Special Populations in the Runner: The Skeletally Immature/Adolescent Runner
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I. Introduction
   a. General benefits of exercise
   b. Red Flags in the Skeletally Immature Runner

II. Injury Risk and Patterns
   a. Injury Rates
   b. Risk Factors
      i. Female Athlete Triad
      ii. Achieving a “competitive body” might be detrimental to health
   c. Common injury patterns
      i. Apophyseal injuries/avulsions
      ii. Bony lesions/stress fractures
      iii. Other types of common injuries

III. Running Biomechanics in the Developing Athlete
   a. Biomechanical Considerations
   b. Running Performance
      i. Physiological
      ii. Muscle strength
      iii. Muscle power
      iv. Anthropometric
   c. Building aerobic capacity in kids

IV. Unique Considerations for the Skeletally Immature Runner
   a. Cardiopulmonary
      i. Aerobic capacity related to growth
      ii. Stroke volume, cardiac output, and max heart rate
      iii. Oxygen extraction at the tissue level
   b. Musculoskeletal
      i. Bone
         1. Bone mineral density related to dietary intake
         2. Open growth plates
      ii. Tendon and Ligament
         1. Apophyseal tendon attachments are weak
         2. Amount of physical activity may cause microinjury to these attachment sites
   c. Temperature regulation
      i. Heat intolerance – heat absorption due to higher surface area to mass ratio and lower sweating rates
      ii. Importance of hydration in skeletally immature runners
   d. Psychological Considerations
      i. Effects of weekly training volumes
      ii. Positive psychological benefits of sport and competition
iii. Psychological stress and increased injury risk
iv. Importance of goal setting

V. Exercise prescription considerations
   a. Resistance training
   b. Endurance training
   c. Neuromuscular control

Special Populations in the Runner: The Pregnant and Postpartum Runner
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VI. Pregnant runner (*Physical exercise in pregnancy has minimal risk)
   a. Unique considerations pregnant runner
      i. Emotional/influence of others
      ii. Fetal health
      iii. Daily-weekly changes in physiology/biomechanics
   b. Contraindications to exercise during pregnancy (chart on slide)
   c. Benefits of exercise during pregnancy
      i. Systemic: lower incidence of gestational diabetes, hypertension disorder, improved aerobic capacity, blood pressure; decreased risk of preeclampsia, reduced fatigue, varicosities, and peripheral edema, prevention of excessive gestational weight gain, obesity/weight retention, decrease nausea
      ii. Psychological: improved self-esteem, decreases in depression, improvement/maintenance of fitness
      iii. Childbirth: decreased incident cesarean, increased incidence of vaginal delivery, decreased labor time
      iv. Baby: prevention of chronic disease development in offspring, and appropriate fetal weight gain, Offspring of those who exercised were significantly lighter and leaner at 5 years of age compared with those offspring of women who stopped exercising during pregnancy
      v. Postpartum: decreased recovery time
   d. Physiological/biomechanical changes
      i. Ligament laxity (increased progesterone, relaxin)
      ii. Increased blood volume (up to 50%)
      iii. Increased resting HR (10-15 BPM)
      iv. Temperature regulation
      v. Lower extremity edema
      vi. Weight gain
      vii. COM
      viii. Increased lumbar lordosis
      ix. Anterior pelvic rotation
      x. Diaphragm elevated
   e. Common Musculoskeletal Injuries
      i. Low back pain
      ii. SIJ pain
   f. PT Management and Treatment of the Pregnant Runner
      i. Education
         1. Exercise recommendations (frequency, duration, intensity)
         2. Gabriella belt / SIJ belt, Spanks
         3. Running shoes and orthotics
         4. Stress incontinence
5. Red flags: vaginal bleeding or fluid leaking, regular contractions, dyspnea before exercise, dizziness, headache, chest pain, muscle weakness, calf pain or swelling
   ii. Considerations during treatment
      1. Positioning for manual therapy
      2. Running mechanics

VII. Postpartum runner
   a. Unique considerations of postpartum runner
      i. Breastfeeding
      ii. Bone density
      iii. Lack of sleep
      iv. Diastasis recti
      v. Pelvic floor dysfunction
      vi. Nutrition
      vii. Energy availability
      viii. Running with jogging stroller
   b. Benefits of running postpartum
      i. Less incidence of postpartum depression
      ii. Improved self image/body image
      iii. Weight management
      iv. Socialization
      v. CV health
   c. Physiological/Biomechanical changes
      i. Posture
      ii. Increased lumbar lordosis
      iii. Width of hips
      iv. Changes in feet/arch
   d. Common Musculoskeletal Injuries
      i. Stress fracture
      ii. Lumbar radiculopathy
      iii. Low back pain
      iv. SIJ pain
      v. Hip labral tears
      vi. Pelvic floor dysfunction
   e. PT Management
      i. Education
         1. New Runners
         2. Shoes/Bra
         3. Postpartum depression
         4. Diastasis
         5. Pelvic floor dysfunction
         6. Gait retraining
      ii. Exercise
         1. Core stability
         2. Breathing
         3. Posture
         4. Manual therapy
         5. Myofascial work
Special Populations in the Runner: The Biomechanically Challenged Runner
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VIII. “A runner for whom idealized running is restricted due to co-morbidity.”
   a. Anatomical restriction
      i. Poor AROM/Strength through ROM
      ii. Limited in ability to control movement through necessary range.
      iii. Decreased isolated or composite strength
   b. Modified nervous system
      i. Peripheral Nerve Injury
      ii. Central Nerve Injury
   c. Obesity (body composition for given body mass)
      i. Increased loads at knee/increased quadriceps demand
      ii. Decreased running economy

IX. How to identify a Biomechanically Challenged Runner.
   a. Subjective/History
   b. Functional Movement Screen(s)
      i. Body-weight Squat/Deep Squat
      ii. Active Straight-Leg Raise
   c. Gait Analysis
      i. Frontal Plane
      ii. Sagittal Plane
      iii. Cadence/Vertical Excursion

X. Treating the Biomechanically Challenged Runner
   a. Address primary mobility restriction
      i. Joint Mobilization
      ii. Nerve Mobilization
      iii. Soft Tissue Mobilization/Stretch
   b. Train Movement into Idealized Range
      i. Neuromuscular Re-Education
      ii. Stabilization
   c. Strength Training
   d. Composite Multi-Joint Lifts
      i. Squats
      ii. Deadlifts
      iii. Presses
      iv. Pull(s)
   e. Accessory Lifts
      i. Posterior Chain
      ii. SL Movements
      iii. Core
   f. Long-term tissue change
      i. 3-4 sets of 6-8 reps, >70-80% 1 RM
      ii. Can take 6-12 weeks for significant tissue change

XI. Gait Training
   a. Identify “problem segments” of Total Running Movement
      i. Segmental Practice
      ii. Drills
   b. Running practice with cues
      i. Tactile cues
ii. Auditory cues
iii. Visual cues
iv. Feedback

XII. Unique Considerations for the Biomechanically Challenged Runner
a. Modification of Return-to-Run timeline
   i. Allow for management of primary deficit
   ii. Tissue Turn-over
   iii. Development of fundamental Stability
b. Modification of Running Performance
   i. Speed
   ii. Distance
   iii. Terrain
   iv. Frequency
c. Modification of Patient Expectations
   i. Change to meet capabilities

XIII. Case Presentation

Key Points
- Identify/Address Primary/General Functional Limitations/Deficits
- Modify Dose and Expectation
- Modify Rehabilitation/Recovery Timeline

Special Populations in the Runner: The Aging Runner
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XIV. Introduction
a. Statistics
b. General benefits of exercise on aging
c. Pre-participation screens
   i. Overall health
   ii. Vision
   iii. Comorbidities such as DM and HTN
   iv. ECG testing in those over 40 years old with at least 1 cardiac risk factor

XV. Injury Patterns in the Aging Runner
a. Rates compared to younger runners
   i. “Healthy runner effect”
b. Risk Factors
c. Differences in Injury patterns
   i. Location and types of injuries
      1. Calf, and foot
      2. Hamstring
      3. Decreased incidence in knee injuries compared to younger runners
   ii. OA and total joint arthroplasty

XVI. Running Biomechanical changes and aging
a. Changes in Running Performance
   i. Slower self-selected running speeds
b. Biomechanical Alterations
   i. Shorter stride length
ii. Decreased ability to absorb shock
   1. Higher impact peaks forces and initial loading rates
iii. Decreased propulsion
iv. Smaller knee joint excursions

XVII. Physiologic Changes associated with advanced aging
a. Cardiovascular
   i. Decreased VO2 max
   ii. Decreased maximal HR
   iii. Increased arterial stiffness
b. Pulmonary
   i. Loss of lung elastic recoil and stiffer chest wall
   ii. Increased ventilation/perfusion mismatch
c. Musculoskeletal
   i. Skeletal muscle
      1. Sarcopenia (Type I and II)
      2. Decreased motor unit activation
      3. Loss of flexibility
      4. Decreased angular velocities
   ii. Bone
      1. Decline in bone mineral density
      2. Impact activities and running can decrease bone loss (Vopat, 2014)
   iii. Tendon and Ligament
      1. Decreased tendon and ligament compliance
      2. Physical activity may preserve size and mechanical properties of tendon
   iv. Cartilage
      1. Degradation with inactivity
      2. Slower rate of articular cartilage volume loss with regular vigorous activity
      3. Effects of running on OA and following total joint replacement
d. Fluid replacement and Temperature regulation
   i. Heat stress results in increased core temperature, HR, fluid loss and lower sweating rates
   ii. Cold exposure is associated with blunted vasoconstrictor response and greater loss of heat

XVIII. Exercise prescription considerations for the aging runner
a. Resistance Training
b. Endurance Training
c. Flexibility and Balance
d. Gait retraining and shoe wear considerations
REFERENCES

Adolescent/Youth Runner


Pregnant / Postpartum Runner


Biomechanically Challenged Runner


**Aging Runner**


