A Kinetic and Kinematic Analysis of The Rear Foot Elevated Split Squat 5RM Test

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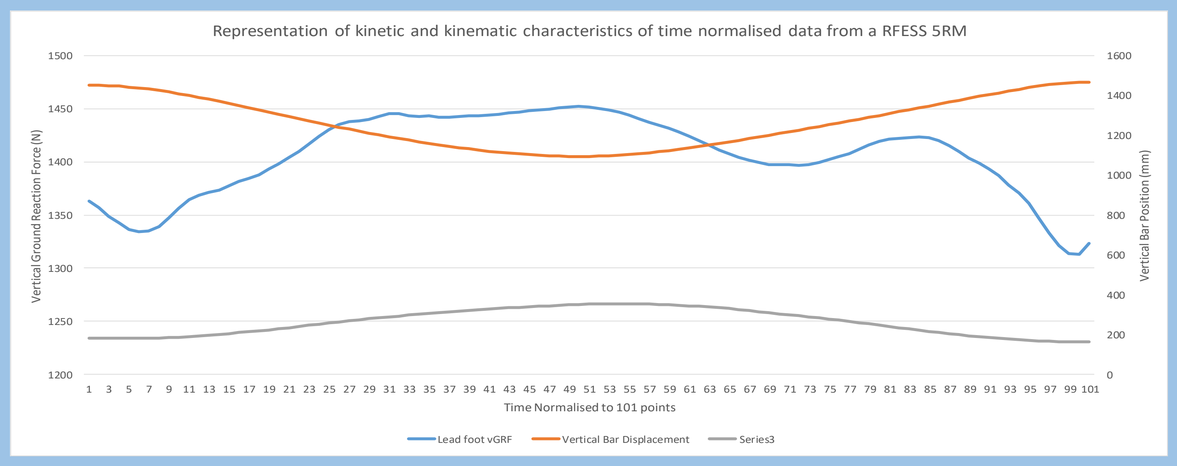
Introduction

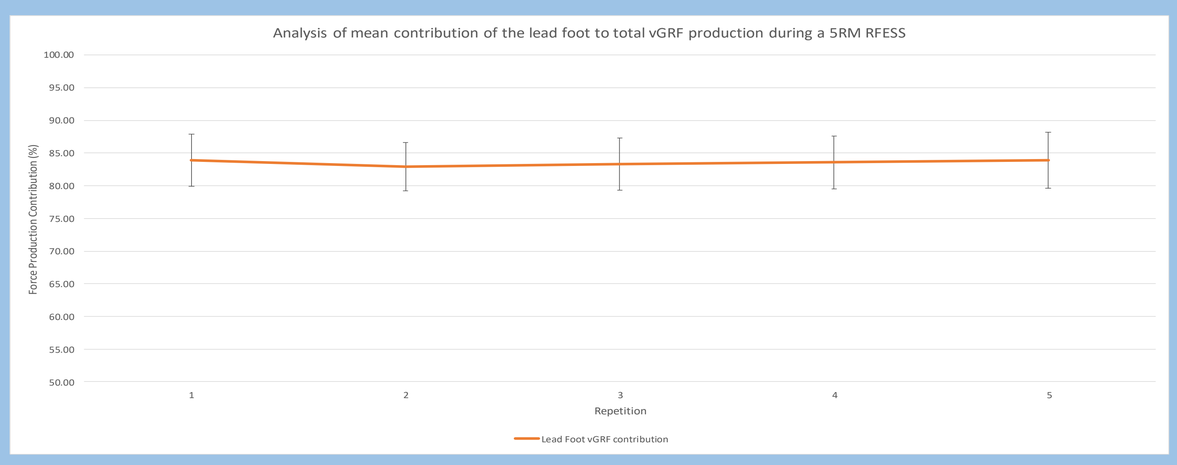
The rear foot elevated split squat (RFESS) is a multi-joint, unilateral resistance exercise, commonly used in strength and conditioning (McCurdy, 2017). McCurdy, Langford et al. (2004) and McCurdy and Langford (2005) have previously reported the RFESS as a reliable measure of unilateral leg strength (1RM ICC, 0.97- 0.99). The aim of this study was to firstly quantify the kinetic and kinematic characteristics of the RFESS 5RM test protocol. Secondly to profile the intra-set differences between repetitions.

Methods

26 volunteers were recruited, (age = 23.8 ±4.6 years, mass = 88.1 ±10.7kg, height = 1.79±0.1m), all subjects were engaged in a structured strength and conditioning program. Kinetic data was collected from the front and rear foot through two independent Kistler force plates.
Kinematic data was captured through Qualysis Track Manager System at 250Hz (Qualysis AB, Gothenburg, Sweden) using 10 cameras (six ceiling mounted and four, floor mounted).

Data was extracted and exported to Biomechanics Toolbar, and a Butterworth, fourth order filter applied. Subsequent data was further exported to R for analysis. A second data set was created in Biomechanics Toolbar, by time normalising the data to 101 time points.



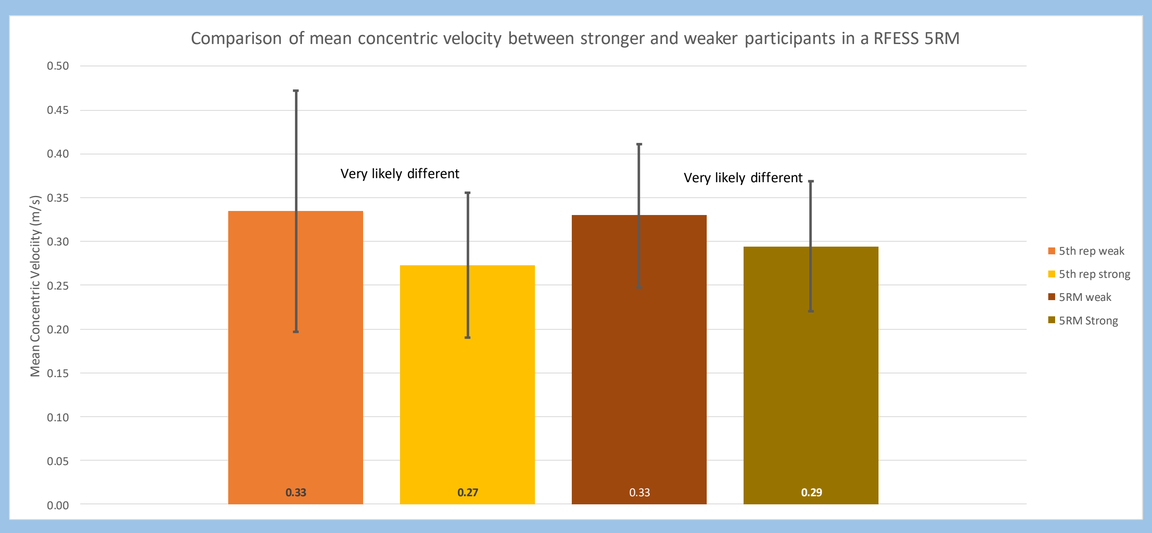


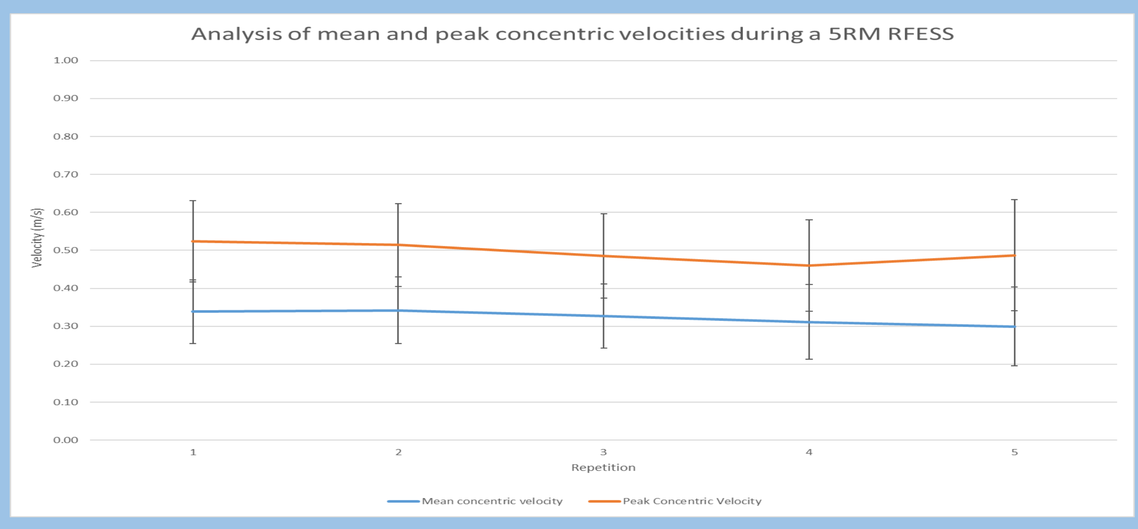
RESULTS

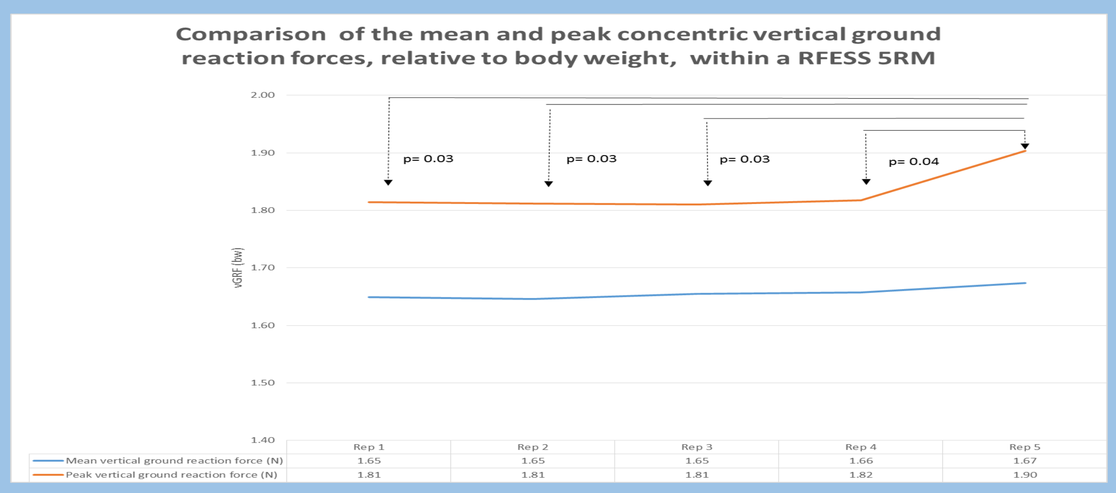
The mean load lifted was 84kg ±16.8kg (0.96 ±0.18 kg/kg). The mean vertical displacement of the bar was 0.38 ± 0.06m, mean concentric velocity was 0.32 ±0.05m/s and peak concentric velocity was 0.49 ±0.11m/s. The mean vertical ground reaction force (vGRF) of the lead foot was 1432.54±200.87N, (1.66 ±0.20BW). The lead foot produced 83.53±4.03% of total vGRF. There were unclear differences in all kinetic variables between all repetitions, except for peak (vGRF) of the lead foot only (1.90±0.28BW) of Repetition 5, which was very likely larger. Repetitions 1 and 2 were likely to very likely to have higher mean concentric velocities (MCV) than repetitions 4 and 5.

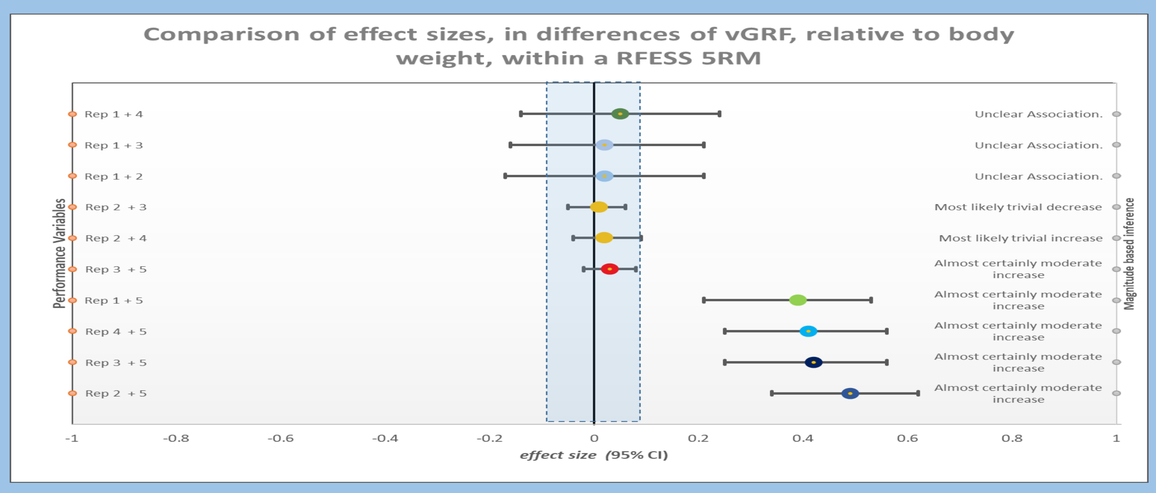
Stronger participants were able to achieve lower concentric velocities, both as a set mean and the 5th repetition of the set

Time normalisation to 101 time points of all repetitions found peak displacement occurred at point 51±6, where peak lead and rear foot vGRF occurred at points 56±33 and 60±40 respectively.









Conclusion:

The RFESS 5RM is valid and reliable method of measuring unilateral leg strength. Mean force contributions across the repetition of ≈15% with unreliable occurrences of peak rear foot vGRF, indicate a reliance on the lead for vertical displacement both eccentrically and concentrically. The RFESS can therefore be considered a unilateral exercise as no clear role of the rear foot could be defined.

A multi-repetition protocol can be used to determine maximal strength, yet intra-set differences may not exist prior to completion of the final repetition. It is recommended that the mean of the repetitions is taken when summarising the kinematic and kinetic variables in a multi repetition test. However, the final repetition MCV maybe used to determine relative intensity of the set or achievement of maximal performance. Based on the data from this study, this value may be 0.27m/s.

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