LEEDS BECKETT UNIVERSITY

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LINKING SPORT SCIENCE AND APPLICATION

The Validity and Reliability of the Rear Foot Elevated Split Squat 5RM to Determine Unilateral Leg Strength Symmetry

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Introduction

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- Asymmetry is of interest to both researchers and practitioners as there is evidence to suggest that it may be linked to an increased risk of injury and reduced performance, although this is equivocal (4,11).
- Previous methods of measuring strength asymmetry have used lab based methods requiring either isokinetic dynamometry or twin force plates.
  - Lab based Isokinetic dynamometry (6, 13, 14, 16)
  - Field based force plate measurements
    - Isometric Mid thigh pull (8), Isometric back squat (9)
- The aim of this study was to validate a method of determining a field based test of unilateral leg strength and subsequent symmetries, which did not require direct measurement of force.
- Increased ecological validity and practicality for S&C coaches

Introduction

- Measurement of symmetry using free weight exercises required a unilateral task
- The rear foot elevated split squat (RFESS) was identified as the preferred exercise.
- DeForest et al. (6) reported peak force in the RFESS (1412.3 ± 258.6 N) as being similar to the back squat (1414.8 ± 251.0 N), but the split squat as significantly lower (1198.6 + 187.9N, $p < 0.05$).
- McCurdy et al., (11) reported the RFESS as a reliable measure of unilateral leg strength (1RM ICC, 0.97- 0.99, 3RM, 0.94-.097).
- The RFESS was identified as a reliable measure of unilateral leg strength which is kinetically comparable to the back squat.
- Found to be comparable to the back squat at developing strength and speed (14)

Methods

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With ethical approval 26* resistance trained male subjects,

3 visits to the lab

1. Familiarization
2. Test
3. Re-test.

- 5 continuous repetitions, with no pause or bilateral stance within 30s data capture window.

- Only toe of the rear foot placed on the force plate
- Force plates under front and rear foot, 10 Qualysis 3D motion capture cameras.
- 5 attempts to achieve maximal load.

*17 participants complete test and re-test conditions

Methods

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- Each set recorded using a PUSH wearable device and repetitions in reserve rating of perceived exertion (RIR-RPE).
- Zourdos et al., (15) reported a mean RIR-RPE of 9.6-10 for 1RM Back squat.
- Concentric velocity for maximal strength testing 1RM backs squats have been reported as 0.24±0.04 m.s.$^{-1}$ (17), 0.28±0.07 m.s.$^{-1}$ (5)
- Mean concentric velocity (MCV) calculated on the 5th repetition and set RIR-RPE recorded after each trial.
- Criteria to achieve a valid maximal attempt.
  - RIR-RPE of 9.5 or greater
    and
  - MCV of less than 0.28 m.s.$^{-1}$
- RIR-RPE scores from submaximal trials was used to predict maximal load and reduce number of trials required.

Symmetry Calculations

The method of calculating symmetry has been varied across previous research, disagreement between methods in symmetry found from same data set (3).

Symmetry was calculated, using a modified percentage difference method. (3)

((100/(max value))-(min value) x (-1)+100)IF(left<right,1,-1))+100*

- A score of less than 100 indicates the left limb achieved a greater score than the right, conversely greater than 100, the right performed better.
- Data not normally distributed and was log transformed
- All data reported at 95% confidence limits.

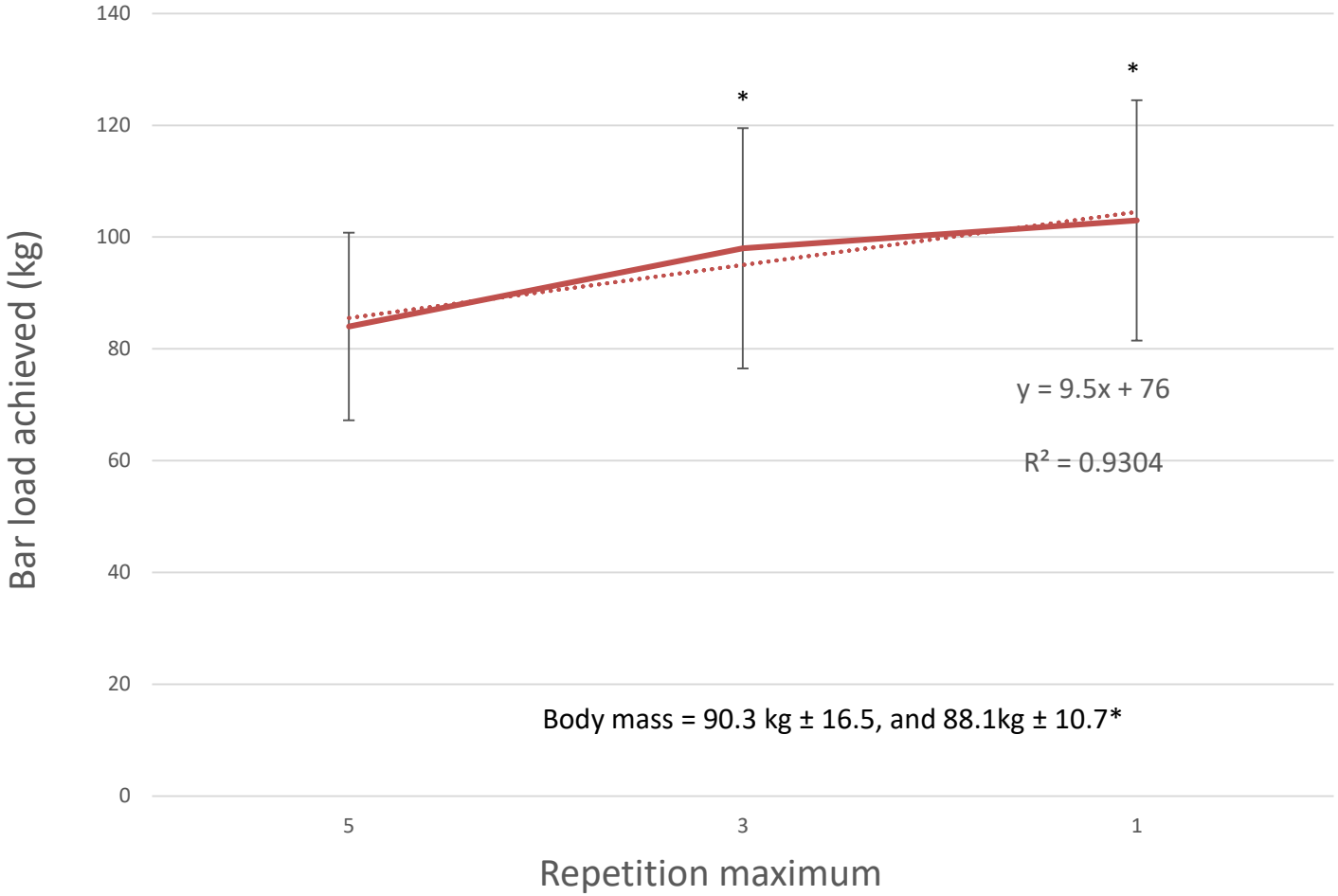
*symmetrical score of 100 can be log transformed, where asymmetry value of 0 could not.

Results

- The mean bar load of all successful trials from both limbs and test conditions was 84kg ±16.8kg (0.96 ±0.18 kg/kg).
- Between test and re-test conditions a most likely very large positive correlation (r =0.93, 0.88-0.96), excellent level of reliability was found (ICC = 0.93 CL 0.88-0.96). A most likely positive increase (9.3%) in bar load was observed between test and re-test conditions

	Test 1		Test 2	
	Left	Right	Left	Right
Mean bar load (kg) ±SD	80.9±15.2	82.0±16.37	89.5±16.3	88.8±18.2
Mean bar load, normalised to body mass (kg/kg) ±SD	0.92±0.17	0.94±0.19	1.0±0.2	0.99±0.2

Mean bar loads achieved during a RFESS maximal strength test



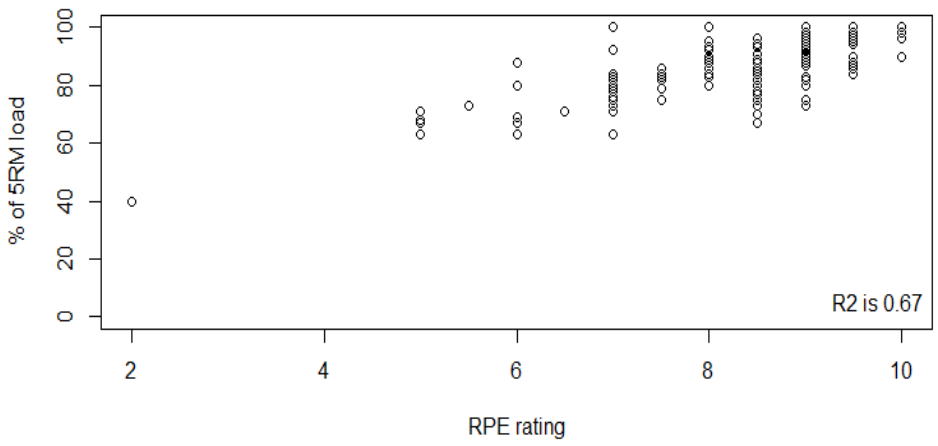
* MCCURDY, K., LANGFORD, G. A., CLINE, A. L., DOSCHER, M. & HOFF, R. 2004. The reliability of 1- and 3rm tests of unilateral strength in trained and untrained men and women. *Journal of Sports Science & Medicine,* 3**,** 190-196. (12)

Results

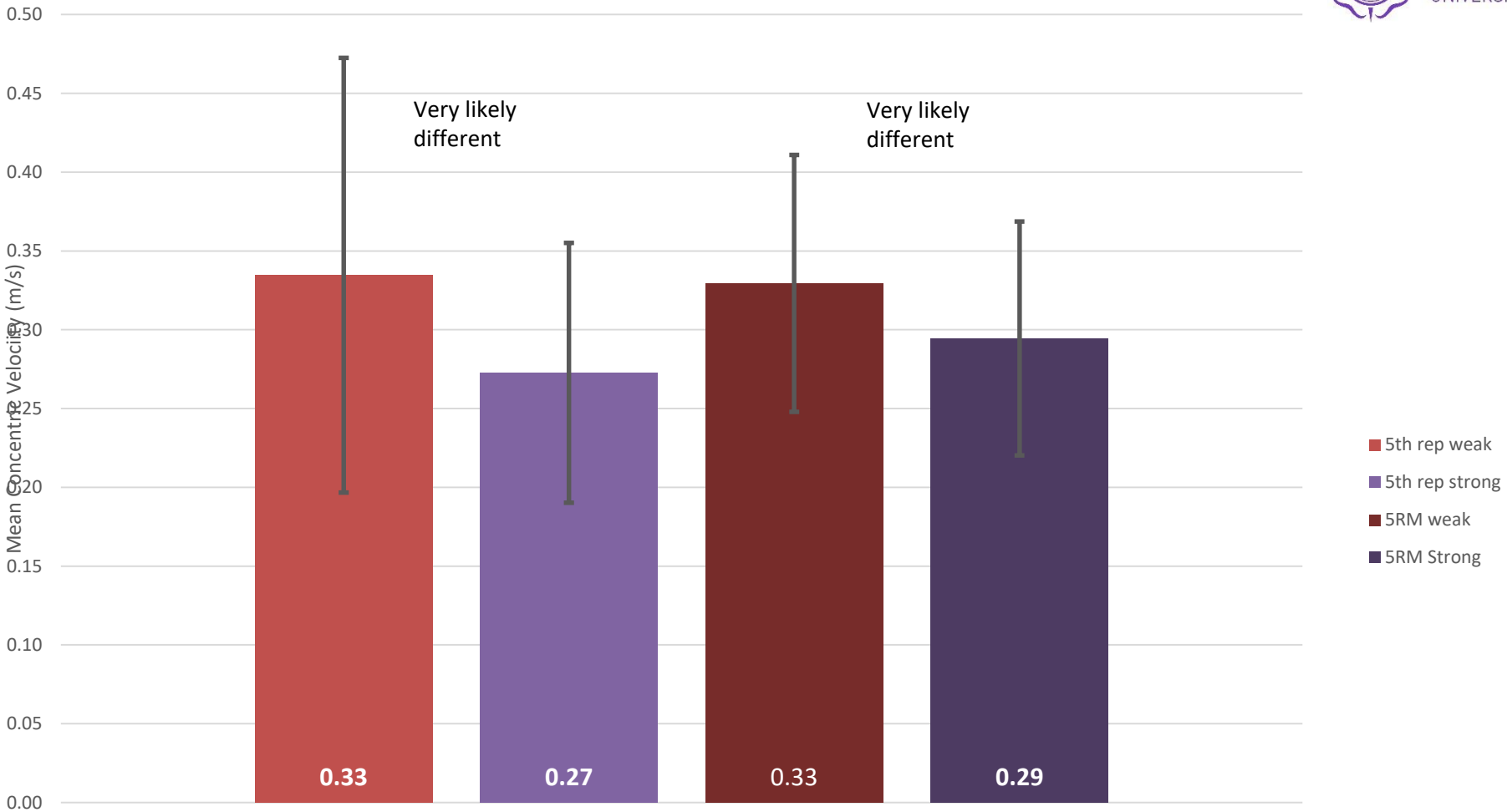
- Pearson product moment correlation found a most likely very large positive correlation between the percentage of 5RM and RIR-RPE indicated
- r = 0.82, 0.77-0.86.
- The mean RPE rating indicated for all maximal trials was 9.6 ± 0.8 (CV =8%),

RESISTANCE EXERCISE-SPECIFIC RATING OF PERCEIVED EXERTION (RPE)

Rating	*Description of Perceived Exertion*
10	*Maximum effort*
9.5	*No further repetitions but could increase load*
9	*1 repetition remaining*
8.5	*1-2 repetitions remaining*
8	*2 repetitions remaining*
7.5	*2-3 repetitions remaining*
7	*3 repetitions remaining*
5-6	*4-6 repetitions remaining*
3-4	*Light effort*
1-2	*Little to no effort*



Comparison of mean concentric velocity between stronger and weaker participants in a RFESS 5RM



Results (Symmetry Reliability)

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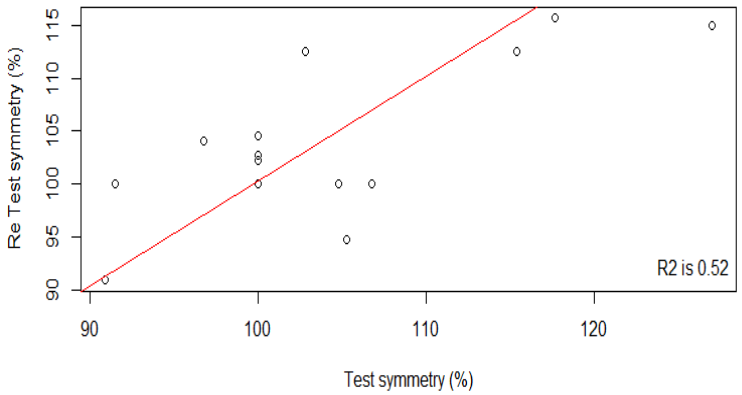
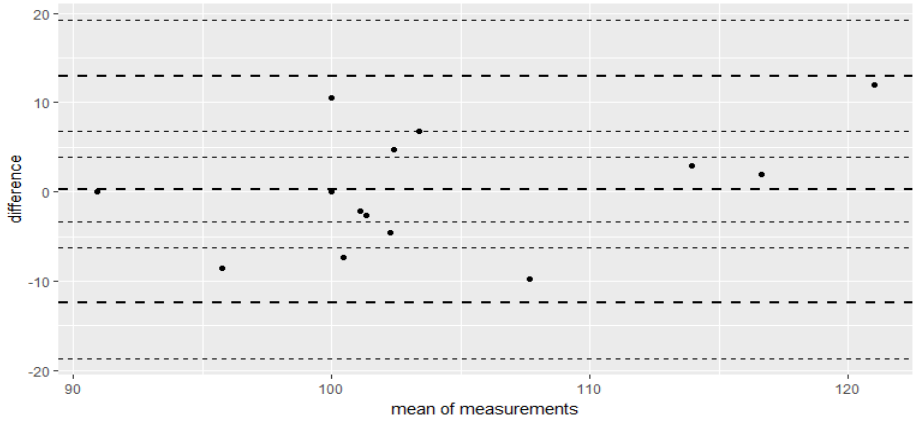
Mean symmetry (all trials)	Standard error of the mean	Mean symmetry (test 1)	Mean symmetry (test 2)	ICC (95% confidence interval)
102.15± 7.95%	1.29%	99.67 ±18.77%,	102.84 ± 6.35%)	0.73, 0.39-0.89





Results (Symmetry Validity)

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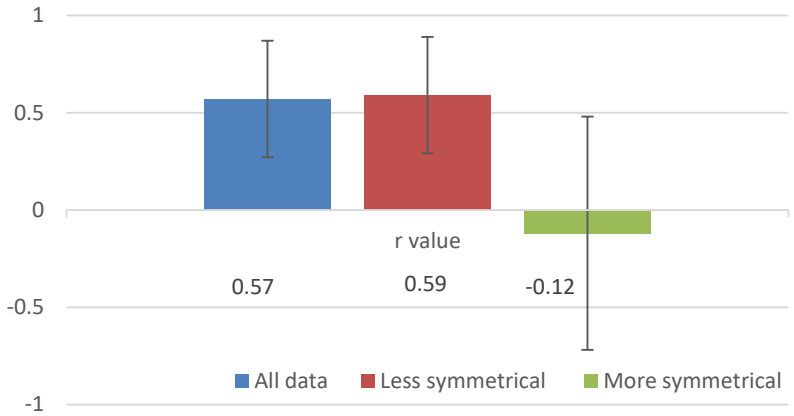
	r value	Beneficial or substantially positive effect	Negligible or Trivial effect	Harmful or substantially negative effect
Mean lead foot only vGRF (N)	0.57, (0.30 to 0.76)	99.9% very likely	0.1% very unlikely	0.0% most unlikely
Mean lead and rear foot vGRF (N)	0.63, (0.39 to 0.79)	100% very likely	0.0% very unlikely	0.0% most unlikely

Most likely large positive correlation between symmetry of bar load and lead foot vGRF

Symmetry threshold = (Mean load asymmetry – 100) + (1.64 + Standard Error of the Mean) (1).

Threshold boundaries of load asymmetry (94.91% - 105.9%)

Most Comparison of Correlation analysis between bar load symmetry and lead foot vGRF symmetry



Practical Applications

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- The findings from the current study indicate that the RFESS is a reliable method of determining unilateral leg strength in a field setting.
- Valid method of measuring leg strength symmetry, without the need for force plates or isokinetic dynamometry
- Specific threshold of asymmetry detection for this sample ± 5.09%
  - Thresholds may change for different populations.
- Athlete experience and compotence can affect their ability to achieve a true 5RM value, familiariasition is required. (16)
- Increased validity if the guidelines below are achieved
  - MCV of 5th repetition ≤ 0.27m/s
  - RIR-RPE ≥ 9.5

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