BIOMECHANICAL CONSIDERATIONS FOR THE FEMALE ATHLETE

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DISCLOSURES

- I have no relevant financial relationships with commercial interests.

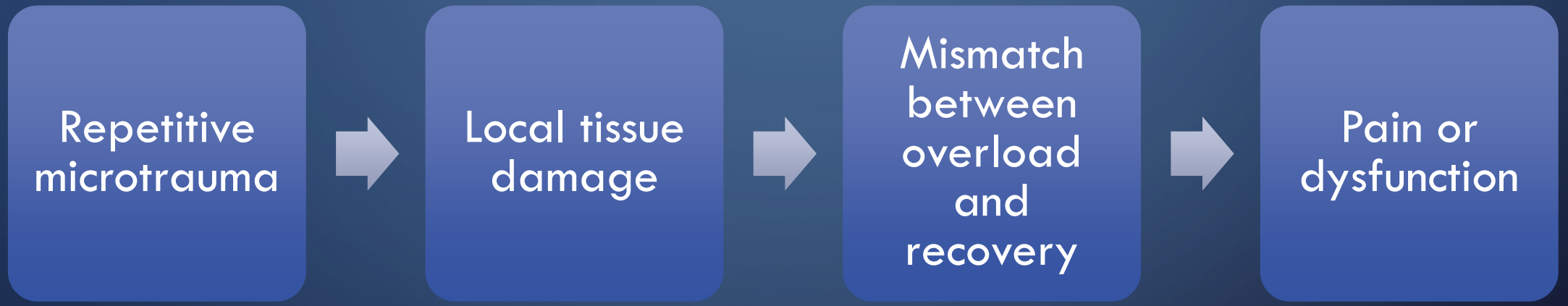
OBJECTIVES

1. Define overuse injuries and associated risk factors.
2. Describe musculoskeletal anatomical differences between males and females.
3. Describe kinetic chain and biomechanical considerations for injury in the context of the female athlete.
4. Discuss bone health specific to the female athlete.
5. Discuss risk factors for bone stress injuries with specific considerations for female athletes.

OVERUSE INJURIES

THE FEMALE ATHLETE

OVERUSE INJURIES



WHAT'S FAULTY?

- Anatomical vs functional

- Kinetic chain analysis
- Biomechanical analysis

EVERYTHING MATTERS

- Muscle
- Fascia
- Tendons
- Ligaments
- Nerves

CONSIDERATIONS / RISK FACTORS

Training errors

- Inexperience
- Training loads
- Equipment- shoes
- Terrain

Kinetic chain deficits

- **Anatomical**
  - **Spinal curvatures**
  - **Lower extremity alignment**
  - **Leg length discrepancy**
- **Functional**
  - **Posture**
  - **Strength**
  - **Flexibility**
  - **Biomechanics**

Low energy availability

- Insufficient intake
  - Macro/micronutrient deficits
- Excessive activity
- Cues: menstrual dysfunction/low testosterone, poor bone health, fatigue
- (fe)male athlete triad / RED-S

Other health conditions

- Medications
- GI malabsorption
- Fatigue
- Blood loss
- Low bone mineral density

ANATOMICAL DIFFERENCES BETWEEN THE SEXES

THE FEMALE ATHLETE

PRIOR TO PUBERTY

- Males and female have similar:
  - Height
  - Weight
  - Muscle mass
  - Heart size
  - Sports performance
  - Aerobic capacity

POST-PUBERTY

- Females have:
  - Shorter stature (10% shorter on average; weighs 30-40 lbs less on average)
  - Less lean body mass (lower androgens)
  - Greater percentage of body fat (higher estrogens; hips and thighs)
  - Lower bone density
  - Wider pelvis
  - Greater Q angle
  - Breast development

PSYCHOSOCIAL CONTEXT

CALORIC RESTRICTION/ ”HEALTHY EATING”

- Pressures for leanness
- Carbs labelled as “bad”
- Fear that pubertal changes will affect performance
- Less dairy consumption

LESS STRENGTH TRAINING

- Lack of weight room exposure for girls
- Fear of developing “big muscles”

ADOLESCENT BONE HEALTH

- BMD peaks in early 20s
- BMD can be impacted by exercise, caloric intake, and hormones

POST-PUBERTY

- Iron losses through menses
  - Anovulatory menses – menorrhagic, frequent menses, breakthrough bleeding
- Cyclical hormonal impact
  - Alterations in energy and strength levels
- Breast development impacts
  - Kyphosis, back pain
  - Change in center of mass

ROLE OF MUSCLE AND BONE

- Muscle is responsible for shock absorption
  - Modulate bone loads during activity
  - Minimizes off-axis loads and increases compressive bone loading
- Fatigued muscle
  - Cannot do its job (poor local muscle endurance, poor overall fitness)
  - May also alter biomechanics to use less fatigued muscles (compensatory patterns alter loading stresses)

ROLE OF MUSCLE AND BONE

- Bone and muscle adapt to their training
  - Consider overtraining AND undertraining risks
- Consider sarcopenia
  - Sedentary individual starting a new exercise program

CLINICAL EVALUATION

THE FEMALE ATHLETE

KINETIC CHAIN EVALUATION → IN-OFFICE EVAL

- Structural characteristics
- Asymmetries
- Malalignments
- Muscle imbalances
  - Tightness patterns (flexibility)
  - Weakness patterns (strength)
  - Activation patterns (neuromuscular control)
- Gait

- Static evaluation
- Dynamic evaluation

BONE STRESS INJURY RISK FACTORS → STATIC EVAL

- Muscle imbalances
- Poor core strength
- Leg-length discrepancies (sacrum)
- Femoral anteversion
- Increased hip external rotation
- Genu varum
- Excessive Q angle
- Narrow tibia width (tibia)
- Smaller calf girth and less muscle mass in lower limb of female runners
- Hindfoot and forefoot varus (tibia)
- Pes cavus (fibula, metatarsals)
- Morton's toe (2nd MT)

Ref: Bennell 1996, James 1978, Blaiser 2018

COMMON TRENDS

- Generalized weakness
- Poor muscle endurance (or FATIGUE!)
- Poor core strength
- Relative muscle strength, flexibility
- Poor lower quarter stability
- Poor squat mechanics

SOFT TISSUE OVERUSE INJURIES

- Patellofemoral pain syndrome (PFPS)
  - Wide pelvis
  - Increased knee valgus
  - Femoral anteversion
  - Relative gluteus medius weaknes
- Iliotibial band syndrome (ITBS)
  - Wider pelvis
  - Prominent greater trochanter

BSI BIOMECHANICAL RISK FACTORS → DYNAMIC EVAL (RUN GAIT ANALYSIS)

- Excessive hip adduction (tibia)
- Increased knee internal rotation
- Excessive subtalar pronation / hindfoot eversion (tibia)
- Heel strike (tibia)

BONE HEALTH

BONE HEALTH

- Consider lab work up and DXA in female athletes concerning for poor bone health (RED-S)
- Prefer to intervene sooner, esp in adolescent
- Intervention may be as simple as dietary adjustments – referral to sports dietician
- May also require hormonal vs other treatment for improved bone density
- Consider hormonal impact of menopause
- Kinetic chain and biomechanical evaluation!

CALCIUM & VITAMIN D

- Dietary calcium: 1300 mg per day (adolescent), 1000 mg per day (premenopausal), 1200 mg per day (postmenopausal)
  - Dietary > supplement
- Vitamin D: 600 IU vitamin D per day (1000 IU per day for postmenopausal)
- Goal: Vitamin D > 40
  - >30 is “adequate”
  - 20-29 is insufficient
  - <20 is deficient

SUMMARY

- Overuse injuries are multi-factorial.
- Women's bodies are different anatomically, functionally, and physiologically.
- Low energy availability is common in female athletes and has significant consequences – Don't miss it!
- Consider biomechanical deficits in injury prevention.
- Bone health is crucial.

THANK YOU

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REFERENCES AVAILABLE UPON REQUEST