Don’t Sweat It: The Potential Role of Dermal Calcium Losses on Calcium Homeostasis During Exercise

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Outline

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Background/Rationale

- Male Athletes (Cycling and Basketball)
  - Cyclists lost -1.5% of bone mass over 1 year\(^1\)
  - Basketball players lost bone mineral content\(^2\)
    - -6.1% overall, -10.5% in the legs
    - Reversed with calcium supplements

- Suggests a calcium-dependent relationship
  - Calcium is lost, promotes calcium release from the skeleton

Background/Rationale

- Where is the calcium going?
  - Sweat
  - Urine
  - Skeletal Muscle
  - Nervous System (?)
Animal Studies

- Animal studies largely show benefit of exercise on bone
  - Use rodent models
    - Rodents do not sweat
    - No potential dermal losses

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Animal Studies

- Some evidence of dermal calcium losses in horses
  - Horses DO sweat
    - Evidence of calcium ion losses in sweat\(^{3,4}\)
    - Differences in calcium losses in warm vs. cool
    - Sweat losses in horses exceeds dietary intake
      - Constant state of calcium deficiency during competitive season
      - May contribute to high stress fracture rate

Background/Rationale

Sweating during exercise

Dermal calcium loss

↓

Serum calcium

↓

↑

PTH

↑

Bone resorption

Stabilization of serum calcium

Kohrt, WM et al., unpublished

The PACE Experiments

PTH and Calcium Responses to Exercise
The PACE Experiments

Is the mechanical benefit of exercise on bone diminished by the metabolic response to exercise (disruption in calcium homeostasis)?

- **EXP1**: Does sweating (surrogate for calcium loss through the skin) impact bone markers?
  - Exercise in a warm vs. cool condition

- **EXP2**: Does preventing a decrease in serum ionized calcium during exercise impact bone markers?
  - Calcium clamp vs saline clamp

The PACE Experiments

- **Quick Methods:**
  - **EXP1** (Male and Female):
    - 18-45 years old, generally healthy
    - 60 minute stationary cycling bout @ ~80% VO2Peak
    - Cool (~18°C/64°F) vs. Warm (28°C/82°F)

  - **EXP2** (Male Only):
    - 18-45 years old, generally healthy
    - 60 minute stationary cycling bout @~80% VO2Peak
    - Continuous calcium infusion vs. continuous half-normal saline infusion

- **Samples Collected:**
  - Blood (parathyroid hormone (PTH); carboxy-terminal collagen crosslinks (CTX); serum ionized calcium (iCa); total calcium (Ca))
  - Urine (total calcium)
  - Sweat (total calcium)
Different temperature conditions (warm vs. cool) did not appear to influence bone markers
- Despite sweat losses being ~50% greater in warm condition
PACE Results- EXP1

- Dermal calcium losses may not be the driver
  - Highly variable between participants
- Was the exercise too intense?
  - Some participants struggled to finish the full 60 minute ride
  - Changes in pH can influence measured markers

PACE Results- EXP2

- Preventing the decrease in serum ionized calcium at the onset of exercise (via a calcium clamp) does attenuate the bone resorption response

Kohrt, WM et al., unpublished
PACE Results- EXP2

Kohrt, WM et al., unpublished
**PTH And Calcium Responses to Exercise in Older Adults (PACE Sr.)**

- Outcomes of an impaired bone response more immediately problematic

- Older adults show similar disruptions in calcium homeostasis
  - Older Women: Markers of bone resorption (PTH, CTX) increase during vigorous treadmill walking⁵
  - Markers stabilized with calcium supplements

**PACE Sr: Why Older Adults?**

- Physiological Differences:
  - Sweating and sweat rate
  - Diminished bone formation capacity
    - More load needed compared to younger adults
    - Shift in bone formation/bone resorption cellular dominance

**PACE Sr. EXP1 and 2**

- Unanticipated results from EXP1 warrant further investigation
- Experiments 1 and 2 identical to PACE except:
  - Age range: 60-80 years
  - Exercise modality: treadmill walking
Future Directions

- Long-term training studies
  - Acute vs. chronic response
  - BMD changes vs. bone strength changes

- Supplement studies
  - When?
  - How?
  - How much?

- Different exercise modalities

Our Research Participants and CTRC Staff

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Questions?