Impact of Iron Depletion Without Anemia on Performance in Trained Endurance Athletes at the Beginning of a Training Season: A Study of Female Collegiate Rowers
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**Background:**
- Iron deficiency is the most prevalent nutrient deficiency in the world.
- In the United States, iron deficiency with anemia affects 3–5%, and iron deficiency without anemia (IDNA), ~16%, of premenopausal women.
- Female athletes are more susceptible to IDNA (25–35%), which is 5–7 times more prevalent than iron deficiency with anemia.
- Iron plays an important role in oxidative metabolism, which is the primary energy pathway for endurance athletes.

**Purpose:** to examine the iron status of female collegiate rowers at the beginning of a training season and determine the association between IDNA and reported rowing performance.

**Methods:**
- **Cross-sectional study**
  - **Subjects:**
    - Varsity and second-semester novice female rowers who were >18 years of age and able to begin regular training for their sport.
    - Subjects were recruited at the beginning of the conditioning phases of their competitive rowing seasons (on arrival on campus post-summer and post-winter breaks).
    - A medical screening (NCAA-required) excluded all athletes not healthy enough to participate in their rowing training.
    - Out of 199 eligible female rowers, 165 completed the iron-status screening.
  - **Protocol:**
    - Measured:
      - Iron-status variables (Hgb, Hct, blood cell count, α-1-acid glycoprotein).
      - Demographic variables.
      - Current dietary supplement use.
      - Health and menstrual status.
      - Habitual physical activity.
    - Performance was self-reported best times to complete a 2-km simulated race on the ergometer from the previous season (2-3 months before iron status screening).
    - Performance was later validated with measured performance in a subsample of 48 rowers.
    - Rowers were classified as either iron depleted (sFer <20 µg/L) or normal (sFer 20 µg/L).
    - Anemic subjects (n = 16) were eliminated from study.

**Definitions:**
- **Serum ferritin (sFer):** most common index of body-iron stores and reflects iron stored in the liver. sFer can be falsely elevated in an inflammatory state (e.g., infection, postexercise).
- **Soluble transferrin receptor (sTfR):** a transmembrane protein regulated by cellular iron status, reflects iron deficiency at the tissue level and is a more sensitive index of functional iron deficiency than sFer. sTfR is unaffected by inflammation and has been shown to have lower within-subject variability in intense training.
- sFer and sTfR respond to iron supplementation in opposite directions (sTfR decreases and sFer increases).
Results:

- 30% (n = 44) of the nonanemic rowers were found to be iron depleted (sFer <20.0 µg/L)
- 12% (n = 18) were clinically iron deficient (sFer <12.0 µg/L)
- 19% (n = 28) had high values of sTfR (>8.0 mg/L) (early functional iron deficiency)
- 10% had total body iron <0 mg/kg (severe iron deficiency)
- 3 had an α-1-acid glycoprotein value >140 mg/dl (inflammation)
- 19% of screened subjects had a previous history of anemia or iron deficiency
- 33% reported consuming a multivitamin/mineral supplement either intermittently or regularly
- No significant interactions between iron status and the amount of time spent in physical activity
- Rowers with sFer <20.0 µg/L, 2-km times were 21 s slower than normal iron status (p = .004)
- Relationship between sFer status and 2-km time was stronger with sFer <15 µg/L (p = .002)

Discussion:

- 30% prevalence of IDNA in this study similar to previously reported for other female athletes participating in endurance sports
- The prevalence of IDNA in this study may have been affected by intake of multivitamin or mineral supplements, some of which contain iron
- sFer cutoff of 20 µg/L may have misclassified rowers as normal, and examination of optimal sFer levels for female athletes is warranted
- 42% of rowers had sFer <25 µg/L, and the relationship between sFer and reported 2-km performance time remained significant using this cutoff
- Did not have measure maximal oxygen consumption or blood lactate in rowers
- Menstrual status and high training load were not measured

Applications:

- Strategies to easily screen and improve iron status may be useful for female endurance athletes at the beginning of a training season
  - Iron status may decrease with increased levels of physical training over time
  - Early screening and iron supplementation at beginning of training season may help prevent further decrements in iron status throughout training and competitive season
- It would be important to confirm these results in a longitudinal study