Article

Adaptive Sports/Recreation Topic Categories
- Female Athlete Triad
- Relative Energy Deficiency in Sport (RED-S)
- Paralympic Athletes

Research Questions
- What is the prevalence of factors (low energy availability (LEA), low bone mineral density (BMD), and menstrual dysfunction) associated with the Female Athlete Triad (Triad)/Relative Energy Deficiency in Sport (RED-S) in elite para athletes?
- What are the differences among sex, disability type, and sport type in health issues stemming from low energy availability?

Methodology
- Electronic survey was distributed to 659 US elite para athletes training to qualify for the 2016 Rio Summer Paralympic Games or the 2018 Pyeongchang Winter Paralympic games.
- Since no validated questionnaire existed for data collection, investigators reviewed available studies to reach consensus on questions of the survey in order to characterize known Triad/RED-S components and health concerns in this population.
- Survey distribution and data collection occurred in July – August 2016. The following data were collected from participants:
  - Athlete characteristics: sex, age, race, disability type, primary sport type, and ambulatory status.
  - Factors associated with low energy intake were assessed using:
    - The Eating Disorder Examination Questionnaire (EDEQ) dietary restraint and pathologic behaviour subscales.
    - Self-reported history of a diagnosed eating disorder.
    - Height and weight to calculate body mass index.
    - Athletes’ characterization of themselves as underweight, ideal weight, or overweight.
    - Athletes’ report of whether they felt pressure or not to maintain a certain body weight to improve athletic performance.
  - Menstrual function in females was assessed using:
    - Self-reported history of menstrual cycles in the past 12-month period.
      - Evaluation for oligomenorrhea (6-9 menstrual cycles/year) or amenorrhea (less than 6 menstrual/year).
    - Age of menarche.
  - Participants were excluded from this section if > 50 years or if they were on oral contraceptive pills in the past 12 months.
  - Low BMD and stress reaction/fracture was assessed using:
    - Self-reported history of stress reaction or stress fracture, and total number experienced.
• Stress reactions or stress fractures had to be confirmed based upon whether they occurred after onset of disability, occurred in a plausible location, were related to sport, and were diagnosed with imaging (e.g. x-ray, MRI, or CT).
  ▪ Potential diagnosis of low BMD, osteopenia, or osteoporosis by a dual x-ray absorptiometry (DXA) scan.
  ▪ A known family history of low BMD, osteopenia, or osteoporosis.
  o Finally, athletes were asked whether they had heard of the terms Female Athlete Triad or RED-S.

**Results**

• 264 of the 659 para athletes who were contacted completed the survey; response rate = 40%. Final analysis included 260 athletes (150 males, 110 females; average age 31.7 +/- 11.5 years). Majority were Caucasian and had experienced either a spinal cord injury (30.4%) or lower extremity amputation (25.8%).

• Low energy availability
  o 3.1% reported history of a diagnosed eating disorder.
  o 18.5% had an elevated EDEQ dietary restraint subscale score and 32.4% had an elevated EDEQ pathologic behaviour subscale score.
  o 61.5% indicated they were currently attempting to change their body composition or weight to improve sport performance (63.3% of male athletes and 59.1% of female athletes).
  o 46.7% of athletes considered themselves overweight; of these, 55% had a BMI > 25.

• Menstrual dysfunction of 105 females with available data
  o 13.4 % reported history of delayed menarche ≥ 15 years.
  o 25 female athletes (age 33.7 ± 9.1 years) had menstrual dysfunction.
    ▪ 24.0% had oligomenorrhea.
    ▪ 20.0% had amenorrhea.

• Low BMD and history of stress reaction/stress fracture
  o 53 reported a history of stress reaction or stress fracture, but only 24 had a history of stress reaction or fracture that occurred after the onset of disability, occurred in a plausible location, was related to sport, and was diagnosed by imaging.
    ▪ 13 athletes had a history of one stress reaction or fracture.
    ▪ 11 had a history of two stress reactions or fractures.
  o 8.5% had a history of low BMD diagnosed by DXA scan.
  o 13.1% reported known family history of osteopenia or osteoporosis.

• Awareness of the Female Athlete Triad and RED-S
  o 8.1% of all athletes were aware of the Triad; 9.2% were aware of RED-S

• Sub analysis according to sport type or type of disability
  o Over 50% of athletes in the sports of cycling (males and females), soccer 7-a-side (males only), rowing (females only), and track and field (males only) met criteria with regard to concerns for weight.
  o Of 24 athletes reporting history of stress fracture or fracture, 42% of these were track and field athletes.
  o Over 50% of athletes with spinal cord injury (females only), cerebral palsy (females only), acquired central neurological injury (males and females), and visual impairment (males and females) reported weight concerns.
Athletes with spinal cord injury accounted for 20.8% of bone stress injuries and 54.5% of those with history of low BMD.

Discussion/Conclusion

- Few athletes reported a history of an eating disorder, but a significant number of athletes had elevated EDEQ scores indicating possible concerns regarding LEA.
- A significant number of athletes indicated negative self-perception toward body habitus and weight.
- Over half of athletes were attempting to change their body composition or weight for sport performance.
- These findings with regard to energy availability and perception of body habitus were comparable in both the female and male athletes.
- Over half of females < 50 years and not on oral contraceptive pills met criteria for oligomenorrhea or amenorrhea.
- 9% of athletes had a history of at least one bone stress injury, with a higher proportion being athletes with history of spinal cord injury.
- Awareness of the Triad and RED-S was low in both female and male athletes, regardless of sex, sport type, or disability type.
- Future research should further evaluate the associations between these factors and individual sports or disability types.

Article Strengths

- This is the first study to assess the prevalence of factors associated with the Triad/RED-S across all sport and disability types in elite level para athletes.
- Multiple relevant factors related to low energy availability, menstrual status, and bone health were explored in the survey.

Article Weaknesses

- Findings were based upon self-report (subjective assessment).
- Low response rate of 40% on the survey possibly resulted in response bias.
- Influence of racial/ethnic factors was not assessed.
- Low sample size, particularly in the assessment of menstrual status.
- BMI assessments may be of limited utility in populations such as amputees, short stature, spinal cord injury with resultant muscle atrophy, etc.
- Results indicate findings from the elite para athlete population; they may not be generalizable to all individuals with disabilities participating in adaptive sports.
- Survey instrument had not been validated.

Take Home Messages

- Factors associated with LEA, menstrual dysfunction (females only), and impaired bone health were observed in elite Paralympic athletes, regardless of sex.
- Awareness of the Triad/RED-S is low in para athletes.
- Greater efforts should be made to advance screening efforts and to educate both female and male para athletes about the consequences of these concerns.
- Future research should evaluate the associations between these factors and individual sports or disability types.
- Efforts are needed to determine the energy requirements and the short- and long-term consequences of low energy availability to optimize athletic performance and overall health of elite para athletes.