Assessment of Injury Risk Screening Methods for Identification of Functional Impairment

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BACKGROUND AND PURPOSE

- More than half of all injuries reported by high school and college athletes are lower extremity sprains and strains, which can lead to chronic disability[1]
  - Research evidence suggests that targeted interventions for modifiable risk factors have the potential to prevent sport-related injury[2]
- Injury risk screening can identify individual athletes who have the greatest potential to benefit from targeted training
  - Risk assessment should include objective measures of performance capabilities and self-ratings of past injury effects[3]
- The Sport Fitness Index (SFI) is a 10-item survey that numerically represents global function on a 0-100 scale[4]
  - Derived from analysis of items from validated joint-specific outcome instruments, with retention and consolidation of those having greatest value
- Ankle sprains account for 20% of all injuries treated in ERs,[5] which can increase risk for subsequent injury to any component of the kinetic chain[6]
  - The Ankle Instability Instrument (AII) is a validated self-reported ankle instability questionnaire that identifies chronic ankle instability (CAI)[7]
  - Restricted dorsiflexion (DF) is believed to be a risk factor,[8] which is most reliably measured using trigonometry rather than an inclinometer[9]
- The purpose of this study was to assess associations among injury risk screening measures that included DF, AII, and SFI, and the extent to which participants who exhibited restricted DF might derive benefit from an intervention designed to enhance lower extremity segmental alignment

PARTICIPANTS AND PROCEDURES

- 206 college students; n=55 males: 22.3 ±3.9 years; 178.3 ±7.9 cm, 79.9 ±15.2 kg; n=151 females: 21.3 ±2.3 years; 166.1 ±6.9 cm, 65.7 ±12.1 kg
  - Electronic survey questions included the SFI (Figure 1, Table 1), injury history inventory (categories of muscle/joint injuries by location), and the AII
    - Injury definition: Any self-reported musculoskeletal injury that resulted in time lost from activity during the previous 12-month period
    - Classification of cases as having ankle instability was based on at least 5 "yes" responses among 9 items comprising the AII
  - DF measured by an inclinometer aligned with lower 1/3 of tibia crest in standing position; 3 measures of both extremities
    - 6 participants identified with DF ≤ 1 SD below cohort mean; selected for participation in a single-session experimental intervention
      - n=2 males: 21 ±0 years, 82.0 ±11.0 kg, 181.5 ±3.5 cm; n=4 females: 20.5 ±0.6 years; 64.9 ±7.5 kg, 168.9 ±10.5 cm
    - 30-s intervention involved internal/external hip rotation with simultaneous squatting and maintenance of neutral lumbo-pelvic position
    - Trigonometric method used to acquire 3 measures of both extremities before, immediately after, and 48 hours after intervention (Figure 2)
      - Repeated measures analysis of variance analysis performed to assess any change in DF for either extremity
  - Reliability of DF measures derived from inclinometer and trigonometric methods assessed by calculating intraclass correlation coefficient (ICC)
- Exploratory analysis performed to identify any associations among SFI responses, self-reported injury history, ankle instability, and DF
  - Receiver operating characteristic (ROC) analyses, median values, and lowest tertile used to define cut-points for binary classifications
  - Cross-tabulation analyses performed to assess strength of associations between binary predictor and status variables

RESULTS

- Very strong association identified between SFI ≤ 80 and self-reported time-loss musculoskeletal injury during previous 12-month period
  - A total of 42 time-loss musculoskeletal injuries reported by 28 individuals (1 injury: 19 cases; 2 injuries: 7 cases; ≥3 injuries: 2 cases) (Table 2)
  - Sensitivity 96%; Specificity 40%; $\chi^2(1) = 14.04$; $p < .001$; OR = 17.92; 95% Confidence Interval: 2.38, 134.83
    - Analysis of each SFI item demonstrated good to excellent discriminatory value for 9 of the 10 (Tables 1 & 3; Figure 3)
- Very strong association identified between SFI ≤ 76 and ankle instability (determined by responses to AII questions; n = 26 ankle instability cases)
  - Sensitivity 92%; Specificity 49%; $\chi^2(1) = 16.06$; $p < .001$; OR = 11.74; 95% Confidence Interval: 2.69, 51.14
    - Analysis of each SFI item demonstrated good to excellent discriminatory value for all 10 (Figure 4)
- No statistically significant differences identified among trigonometric measures of DF for either extremity or between 3 sets of 3 repeated measures
  - ICC (average measures) for 3 sets: Right = .980; Left = .987; Internal consistency within sets ranged from .936 to .992
    - Inclinometer measures of DF for the same 6 participants: internal consistency among 3 measures (single set) were .959 (Right) and .987 (Left)
      - Average differences between trigonometric and inclinometer DF measures: Right = 6.4° (range: -2.9 to 12.6); Left = 9.8° (range: 4.0 to 17.7)
- SFI items 4 (explosive force output limited by pain) and 5 (sport-specific skill limited by pain) associated with bilateral DF difference
  - Highest tertile (≥ 67th percentile) for bilateral inclinometer-derived DF absolute difference was 4° (n=206)
    - Item 4 ≤ 3: Sensitivity 45%; Specificity 77%; $\chi^2(1) = 10.26$; $p = .001$; OR = 2.74; 95% Confidence Interval: 1.46, 5.14
    - Item 5 ≤ 4: Sensitivity 62%; Specificity 61%; $\chi^2(1) = 9.09$; $p = .002$; OR = 2.50; 95% Confidence Interval: 1.37, 4.58

Figure 1

Figure 2

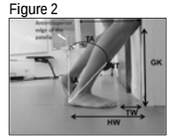


Table 1

SFI Item Value	0	1	2	3	4	5
Frequency Ratings	Persistent	Frequent	Occasional	Infrequent	Rare	Never
Severity Ratings	Severe	Substantial	Moderate	Marginal	Insignificant	Not at all

Table 2

Injured Area	Injuries
Foot/Toes	2
Ankle	11
Lower Leg	2
Knee	12
Thigh	1
Hip/Groin	2
Low Back/ Abdomen	6
Upper Torso/Neck	0
Shoulder/Arm	5
Elbow/Wrist/Hand	1

Table 3

Item	Cut-point	Sensitivity	Specificity	OR	95% CI
1	≤ 2	68	70	4.85	2.06, 11.40
2	≤ 3	89	48	7.79	2.27, 26.73
3	≤ 3	71	63	4.24	1.77, 10.17
4	≤ 3	57	75	3.94	1.73, 8.96
5	≤ 4	70	57	2.83	1.22, 6.61
6	≤ 3	57	64	2.32	1.03, 5.20
7	≤ 4	89	39	5.28	1.53, 18.14
8	≤ 2	68	72	5.40	2.29, 12.74
9	≤ 4	86	47	5.36	1.79, 16.09
10	≤ 4	86	23	1.74	0.57, 5.31

Figure 3

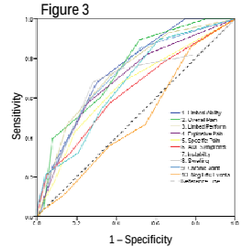
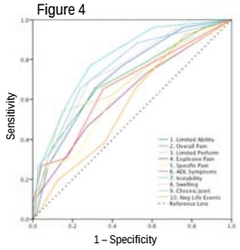


Figure 4



CLINICAL RELEVANCE

- SFI score appears to provide an exceptionally good means to quantify persisting adverse effects of previous injuries on functional capabilities
  - Any time-loss musculoskeletal injury that occurred within the previous 12 months, as well as the existence of ankle instability
- Contrary to expectation, DF did not demonstrate a strong association with self-rated functional capabilities or the existence of ankle instability
  - Strongest DF relevance to functional limitations was bilateral difference of 4° (cases in highest tertile); stronger effect of asymmetry vs. magnitude
- Excellent reliability observed for DF measures derived from either inclinometer or trigonometric method, but magnitudes differed
  - DF values derived from trigonometric method were substantially larger than those from inclinometer, probably due to different angle definitions
- Self-ratings of functional capabilities obtained from SFI items can provide information that is highly relevant to injury risk screening, and may serve as a means to identify individuals who need further assessment (e.g., DF measurement) and/or intervention to improve function and reduce injury risk

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