THE EFFECTS OF A COMPETITIVE SOCCER MATCH ON JUMP PERFORMANCE AND INTER-LIMB ASYMMETRIES IN ELITE ACADEMY SOCCER PLAYERS

ABSTRACT

The purpose of the present study was to investigate the effects of a competitive soccer match on jump performance and inter-limb asymmetries over incremental time points during a 72-hour (h) period. Fourteen elite adolescent players from a professional English category three academy performed single leg countermovement jumps (SLCMJ) pre, post, 24, 48, and 72-h post-match on a single force platform. Eccentric impulse, concentric impulse, peak propulsive force, jump height, peak landing force, and landing impulse were monitored throughout. Inter-limb asymmetries were also calculated for each metric as the percentage difference between limbs. Significant negative changes ($p < 0.05$) in jump performance were noted for all metrics at all time points, with the exception of jump height. Inter-limb asymmetries were metric-dependent and showed very large increases, specifically post-match, with a trend to reduce back towards baseline values at the 48-h time point for propulsive-based metrics. Asymmetries for landing metrics did not peak until the 24-h time point and again reduced towards baseline at 48-h. The present study highlights the importance of monitoring distinct jump metrics, as jump height alone was not sensitive enough to show significant changes in jump performance. However, inter-limb asymmetries were sensitive to fatigue with very large increases post-match. More frequent monitoring of asymmetries could enable practitioners to determine whether existing imbalances are also associated with reductions in physical performance or increased injury risk.

Key Words: Performance monitoring, imbalances, recovery

INTRODUCTION

During match play, soccer athletes are required to perform repeated high intensity, intermittent, and multi-directional actions in unpredictable environments. Specifically, jogging, sprinting, jumping, and changes of direction are common in soccer which frequently require high levels of unilateral force production (3,32,37). Mohr et al. (33) documented approximately 1300 individual or combinations of these actions throughout match-play, which have been shown to occur and subsequently change on average every five seconds. With players consistently required to perform these actions and react to external stimuli such as opponents and ball trajectory to name just a couple, asymmetrical loading is a natural consequence; thus, inter-limb asymmetries are likely a by-product of the sport which has been shown in comparable team sport athletes (23). In addition, the action of kicking is also likely to contribute to inter-limb differences in soccer players due to the inherent nature of the non-kicking limb required to stabilize each player (and thus absorb ground reaction force) during the action itself. Furthermore, inter-limb asymmetries have been negatively associated with sports performance markers (6,9,25,31), in addition to increased injury risk about the hip (5), knee (14) and ankle (18). Thus, quantifying and monitoring changes in asymmetry could be deemed important to both maximize physical performance and reduce potential injury risk.

The relationship between fatigue and physical performance has been found increasingly important as reduced physical performance inclusive of: total distance covered, high speed running, sprint distance, accelerations, and decelerations (1,45) have also been noted during the latter periods of each half. Chronic effects of neuromuscular fatigue have also been shown to remain up to 48 hours post-match (2,27,44). Within the available literature, simulated match protocols have been utilized to induce player fatigue and monitor both their acute and chronic effects on performance. Significant intra-limb decreases of 13-15% in functional hamstrings to quadriceps strength ratio (H:Q) have been shown following the Loughborough intermittent shuttle test and a soccer-specific aerobic field test, respectively (10,43). Soccer players are generally involved in > 70 matches per season with ~3-6 training sessions every week, leaving little time for recovery (27,41). Thus, the time course of residual periods where elevated asymmetry may be present also requires examination to inform training prescription and identify vulnerable periods where players may be at a greater risk of injury.

Previous studies have focused on the use of isokinetic dynamometry to measure inter-limb asymmetries (14,16,43). Although useful, isokinetic assessments involve isolated joint actions under the constraints of laboratory conditions and are likely to be time-inefficient in comparison to alternative field-based tests. More recent investigations have highlighted the use of unilateral jump tests to quantify asymmetries in soccer players such as the single leg countermovement jump (SLCMJ) and various hop tests (9). Bishop et al. (9) reported jump height asymmetries of ~12% in youth female players from the SLCMJ, which were double that of any horizontal hop tests. Furthermore, these inter-limb differences were associated with reduced sprint (r = 0.49 to 0.59) and jump performance (r = -0.47 to -0.58) suggesting that players with smaller asymmetries outperformed those with larger differences. However, test protocols in the aforementioned study were performed when players were fresh. At present, the association between side-to-side differences and fatigue in soccer is particularly scarce with studies only using simulated protocols to induce fatigue (10,16,29,43). These protocols exclude the auxiliary actions synonymous with soccer (such as physical duals); thus, not providing a true representation of the demands of competitive match-play.

Therefore, the first aim of the present study was to quantify inter-limb asymmetries in a cohort of elite academy soccer players. The second aim was to determine the effects that a competitive soccer match has on these side-to-side differences. The final aim was to monitor these asymmetries over a 72-h period, which would provide an insight into the relationship between asymmetries, fatigue, and recovery. It was hypothesized that asymmetries would significantly increase post-match with notable reductions seen throughout the 72-h recovery period.

METHODS

Experimental Approach to the Problem

This study examined the acute effects of a single 90-minute soccer match during the in-season period on inter-limb asymmetries in elite male youth soccer players throughout a 72-h time period. Asymmetries were measured using the SLCMJ with all testing conducted on a uniaxial force platform. The SLCMJ had been included in previous strength and conditioning programs bi-weekly for up to six weeks pre-testing, ensuring that all players were fully familiar with the testing protocols. In addition, a complete simulated familiarization session was carried out seven days prior to the experimental trial. Assessments were conducted at scheduled intervals: two hours pre-match, one hour post-match and 24-h, 48-h, and 72-h post-match. To limit external influences, subjects were asked to maintain regular diet and sleeping habits throughout the duration of the study, (details of which were previously provided to players as part of the club's in-house player development program). Within-session reliability was computed three ways at each time point, noting that reliability of some force platform metrics have been affected when athletes are in a fatigued state (21).

Subjects

Fourteen elite adolescent male soccer players (age: 17.6 ± 0.5 yr; body mass: 63.2 ± 6.7 kg; height: 1.77 ± 0.8 m) from a professional English category three academy volunteered to participate in this study. All subjects were regularly completing six hours of technical soccer training and three hours of supplementary strength and conditioning training per week. All subjects had a minimum soccer specific and resistance training age of two years. All participants were free from injury and illness at the time of testing and for the duration of the study period. Parental and participant consent was obtained prior to commencement of the study owing to the participant age and ethical approval was granted from the appropriate institutional review board.

Procedures

Single Leg Countermovement Jumps (SLCMJ).

Participants stood on the center of a force plate (400 series performance force plate; Fitness Technology, Australia) operating at 600 Hz, motionless for 2-seconds enabling their system mass to be calculated. Upon instruction, subjects performed a countermovement to a self-selected depth followed immediately by triple extending at the ankles, knees, and hips performing a maximal effort vertical jump. Instructions were to "jump as fast and as high as possible after my countdown". Subjects were required to keep their hands on hips and legs fully extended at all times during the flight phase of the jump; any deviation from these resulted in a void trial and subsequently retaken after a 30-second rest period. The non-jumping limb was required to remain slightly flexed at the hip and knee so that the foot was hovering approximately parallel to the mid-shin of the jumping limb, with no swinging allowed. This was monitored closely by an accredited strength and conditioning coach to ensure consistency throughout all testing protocols. Prior to the assessment protocol, participants completed a standardized warm up consisting of lower body dynamic stretches (multi-planar lunges, inchworms, 'world's greatest stretch' and squat variations) and practice jumps at 60, 80, and 100% of maximum perceived effort. For data collection, all subjects performed three trials on each limb at each time point, separated by a 30-second rest period between each trial.

Force-time data were analyzed to obtain the dependant variables and manually extracted before being transferred to a personal computer at 600 Hz though USB, which was initially examined through custom made software (Ballistic measurement system, XPV7; Fitness Technology, Australia). The dependant variables for the propulsive phase were: eccentric impulse (the sum of impulse from the end of unweighting period up until the end of the braking phase), concentric impulse (the sum of impulse from the end of the braking phase up until take off), peak force (maximum force obtained during the propulsive phase of the jump), and jump height (jump height was calculated using the velocity at take-off). For the landing phase: landing impulse (the sum of impulse upon landing up until peak landing force) and peak landing force (maximum force obtained during the landing phase of the jump) were all later calculated in Microsoft Excel with force thresholds calculated from body weight ± 5 standard deviations (SD) (11,17,36).

Statistical Analysis

All statistical analysis was completed using SPSS Statistics software (version 21.0; SPSS, Inc., Armonk, NY, USA) with data presented as mean ± SD. The normality of data was identified using the Shapiro-Wilk test. Previous research has highlighted reduced consistency and reliability when interpreting athlete data in a fatigued state (12); thus, reliability was computed at each time point. Reliability was calculated for each metric using the coefficient of variation (CV), a two-way random intraclass correlation coefficient (ICC) with absolute agreement and 95% confidence intervals, and the standard error of the measurement (SEM). CV were calculated in Microsoft Excel using the formula (SD/average)*100 and the SEM computed via the formula $SD*\sqrt{(1-ICC)}$. ICC's ≥ 0.70 and CV $< 10\%$ were considered acceptable (4,12). A one-way repeated measures ANOVA was used to compare the dependant variables in relation to each time point with statistical significance accepted at $p < 0.05$ and post-hoc Bonferroni testing was used when differences were identified. Cohen's *d* effect sizes (ES) were calculated to determine magnitude of change and interpreted in line with previous suggestions: trivial = < 0.35; small = 0.35-0.80; moderate = 0.80-1.5; large = > 1.5 (40). Finally, inter-limb asymmetries were quantified using a standard percentage difference method: 100/(max value)*(min value)*-1+100 in line with previous suggestions (8), and the change in asymmetries were reported at each time as a percentage change relative to the baseline value.

RESULTS

Within-session Reliability

Upon further analysis illustrated in Table 1, it was found that the majority of metrics demonstrated acceptable reliability and consistency in values. However, jump height and peak landing GRF were found to show notably lower reliability (ICC ≤ 0.69), in addition to landing impulse and concentric impulse which demonstrated remarkably high variability (CV range = 18 to 30%) across a variety of different time points.

*** INSERT TABLE 1 ABOUT HERE ***

Change in Mean Scores

A representation of all mean data and their subsequent changes in performance for each time point are shown in Table 2. Group means were found to significantly ($p < 0.05$) decrease from baseline at all time points for eccentric impulse, peak propulsive GRF and landing impulse, and significantly increase for peak landing GRF. Significant decreases were also found from post and 24-h to 48-h and 72-h for eccentric impulse and peak propulsive GRF. Further significant decreases were noted between 48-h to 72-h on the left side only for eccentric impulse and propulsive peak GRF. Finally, jump height was only found to be significantly reduced on the left side between post to 24-h and increased between 24-h to 72-h.

*** INSERT TABLE 2 ABOUT HERE ***

Change in Inter-limb Asymmetries

Inter-limb asymmetry values for each time point are shown in Table 3 and Figure 1. SLCMJ mean asymmetries significantly increased ($p < 0.05$) from pre to post and/or 24-h for concentric and eccentric impulse, peak propulsive GRF, and peak landing GRF with small to large ES (0.37-3.15). Significant reductions in asymmetry were shown from post and 24-h to 48-h and 72-h for eccentric impulse, peak propulsive GRF and peak landing GRF.

*** INSERT TABLE 3 AND FIGURE 1 ABOUT HERE ***

DISCUSSION

The aim of the present study was to quantify inter-limb asymmetries and jump performance in elite academy soccer players before and after a match at incremental time points. Significant changes in side-to-side differences and jump performance were observed at various time points with a trend for the largest asymmetries and reduction in jump performance evident immediately post-match. As per the hypothesis, inter-limb asymmetries returned to a similar level as the pre-match values at the 48-h time point; however, jump performance for multiple metrics was still significantly reduced. These results indicate that assessing multiple metrics during jump performance may be a more sensitive means of identifying a player's readiness to recover in comparison to asymmetry alone.

Table 1 shows reliability data for CMJ metrics at all time points. The relevance here being that when players have competed (and are in a fatigued state), this may impact the reliability of collected data; thus, understanding its usability was required. Noting that CV values were considered acceptable if < 10%, the only metrics to consistently show acceptable CV were peak force (right), landing impulse (right) and peak landing force (both). Typically, there was a trend for test variability to be lower at baseline prior to the match; thus, the effects of a competitive soccer match may have had a detrimental effect on the reliability of some metrics (e.g., eccentric impulse). However, it is important to highlight that concentric impulse and jump height showed the largest variability (CV range = 18 to 30%); thus, practitioners should be mindful of such metrics if monitoring unilateral jump performance during the recovery period post-matches. Furthermore, when investigating 72-h in particular, it was clear to see that due to the addition of a light tactical training session on the afternoon of 48-h, the reliability of some metrics (such as jump height) were again detrimentally affected. Due to the constraints of congested fixtures which is associated with professional soccer, it was not possible to allow these players three days of recovery. Given the variation in metric reliability across time points, this further supports the notion that in-depth jump analysis is key when interpreting real change (12,20,21).

Table 2 shows the mean scores for all jump metrics. Previously, it has been reported that impairment of neuromuscular function is present up to 72-h post-match, with the 0 to 24-h showing the greatest reduction in jumping and aerobic performance (12,20,29,42). Results from the present study showed that only concentric impulse and jump height were fully recovered on both limbs at the 48-h time point, with the remaining metrics still exhibiting significant differences from baseline two days post-match. Notably, of all the metrics analysed, eccentric impulse and peak propulsive GRF yielded the greatest significant change in means over the course of 24-h post-match (*d* range: post = 5.78-3.40, 24-h = 4.56-2.99). A reduction in eccentric impulse capacity at all time points compared to baseline, likely resulted in athletes altering their jump strategy, allowing time to produce the necessary force without significantly affecting jump height in a fatigued state; thus, warranting the investigation of further metrics other than jump height alone (13,20,21). Furthermore, jump height was shown to have no significant decreases in performance post-match; rather, a small, non-significant increase was actually seen on the left side at this time point. These results perhaps suggest that jump height maybe not be sensitive enough to detect significant immediate change as athletes may mask fatigue by compensating using different strategies (as discussed previously). When considering the landing metrics, landing impulse and peak landing GRF were both sensitive enough to show large significant increases in force-time data at each time point compared to baseline, which has also been shown in comparable research (35). Although challenging to explain with certainty, it seems plausible to suggest that a loss of neuromuscular control may explain why significant increases in landing forces were experienced. The effects of a competitive match clearly resulted in ‘heavier landings’ which represent a serious consideration for practitioners. Given that previous research has identified landing mechanics as being a potential risk factor for injury (15,19,24), practitioners could consider landing-based metrics as useful markers of readiness to train during the recovery process.

Table 3 and Figure 1 show the changing nature of inter-limb asymmetries at each time point. Initially, ECC impulse and peak propulsive GRF showed the highest pre-match leg asymmetries (14.24 and 14.71, respectively). These were shown to significantly elevate immediately post-match increasing 2.25 and 2.16 times greater than baseline with large ES (*d* = 3.15 and 2.80, respectively), then plateauing over the succeeding 24-h before returning to near baseline 48-h. Notably, jump height was found to display the greatest change in asymmetry, increasing immediately post-match by 3.7 times greater than pre-match, representing a moderate ES (*d* = 1.18). This is particularly striking as this metric showed just a 4.65% asymmetry value pre-match, which can be considered small (7). The relevance being that this has the potential to mislead practitioners unless monitored throughout the time course of 24 to 48-h. Furthermore, given that jump height also showed high variability (CV range = 18 to 30%), this further highlights the need to monitor multiple metrics during jump profiling, and not rely solely on outcome measures. Interestingly, landing metrics were found to take longer to exhibit their peak leg asymmetries; exponentially worsening until 24-h where both metrics climbed to 2.24 and 2.11 times greater than baseline displaying large to moderate ES for landing impulse (*d* = 1.7) and peak landing GRF (*d* = 1.38), respectfully.

When interpreting asymmetries in a more general manner, previous research has highlighted the test and metric-specific nature of asymmetries (9,14,23,26,28,39), and to the authors' knowledge, this is the first study to examine the effects of competition on inter-limb asymmetries in an elite soccer population. Previous research has suggested that 15% might be a threshold where the risk of injury increases (26); however, more recent suggestions advocate 10% as a target to aim for (28,34). When this conflicting evidence is considered and the test-specific nature of asymmetries is deliberated, it seems prudent to suggest that multiple metrics be considered to further our understanding of how inter-limb asymmetries interact with measures of physical performance and injury risk. In the present study, the largest inter-limb differences were noted for peak propulsive force and eccentric impulse (Figure 1). Noting that these metrics can only be obtained from a force platform and showed a trend to exhibit substantially greater differences than the outcome measure of jump height, it is suggested (where possible) that the monitoring of inter-limb differences is conducted using force platforms. As a final point, it is worth noting that it is unlikely that elite soccer players will be granted three days of recovery after matches. With a light tactical training session prescribed after the 48-h time point, this may explain the subsequent increase in asymmetries at 72-h. The results highlight the importance of frequent asymmetry monitoring, which has been emphasized in previous literature (7,35).

PRACTICAL APPLICATIONS

The findings of the present study highlight the changing nature of jump performance and inter-limb asymmetries after a competitive soccer match. Strength and conditioning coaches should consider using the unilateral CMJ in addition to or in place of the more commonly accepted neuromuscular fatigue monitoring method of bilateral CMJ. Noting that many of the actions in soccer occur unilaterally (such as sprinting, changing direction, and kicking), it seems logical to suggest that unilateral jump profiling serves as an ecologically valid means for soccer athletes. In addition, given the previously reported associations between inter-limb asymmetries and reduced physical performance and injury risk, frequent monitoring of side-to-side differences may provide practitioners with a true picture of the interaction between asymmetry and performance or injury risk. The relevance here being that literature pertaining to the longitudinal tracking of asymmetry is scarce. Finally, with leg asymmetries highlighted up to 72-h, this insight can further objectively enlighten the coaching staff on player welfare and subsequently inform their approach to adapting training loads on an individual level; thus, improving training quality, player readiness and ultimately, match performance.

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Table 1: Within-session reliability data for unilateral countermovement jump metrics at pre, post, 24, 48 and 72 hours post-match.

CMJ Metric	**Pre**	**Post**	**24-h**	**48-h**	**72-h**
Eccentric impulse (R)					
CV (%)	6.61	9.21	11.78	12.12	8.50
ICC (95% CI)	0.95 (0.82-0.99)	0.96 (0.87-0.99)	0.98 (0.97-0.99)	0.95 (0.34-0.99)	0.90 (0.45-0.97)
SEM	2.74	2.43	2.25	4.06	3.87
Eccentric impulse (L)					
CV (%)	8.76	10.59	13.12	11.94	11.39
ICC (95% CI)	0.93 (0.77-0.98)	0.89 (0.65-0.96)	0.97 (0.89-0.99)	0.84 (0.69-0.96)	0.97 (0.80-0.99)
SEM	3.51	3.22	2.24	6.18	2.32
Concentric impulse (R)					
CV (%)	18.25	17.99	20.95	21.04	21.18
ICC (95% CI)	0.77 (0.42-0.92)	0.76 (0.42-0.92)	0.89 (0.69-0.97)	0.74 (0.38-0.91)	0.71 (0.32-0.89)
SEM	13.92	10.94	9.34	15.20	15.21
Concentric impulse (L)					
CV (%)	20.29	20.73	22.48	23.97	20.73
ICC (95% CI)	0.85 (0.55-0.95)	0.77 (0.29-0.92)	0.75 (0.27-0.92)	0.84 (0.52-0.95)	0.77 (0.27-0.92)
SEM	11.43	11.29	12.47	12.41	11.22
Peak force (R)					
CV (%)	5.52	8.15	9.67	8.35	7.91
ICC (95% CI)	0.80 (0.58-0.95)	0.92 (0.77-0.97)	0.95 (0.87-0.99)	0.56 (0.11-0.83)	0.85 (0.60-0.95)
SEM	41.05	29.48	26.57	78.83	40.04
Peak force (L)					
CV (%)	10.38	10.68	14.33	12.28	11.55
ICC (95% CI)	0.89 (0.86-0.99)	0.95 (0.84-0.98)	0.92 (0.78-0.99)	0.90 (0.78-0.99)	0.99 (0.96-0.99)
SEM	33.69	21.43	35.70	46.13	12.75
Jump height (R)					
CV (%)	19.51	29.29	19.68	22.19	23.48
ICC (95% CI)	0.89 (0.71-0.96)	0.69 (0.27-0.89)	0.92 (0.78-0.97)	0.89 (0.71-0.96)	0.77 (0.43-0.92)
SEM	0.01	0.03	0.01	0.01	0.02

Jump height (L)					
CV (%)	22.15	30.00	25.80	24.23	30.00
ICC (95% CI)	0.85 (0.25-0.96)	0.60 (0.20-0.86)	0.86 (0.60-0.95)	0.72 (0.31-0.90)	0.57 (0.17-0.85)
SEM	0.02	0.04	0.02	0.02	0.04
Landing impulse (R)					
CV (%)	8.96	8.13	7.64	7.05	8.71
ICC (95% CI)	0.68 (0.28-0.88)	0.63 (0.20-0.86)	0.57 (0.11-0.84)	0.58 (0.12-0.84)	0.65 (0.23-0.87)
SEM	1.41	1.69	1.72	1.42	1.72
Landing impulse (L)					
CV (%)	8.96	8.13	16.18	14.81	15.00
ICC (95% CI)	0.81 (0.52-0.93)	0.84 (0.59-0.95)	0.70 (0.32-0.89)	0.81 (0.53-0.93)	0.81 (0.54-0.93)
SEM	1.09	1.10	2.79	1.76	1.93
Peak landing force (R)					
CV (%)	7.48	7.63	7.93	8.86	7.80
ICC (95% CI)	0.90 (0.73-0.97)	0.93 (0.78-0.98)	0.89 (0.70-0.96)	0.88 (0.67-0.96)	0.91 (0.75-0.97)
SEM	62.36	64.96	86.78	91.96	74.32
Peak landing force (L)					
CV (%)	7.48	7.63	8.63	5.72	5.86
ICC (95% CI)	0.74 (0.25-0.94)	0.71 (0.32-0.89)	0.83 (0.26-0.98)	0.64 (0.21-0.87)	0.69 (0.27-0.90)
SEM	101.77	134.15	134.76	109.92	119.97

CMJ = countermovement jump; R = Right; L = Left; CV = coefficient of variation; ICC = intraclass correlation coefficient; CI = confidence interval; SEM = standard error of the measurement.

Table 2: Mean unilateral countermovement jump data ± standard deviations for pre, post, 24, 48 and 72 hours post-match.

CMJ Metric	**Pre**	**Post**	**24-h**	**48-h**	**72-h**
ECC impulse-R (Ns)	173.68 ± 11.67 ^{bcde}	135.54 ± 12.48 ^{ac}	134.96 ± 15.90 ^{abd}	152.88 ± 18.52 ^{abc}	141.24 ± 12.00 ^{a}
ECC impulse-L (Ns)	135.54 ± 13.28 ^{bce}	92.17 ± 9.76 ^{ade}	95.56 ± 12.53 ^{ade}	130.97 ± 15.64 ^{bce}	110.52 ± 12.59 ^{abcd}
CON impulse-R (Ns)	157.64 ± 28.77 ^{b}	124.96 ± 22.47 ^{a}	135.11 ± 28.30	141.17 ± 29.70	132.19 ± 28.00 ^{a}
CON impulse-L (Ns)	147.49 ± 29.92 ^{bce}	112.35 ± 23.29 ^{a}	110.51 ± 24.84 ^{a}	129.87 ± 31.13	112.35 ± 23.29 ^{a}
Peak force-R (N)	1679.1 ± 92.73 ^{bcde}	1278.52 ± 104.23 ^{ade}	1280.76 ± 123.89 ^{ade}	1428.09 ± 119.25 ^{abc}	1325.51 ± 104.79 ^{abc}
Peak force-L (N)	1432.16 ± 100.66 ^{bcde}	871.36 ± 93.08 ^{ade}	903.53 ± 129.51 ^{ade}	1206.53 ± 148.10 ^{abce}	1052.69 ± 121.58 ^{abcd}
Jump height-R (m)	0.19 ± 0.04	0.19 ± 0.06	0.16 ± 0.03	0.16 ± 0.04	0.17 ± 0.04
Jump height-L (m)	0.19 ± 0.07	0.20 ± 0.06 ^{c}	0.16 ± 0.04 ^{be}	0.17 ± 0.04	0.20 ± 0.06 ^{c}
Landing impulse-R (Ns)	29.38 ± 2.22 ^{bc}	31.18 ± 2.15 ^{ae}	31.68 ± 5.13 ^{ae}	30.27 ± 4.04 ^{c}	29.57 ± 4.44 ^{bc}
Landing impulse-L (Ns)	27.83 ± 2.49 ^{bce}	34.08 ± 2.77 ^{a}	36.20 ± 2.61 ^{abd}	31.14 ^{abc}	31.33 ± 2.90 ^{a}
Peak landing force-R (N)	2662.81 ± 199.21 ^{bcde}	2963.55 ± 212.91 ^{ace}	3271.16 ± 259.30 ^{abd}	2983.55 ± 264.37 ^{ace}	3195.73 ± 249.12 ^{abd}
Peak landing force-L (N)	2811.71 ± 179.22 ^{bcde}	3263.55 ± 249.10 ^{ace}	3823.25 ± 329.77 ^{abd}	3217.99 ± 184.23 ^{ace}	3703.72 ± 216.87 ^{abd}

CMJ = countermovement jump; ECC = eccentric; CON = concentric; R = Right; L = Left; ^{a} = significantly different from pre-match value; ^{b} = significantly different from post-match value; ^{c} = significantly different from 24-h match value; ^{d} = significantly different from 48-h match value; ^{e} = significantly different from 72-h match value.

Table 3: Inter-limb asymmetry values (reported as percentages) for unilateral countermovement jump data pre, post, 24, 48 and 72 hours post-match and Cohen's *d* effect sizes reported relative to pre-match values.

Asymmetry %	**Pre**	**Post**	**24-h**	**48-h**	**72-h**
ECC impulse	14.24 ^{bce}	32.00 ^{ade}	29.20 ^{ade}	14.33 ^{bc}	21.75 ^{abc}
Effect size		3.15	2.80	0.01	1.36
CON impulse	7.73 ^{c}	10.50	18.50 ^{a}	9.88	15.19
Effect size		0.31	1.02	0.30	0.84
Peak force	14.71 ^{bc}	31.85 ^{ade}	29.45 ^{ade}	15.51 ^{bc}	20.58 ^{bc}
Effect size		2.80	2.23	0.12	0.96
Jump height	4.65 ^{e}	17.22	6.52 ^{e}	5.47	20.49 ^{ac}
Effect size		1.18	0.50	0.23	2.05
Peak landing impulse	5.89 ^{c}	8.51 ^{cde}	13.14 ^{abde}	4.03 ^{bc}	5.61 ^{bc}
Effect size		0.62	1.71	-0.47	-0.07
Peak landing force	7.22 ^{ce}	9.13 ^{ce}	15.22 ^{abd}	7.29 ^{ce}	13.72 ^{abd}
Effect size		0.32	1.38	0.01	1.19

ECC = eccentric; CON = concentric; ^{a} = significantly different from pre-match value; ^{b} = significantly different from post-match value; ^{c} = significantly different from 24-h match value; ^{d} = significantly different from 48-h match value; ^{e} = significantly different from 72-h match value.

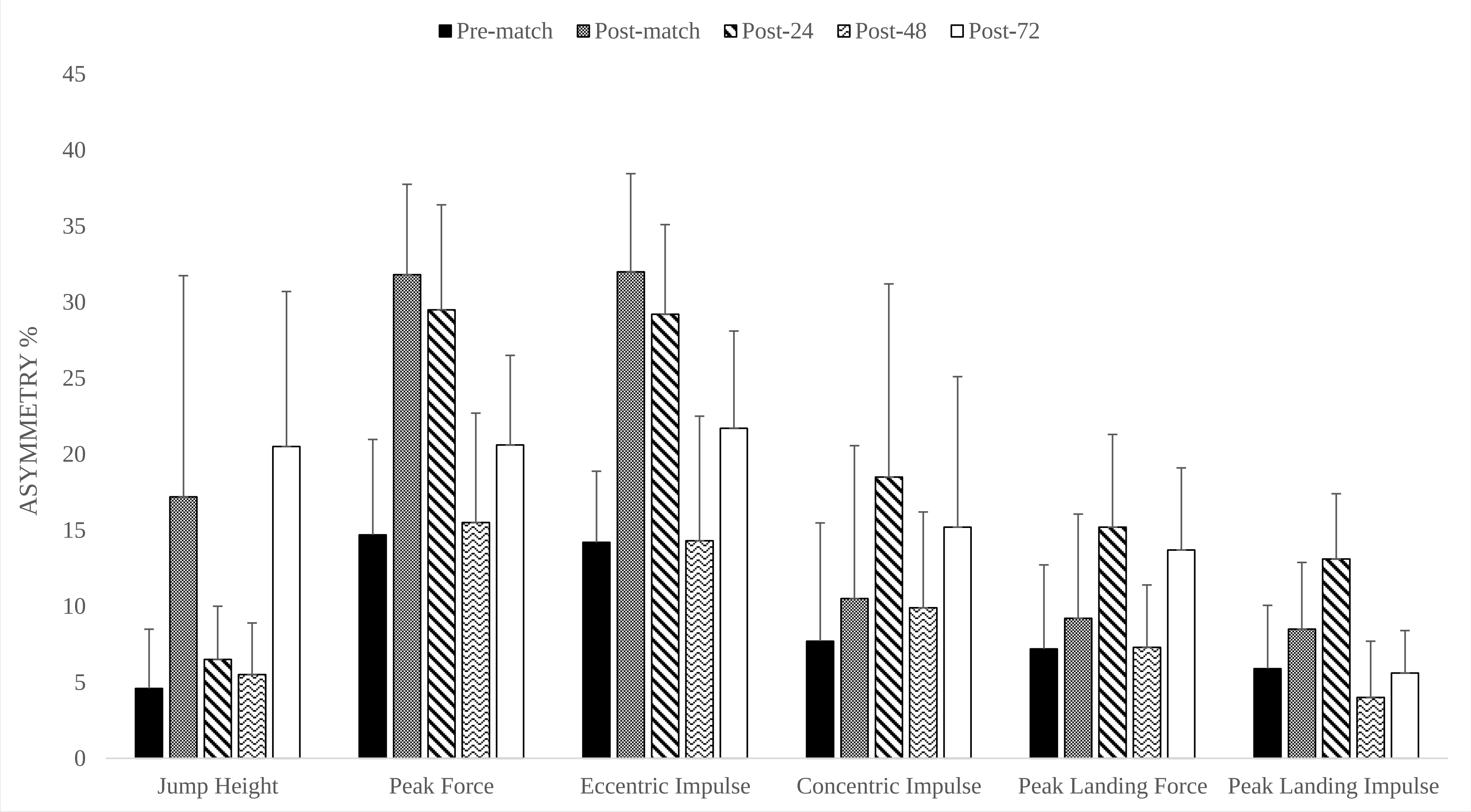

Figure 1: Inter-limb asymmetry values and standard deviations (error bars) for SLCMJ metrics at pre, post, 24, 48 and 72 hours post-match.