Cross-country skiing is a biomechanically complex sport. There is limited prospective cross-country ski injury data to confirm whether the repetitive endurance training predisposes skiers to overuse injuries. In retrospective studies reporting injury percentages, overuse and acute traumatic injuries to the lower leg and spine are most commonly reported. Cross-country ski injury incidence rates of 1.35 overuse injuries, and 0.73 acute injuries per 1000 exposure hours have been reported. Injury and training surveys help to establish the incidence and severity of injuries and provide data for the first step of injury prevention research. Movement screening may be useful to identify risk factors for future injury, providing data for research into aetiology and mechanisms of injury.

**BACKGROUND:**
- Cross-country skiing has a high incidence of overuse injuries, but the exact factors contributing to these injuries are not well understood.
- Previous studies have reported injury percentages, overuse and acute traumatic injuries to the lower leg and spine.
- Cross-country skiing is biomechanically complex due to the repetitive endurance training.

**STUDY OBJECTIVES:**
- To describe the demographics, movement characteristics, injury type and incidence of elite cross-country skiers in North America.
- We hypothesized that lower extremity injury incidence would be higher than other body regions.
- Secondary aims were to determine if new injury correlated with any movement, demographic, history, training or injury factors.

**METHODS**
- **Recruiting**
  - E-mail coaches of North-eastern USA professional cross-country ski teams to compile interest.
  - Recruited attended six team meetings to explain study process and invite skiers to participate.
- **Movement Screening**
  - Conducted using a movement screen survey including demographics, and history of injury and doing at least one personal email to receive unique link to online survey.
  - MSC video recording, 3 movements, 3 repetitions in 3 views (Fig A).
  - Active straight leg raise: Degree of hip flexion and right/left.
  - McGill trunk flexor endurance time (Fig B).
  - Bending/lifting: trunk extensor endurance time (Fig C).
- **Year Long Activities**
  - Complete automated monthly survey.
  - Biering-Sorensen.
  - Active straight leg raise.
  - Push-up.
  - 35 men and 36 women completed the study.

**RESULTS**
- **I. MALE SUBJECTS HAD HIGHER MCS SCORES THAN FEMALES**
  - MCS score: 23.27 (1.45) vs 22.98 (1.42), p = .002.
  - Right hamstring length (cm): 22.1 (6.4) vs 18.7 (4.7), p = .002.
  - Left hamstring length (cm): 24.6 (8.1) vs 22.9 (5.2), p = .002.
  - Trunk muscle endurance ratio (flexor/extensor): 1.7 (0.4) vs 2.1 (0.6), p = .002.
- **II. HIGH INCIDENCE OF LOWER EXTREMITY INJURIES**
  - Table showing incidence of lower extremity injuries:
    - Incidence: Total number of new injuries/1000 exposure hours.
    - Ratio: Ratio of new injuries per 1000 exposure hours.
    - p-value: Statistical significance level.
- **III. NEW INJURY CORRELATES WITH INJURY HISTORY**
  - Table showing correlation between new injuries and previous injury history.
    - Variables: MCS score, Right hamstring length, Left hamstring length, Trunk muscle endurance ratio, Injury history.
    - p-values: Statistical significance level.
- **IV. LOWER EXTREMITY INJURIES OCCURRED MOST OFTEN**
  - Bar chart showing distribution of lower extremity injuries:
    - Different body parts and body regions.
    - Number of new injuries by body region and gender.

**DISCUSSION AND CONCLUSIONS**
- Cross-country skier new injury correlated with previous injury (consistent with current literature) suggesting prevention of initial injury, and close monitoring of previously injured athletes, are important injury reduction and prevention strategies.
- Cross-country skier new injury did not correlate with:
  - **mean MCS score** (contrary to dancers, but comparable to rowers).
  - The relationship between movement screening and injury needs further study.
  - Exposure hours (contrary to endurance sport literature).
- Training exposure in our study may have been insufficient to influence injury.
- Consistent with the current literature:
  - the incidence of overuse and lower extremity injuries were highest, supporting ongoing research into the reduction and prevention of these injury types in cross-country skiers.
- Training and injury data from multiple consecutive years may better demonstrate differences between ski season and off-season injuries.
- Cross-country skier mean MCS score is comparable to netball players, dancers, and rowers.
- Ongoing study of MCS scores and injury incidence from active populations will improve knowledge about the relationships between movement patterns and injury.

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