education and Medical Supervision
- Sport Alterations
- Training and Conditioning and Prevention
- Delayed Specialization

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## Injury Prevention

- Body Map
- Functional Movement Screen
- ACL Prevention
- Concussion Center
- Education (Coaching Clinic)
- Seasonal Overuse
- Footwear
- Nutrition
- Supplements

"50% of Overuse Injuries are preventable
1993 Med Sci Sports Exerc


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## SLEEP

Only 2%  8 hours of sleep

Depression
Obesity
Academic Performance


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Decreased sleep quality and quantity can impair performance in basketball players.
Athletes may take longer to fall asleep and have lower sleep efficiency than non-athletes.
Social demands, technology and caffeine can interfere with total sleep time.
Recent evidence suggests that enhancing sleep may also enhance performance in basketball players.
Adolescents require greater than 9 hours per night of sleep, yet many adolescents sleep significantly less than 9 hours per night.
To create optimum sleep quality and quantity, maintain a regular sleep routine to ensure an appropriate sleep environment.
To assess sleep, begin with a detailed sleep diary.
GATORADE SPORTS SCIENCE INSTITUTE
SSE #167
SLEEP AND ATHLETES
#POFPS43
Published
July 2017
Author
Shona L. Halson, PhD
Topics


"Wellness 5"
• Exercise
• Sleep
• Nutrition
• Mental Health
• Substance Abuse
Vegetables
Starch
Protein

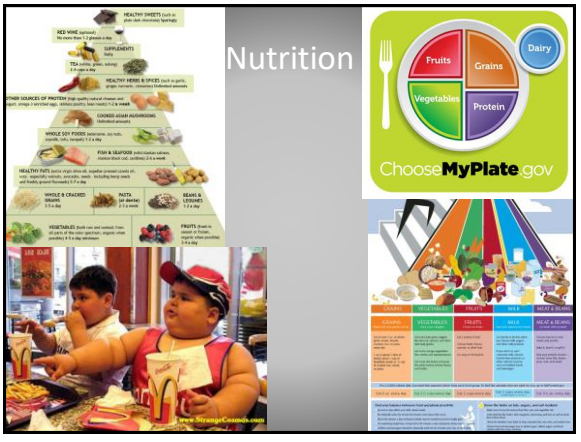
Nutrition
Fruits
Grains
Dairy
Vegetables
Protein
ChooseMyPlate.gov



TABLE 2. SYMPTOMS OF OVERTRAINING

| SYMPTOMS DURING TRAINING | PHYSICAL SYMPTOMS | NONPHYSICAL SYMPTOMS |
|---|---|---|
| Normal workouts feel more difficult | Persistent fatigue | Difficulty sleeping |
| Early fatigue during workouts | Ongoing muscle soreness | Feelings of irritation or anger |
| Faster heart rate with less effort | Loss of appetite | Feelings of depression |
| Decreased strength | Increased aches and pains | Lack of motivation |
| Decreased coordination | Increase in overuse injuries | Fear of competition |
| Physical challenges seem too hard | Frequent colds or infections | Difficulty concentrating |
| Decreased performance on strength, speed, or endurance testing | Lower resistance to common illnesses | Increased sensitivity to emotional stress |

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## RECOMMENDATIONS TO REDUCE OVERUSE INJURY

- When teaching sport skills, reduce endless repetitions of the same task.
- Teach motor skills in a distributed manner, interspersing frequent rest periods with work periods.
- Use random practice, mixing up activities so that the same activity is not repeated excessively.
- Use frequent games to vary practice and enhance motivation.
- Keep workouts interesting and age-appropriate.
- Gradually increase progression of the workload.
- Monitor athletes for fatigue, soreness, and general apathy.
- Take care to reduce workload when changing surfaces.
- Periodize training on a weekly and seasonal basis.
- Take 1–2 days of absolute rest each week.
- Schedule breaks every 2–3 months with a change in activity.
- Encourage children to participate in a variety of sports.□

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## Recent Literature

- Vitamin D in Health and Disease Zhang Nutrition Journal 2010
- Evaluation of Low Back Pain in Athletes Daniels Sports Health 2011
- Sports Related Concussion in Pediatrics Cohen Current Opin Pediatrics 2009
- Non Contact ACL in Female Athletes Renstrom Br J Sports Med 2009
- Overuse Injuries, overtraining, and burnout in child and adolescent athletes Pediatrics 2007
- Journal of Athletic Training 2011

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## References

The DO | Patient Care | In the Field
Prevent overuse injuries in child athletes: Info for family physicians

Back

Overuse Injuries and Burnout in Youth Sports Can Have Long-Term Effects
The American Medical Society for Sports Medicine
Jan 2014

OSTEOCHONDROSIS:Common cause of pain in growing bones Am Fam Physician Feb 2011

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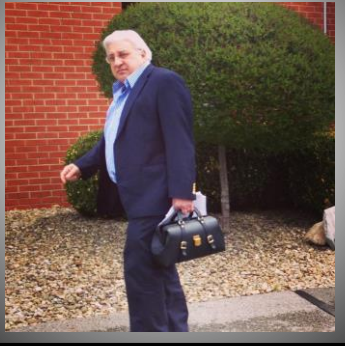
Carlo Dimarco DO
1952-2014

Michael Namey DO
1953-2014



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## Recent Publication

- **Considerations in the management of concussion with an illustrative case example**

**Craig Chappell, DO; Patrick F. Leary, DO, FAOASM, FACSM, FACOFP, FAAFP; Nicole Cerkiewich, OMSIV**
*From the Lake Erie College of Osteopathic Medicine, Erie, PA.*

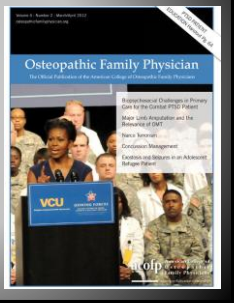
Concussions are extremely common injuries, especially among student athletes. With emerging guidelines that will require physicians to make decisions regarding injured athletes' return to physical activity, the family physician will soon be faced with more frequent questions from injured athletes and with new responsibilities to help ensure patients' safety. Assessment tools such as Sport Concussion Assessment Tool and neurocognitive testing will assist with evaluation and return to play decisions, but ultimately, it is important for the physician to develop a strategy for comfortably and appropriately managing this frequently encountered and challenging problem.



**KEYWORDS:**
Concussion;
Sport;
Neurocognitive testing;
Return to play;
Student athlete

Concussion is a common injury among high school student athletes participating in high-energy sports. The Centers for Disease Control and Prevention reports that there are 2 million nonfatal sports-related concussions in the United States per year.1 The family physician has the greatest potential to impact the outcome of this condition both on the sidelines and in the office. As new information becomes increasingly available, it is imperative for the family physician to be comfortable with the diagnosis and management of the concussed athlete. There is no cure for concussion, so the most important consideration clinically is the safe and timely return of the athlete to activity after injury.2,3 This becomes even more important as emerging practice recommendations make the family physician responsible for return-to-play decisions.

Of the 2 million sports-related concussions occurring each year, more than 136,000 involve high school athletes.4 In the United States, there are currently 14,226 high schools with more than 7.6 million athletes. Of those, more than 1.1 million athletes participate in 11-player football.5 Recent information suggests that most high school concussions

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ORIGINAL CONTRIBUTION

## Effect of Latitude on Vitamin D Levels

Patrick F. Leary, DO, MS; Ina Zamfirova, MS; Johnathan Au, MPH; Ward H. McCracken, DO

From the Lake Erie College of Osteopathic Medicine in Erie, Pennsylvania (Dr Leary); the Russell Research Institute at Lutheran General Hospital in Downers Grove, Illinois (Ms Zamfirova and Mr Au); and the University of Minnesota in Minneapolis (Dr McCracken).

Financial Disclosures: None reported.

Support: Funded by the Lake Erie Consortium for Osteopathic Medical Training (LTS1511).

Address correspondence to Patrick F. Leary, DO, MS, 5401 Peach St, Suite 3400, Erie, PA 16509-2601.

E-mail: pleary@lecom.edu

**Context:** Vitamin D levels have been linked to bone health and to numerous diseases; however, an element that lacks substantial direct data and limits the evidence basis regarding whom to screen for vitamin D deficiency is the effect of latitude on vitamin D levels.

**Objectives:** To determine whether latitude influences vitamin D levels and to investigate the influence of other factors that may affect vitamin D levels, including sex, race, skin type, and body mass index.

**Methods:** Osteopathic medical students were recruited from campuses in Bradenton, Florida, and Erie, Pennsylvania. Surveys were administered to obtain demographic information, and blood samples were drawn to measure total vitamin D levels. Two-sample *t* tests, Fisher exact test, and logistic regression was used to assess differences in total vitamin D levels between the 2 locations.

**Results:** A total of 359 medical students (aged 22-57 years) were included in the study, 194 at the Bradenton campus and 214 at the Erie campus. The mean (SD) vitamin D level was 34.5 (11.8) ng/mL among participants in Bradenton and 28.1 (12.4) ng/mL among participants in Erie. Logistic regression models revealed an adjusted OR of 2.7 (95% CI, 1.77-6.4) for deficient total vitamin D among Erie stu-