Comparison of muscle strength asymmetry between field- and court-based athletes

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Headline

Muscle strength asymmetry (MSA) refers to the relative strength differences between limbs (1). It is suggested asymmetries are training- and competition-history specific, thus athletes may develop MSA in part due to handedness, previous injury or execution of repetitive unilateral and asymmetrical movements (2). Furthermore, it is still not known whether sporting background or gender influences MSA values, which may have implications for diagnosis of MSA and resultant training interventions.

Aim. The purpose of this report was to examine the differences in MSA in various muscle strength qualities between soccer, cricket and court-based athletes.

Methods

Athletes. One hundred and fifteen male (n = 56) and female (n = 59) team-sport athletes participated in this study. team-sport athletes. The male athletes participated in basketball (n = 17; age = 17.3 ± 0.6 years; height = 187.1 ± 9.4 cm; body mass 81.6 ± 10.5 kg), cricket (n = 23; age = 18.7 ± 2.7 years; height = 175.8 ± 6.1 cm; body mass = 76.9 ± 13.3 kg) and soccer (n = 16; age = 20.1 ± 0.6 years; height = 179.1 ± 5.2 cm; body mass 76.0 ± 8.6 kg), whereas the female athletes participated in netball (n = 21; age = 18.1 ± 1.1 years; height = 174.0 ± 6.1 cm; body mass = 66.7 ± 5.1 kg), cricket (n = 23; age = 17.6 ± 1.6 years; height = 165.2 ± 9.2 cm; body mass = 61.5 ± 11.1 kg) and soccer (n = 15; age = 20.6 ± 0.6 years; height = 168.0 ± 7.2 cm; body mass 56.2 ± 6.3 kg). Each athlete was in the preseason phase of training during his or her participation in this study. The investigation was approved by the institutional review board, and all provided appropriate consent to participate, with consent from the parent or guardian of all players under the age of 18. The study conformed to the principles of the World Medical Association's Declaration of Helsinki.

Design. A cross-sectional design was used to compare values of MSA in muscle strength qualities among soccer, cricket and court-based athletes.

Countermovement Jump. Unilateral countermovement jump (CMJ) testing followed similar procedures previously outlined for bilateral CMJ (3), however was only performed with one foot on the force platform, with the other limb unsupported and flexed 90° at the knee. For all CMJs, subjects were instructed to jump "as high and as fast as possible", with the arms akimbo. Depth of the eccentric phase was self-selected by the subjects to maximize CMJ height and ecological validity. Prior to maximal trials, each subject performed two warm-up CMJs, one at 50% and one at 75% of the subjects perceived maximum effort, separated by one minute of rest. Subjects performed three trials, with one minute of rest between trials. Countermovement jump data were collected using a portable force platform sampling at 1000 Hz (Kistler Instrument Corporation, Winterthur, Switzerland, Model 9286AA, SN 1209740). Reactive strength index-modified (CMJ-RSImod) was calculated by dividing jump height by the time to take-off. Jump height (CMJ-JH) was calculated based on the vertical velocity at take-off (4).

Single-Leg Hop Testing. For the single-leg hop for distance (SLH), athletes were instructed to use a countermovement with the arms akimbo, and no restrictions were placed on body angles attained during the preparatory phase, with the instruction to hop as far forward as possible, taking off from one leg, before landing on the same leg. Athletes had to "stick" the landing for two seconds, with no movement of the foot or hands touching the ground, for the trial to be counted. Athletes performed three warm-up trials on each limb, followed by three hops for maximal horizontal distance.

Isometric Mid-Thigh Pull Testing. The unilateral stance isometric mid-thigh pull (IMTP) was performed using a portable force platform sampling at 600 Hz (400 Series Performance Force Plate; Fitness Technology). Athletes obtained self-selected knee and hip angles (knee = 130-150 °; hip = 135-145 °) based on the reports of previous research using bilateral stance IMTP (3). Once the bar height was established, the athletes stood with one foot on the force platform, with the other limb unsupported and flexed 90° at the knee. Each athlete was provided two warm-up pulls on each leg, one at 50% and one at 75% of the athletes perceived maximum effort, separated by 1 minute of rest. Athletes performed a total of six unilateral maximum effort trials (3 with left and right limbs each), interspersed with 2 minutes of recovery between trials. The peak force recorded from the force-time curve during the five second IMTP trial was reported as the IMTP peak force (IMTP-PF), and was presented as a value relative to body mass ($N.kg^{-1}$).

Eccentric Knee Extensor Testing. Eccentric knee extensor (ECC-EXT) muscle torque was assessed at $60\,°.s^{-1}$ using a Kin Com (Chattanooga Group, Tennessee) isokinetic dynamometer. Peak torque was obtained from four maximal repetitions throughout an arc of 90 ° (full knee extension = 0 °). The resistance provided by the weight of the lower-limb was recorded at 30° knee extension for gravity correction purposes, by adding the gravity correction factor: [weight of leg] ∗ [moment arm] ∗ [cosine (angle of flexion)]. The highest peak torque of four repetitions for each limb was used for further analysis, and was presented as a value relative to body mass ($Nm.kg^{-1}$). Data were exported in ASCII format into Microsoft Excel (version 2016, Microsoft Corp., Redmond, WA, USA) for further analysis.

Analyses

Data are presented as either mean ± SD or mean with 90% confidence intervals (90% CI) where specified. Asymmetry in-

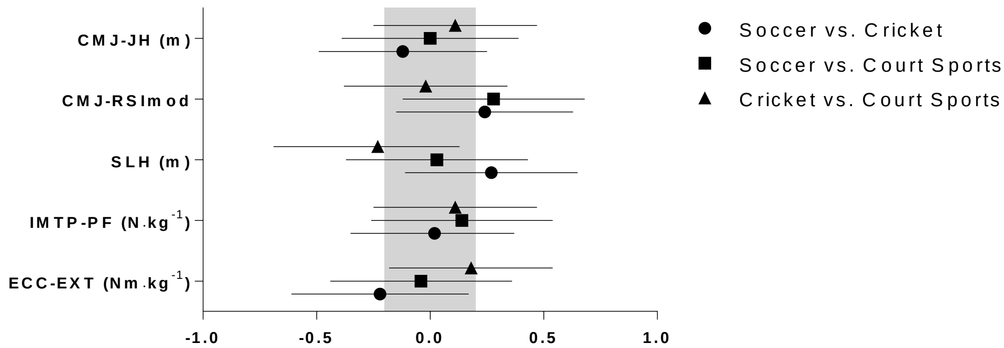

Fig. 1. Standardised differences in muscle strength asymetry for muscle strength qualities among soccer, cricket and court-based athletes

dex for dominant and non-dominant limbs was calculated by the formula: (dominant limb – non-dominant limb/dominant limb x 100). Comparisons were made for both D and ND limb variables between tasks based off the highest between-limb score. The % difference between mean value with 90% confidence intervals (CI) are reported. Effect sizes (ES) with 90% CI were quantified to indicate practical significance of the differences in mean values. The ES were classified as trivial (<0.2), small (>0.2-0.6), moderate (>0.6-1.2), large (>1.2-2.0) and very large (>2.0-4.0) (5). The magnitude of difference in performance variables were assessed qualitatively as follows: <0.5%; almost certainly not, 0.5–5%; very unlikely, 5–25%; unlikely, 25–75%; possibly, 75–95%; likely, 95–99.5%; very likely, and >99.5% almost certainly (6). The effect was deemed unclear when the confidence interval spanned both substantial positive and substantial negative values (±0.2 × between subject SD).

Results

For CMJ-RSImod, %MSA was possibly lower in soccer compared to both cricket (ES = 0.24 ± 0.39; chance of having greater/trivial/lower performance: 57/40/3) and court-based (ES = 0.28 ± 0.40; 63/35/3) athletes. SLH %MSA was possibly higher in cricket athletes compared to both soccer (ES = 0.27 ± 0.38; 62/36/2) and court-based (ES = 0.23 ± 0.36; 56/42/3). ECC-EXT %MSA was possibly higher for soccer athletes compared to both cricket (ES = 0.22 ± 0.39; 54/43/4) and court-based (ES = 0.18 ± 0.36; 46/50/4) athletes. Unclear-to-possibly trivial differences were observed for all other comparisons.

Discussion

The present report sought to determine differences in %MSA in muscle strength qualities among soccer, cricket and court-based athletes. The results of this report indicate differences in %MSA exist, relative to the sport and muscle strength quality examined. The findings of the current report may provide insights for diagnosis of MSA, and present normative MSA data for specific muscle strength qualities across field- and court-based athletes participating in soccer, cricket, basketball and netball. Previous research suggests that MSA's are training- and competition-history specific (7). These results further support the idea that MSA's may be developed because of the repetitive movements characteristic of a given sport. The results of this report revealed different MSA values existed between sports for given muscle strength qualities, except for IMTP-PF and CMJ-JH (unclear-to-possibly trivial differences). These findings suggest that MSA's are task- and variable-specific, indicating MSA's in one direction may not carry-over to asymmetry is another. Therefore, using a single muscle strength quality to assess MSA, in athletes where physical performance is underpinned by several muscle strength qualities, may not provide a complete profile for diagnosis and monitoring of MSA. Furthermore, the findings of the current report may be attributed to continuous repetition of unilateral and asymmetrical movements lead to asymmetrical differences specific to the sport in question. These findings may help us to understand MSA and establish typical thresholds of MSA that are test- and muscle strength quality-specific to the athletic populations analyzed in the current report. This report has identified normative MSA values for specific sporting populations. A note of caution is due here since no consensus exists within the literature for MSA cut-off criteria across different muscle strength qualities, for both performance and risk of injury. Previous cut-off criteria include 10-15% (8, 9), however this report has been unable to support this notion. These findings may help us to determine clinical cut-off criteria for specific muscle strength qualities, which may aid training and monitoring.

Practical Applications

- Differences in %MSA values in muscle strength qualities exist among field- and court-based athletes.
- This report has provided normative %MSA values for CMJ-JH (12-16%), CMJ-RSImod (14-16%), SLH (4-5%), IMTP-PF (4-5%) and ECC-EXT (12-16%), which coaches and researchers can use for training and monitoring purposes.
- %MSA values are variable- and muscle strength quality-specific, which may help in diagnosis and monitoring of MSA.

Limitations

- This report did not address the influence of positional differences on MSA, as players of different positions within the same sport may exhibit different levels of MSA.
- Testing for all athletes was conducted in the pre-season period of their respective sports, therefore time in season may alter an individual's MSA.

Acknowledgments. We are thankful to the athletes for their participation.

Table 1. Comparisons of % muscle strength asymmetry among muscle strength qualities between soccer, cricket and court-based athletes.

				Diff% (90% CI)		
Variable	Soccer	Cricket	Court	Soccer vs Cricket	Soccer vs Court	Cricket vs Court
CMJ-JH (m)	11.58 ± 7.11	12.73 ±10.68	12.90 ± 8.78	-11.7 ± 34.6	0.00 ± 36.6	13.2 ± 47.8
CMJ-RSImod	13.60 ± 10.17	16.32 ± 12.34	15.75 ± 10.80	27.6 ± 51.0	29.6 ± 49.8	1.6 ± 33.3
SLH (m)	3.81 ± 3.50	5.08 ± 4.21	4.31 ± 5.08	34.1 ± 56.9	3.7 ± 6.7	-22.7 ± 31.8
IMTP-PF ($N.kg^{-1}$)	3.93 ± 3.70	4.81 ± 4.55	4.48 ± 3.36	2.5 ± 56.5	19.5 ± 63.0	16.6 ± 63.1
ECC-EXT ($Nm.kg^{-1}$)	16.03 ± 11.73	12.31 ± 8.18	15.09 ± 9.95	-18.6 ± 29.9	-3.9 ± 38.1	18.0 ± 40.9

Note: ECC-EXT = eccentric extensor; IMTP-PF = isometric mid-thigh pull peak force; SLH = single-leg hop; CMJ-RSImod = countermovement jump reactive strength index-modified; CMJ-JH = countermovement jump height; CI = confidence interval.

Dataset

Dataset available on SportPerfSci.com

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References

1. Impellizzeri FM, Rampinini E, Maffiuletti N, Marcora SM. A vertical jump force test for assessing bilateral strength asymmetry in athletes. Med Sci Sports Exerc. 2007;39:2044-50.
2. Bishop C, Turner A, Read P. Effects of inter-limb asymmetries on physical and sports performance: a systematic review. J Sports Sci. 2017:1-10.
3. McMahon J, Rej S, Comfort P. Sex Differences in Countermovement Jump Phase Characteristics. Sports. 2017;5(1):8.
4. McBride JM, Kirby TJ, Haines TL, Skinner J. Relationship between relative net vertical impulse and jump height in jump squats performed to various squat depths and with various loads. Int J Sports Physiol Perform. 2010;5:484-96.
5. Hopkins WG. A scale of magnitudes for effect statistics. A new view of statistics from http://sportsciorg/resource/stats/effectmaghtml. 2002.
6. Hopkins W, Marshall S, Batterham A, Hanin J. Progressive statistics for studies in sports medicine and exercise science. Med Sci Sports Exerc. 2009;41:3.
7. Bishop C, Read P, Chavda S, Turner A. Asymmetries of the Lower Limb: The Calculation Conundrum in Strength Training and Conditioning. Strength Cond J. 2016;38(6):27-32.
8. Schiltz M, Lehance C, Maquet D, Bury T, Crielaard J-M, Croisier J-L. Explosive Strength Imbalances in Professional Basketball Players. J Athl Train. 2009;44(1):39-47.
9. Croisier JL, Forthomme B, Namurois MH, Vanderthommen M, Crielaard JM. Hamstring muscle strain recurrence and strength performance disorders. Am J Sports Med. 2002;30:199-203.