Effects of Soccer Match-play on Unilateral Jumping and Inter-limb Asymmetry: A Repeated Measures Design

Abstract

The aims of the present study were twofold: 1) determine the effects of repeated soccer match-play on unilateral jump performance and inter-limb asymmetries and, 2) examine associations between asymmetry and commonly reported external load variables collected during competition. Single leg countermovement jumps (SLCMJ) and drop jumps (SLDJ) were collected pre and immediately post five soccer matches in elite academy soccer players. GPS data was also collected each match as part of the routine match-day procedures. SLCMJ height and concentric impulse showed significant reductions post-matches ($p < 0.01$; ES: -0.67 to -0.69), but peak force did not ($p > 0.05$; ES: -0.05 to -0.13). SLDJ height and reactive strength also showed significant reductions post-matches ($p < 0.01$; ES: -0.39 to -0.58). No meaningful reductions in asymmetry were present at the group level, but individual responses were highly variable. Significant associations between post-match reactive strength asymmetry and explosive distance ($r = 0.29$; $p < 0.05$), relative explosive distance ($r = 0.34$; $p < 0.05$), high speed running ($r = 0.35$; $p < 0.05$) and relative high speed running ($r = 0.44$; $p < 0.01$). These findings show that unilateral jump tests are more appropriate than asymmetry to detect real change post soccer competition and practitioners should be cautious about using asymmetry to inform decision-making during the temporal recovery period.

Key Words: Between-limb differences; countermovement jump; drop jump; external load.

Introduction

Investigating the association between jump asymmetry and measures of athletic performance has been a popular topic, with a recent rise in such studies using soccer players (5,6,8,9,28). Numerous studies in this population have shown that between-limb differences during jump tests are associated with reduced speed and change of direction speed (CODS) performance (5,8,9,15). In contrast, two studies have reported no association between asymmetry and athletic performance, both of which used elite level male and female players (6,28). Although speculative, it seems likely that elite players would have enhanced strength and power compared to youth or academy players. Given that strength has been shown to be a key factor in the reduction of between-limb asymmetries (4), this may be a possible reason why no associations were evident between asymmetry and performance in elite players. However, all aforementioned studies have collected data from routine fitness testing sessions and reported relationships with surrogate measures of athletic performance (e.g., speed, CODS). Given the conflicting findings between asymmetry and performance and the variable nature of asymmetry (5,8,18,30), this tells us little about the associations between asymmetry and in-game soccer movement patterns.

Soccer is a high-intensity, intermittent sport that requires players to sprint, jump, kick and change direction on multiple occasions in response to different stimuli (41). Time-motion analysis data has shown that elite soccer players cover distances on average of 10-11 km in matches (34). Matches can also include up to 168 high intensity actions (37), 1200-1400 changes of direction (3), and up to 15 jumps per match (31). Given that many of these actions occur unilaterally, the development of inter-limb asymmetries are to be expected, which is supported in previous research by Hart et al. (24) and who showed that asymmetry is a by-product of competing in a single sport over time.

Jump testing has been a common form of monitoring neuromuscular fatigue in soccer athletes (29,38,40). Studies often employ simulated soccer protocols rather than competitive matches to determine acute responses (23,39), with both jump height and reactive strength index (RSI) performance shown to significantly decline immediately post protocols in the bilateral countermovement jump (CMJ) and drop jump (DJ) tests. However, given many movement patterns in soccer occur unilaterally (e.g., cutting, sprinting, kicking) the use of single leg jump tests would also provide an ecologically valid method of assessment. Single leg tests also have the advantage of providing asymmetry data, even when twin force plate systems are not available. To the authors' knowledge, only one study to date has investigated how both single leg jump performance and inter-limb asymmetry responds to competitive soccer match-play. Bromley et al. (11) performed single leg countermovement jumps (SLCMJ) pre, post, 24, 48 and 72 hours after a single competitive soccer match in 14 academy soccer players. Significant reductions ($p < 0.05$) in peak force, eccentric and concentric impulse, and peak landing force were evident on both limbs across the temporal recovery period, but not jump height. Furthermore, when compared to baseline, effect size data showed changes in asymmetry ranging from trivial to very large for peak force (effect size range: 0.12-2.80) and eccentric impulse (effect size range: 0.01-3.15), trivial to large for peak landing force (effect size range: 0.01-1.38) and trivial to moderate for concentric impulse (effect size range: 0.30-1.02), with the largest changes seen either post or 24 hours post-match. This suggests that both single leg jump performance and between-limb asymmetries may be sensitive to change after competitive soccer match-play (11).

Despite the usefulness of this information, no minimum cut-off requirement in 'time played' was specified for players, and a total of 14 participants were counted in the analysis, indicating substitutes were included. In addition, results were not interpreted considering the external workloads performed and were obtained from a single match which does not account for the high game-to-game variability in actions such as high speed running (HSR) and total distance (22). Cumulatively, these limitations reduce our understanding of how single leg jump performance and asymmetry acutely respond to game demands, and what potential associations exist between asymmetry and commonly reported within-game metrics (31). Thus, a repeated measures design would provide a more meaningful understanding of the interaction between single leg jumping, inter-limb asymmetry and soccer match-play.

Therefore, the primary aim of the present study was to determine the effects of repeated soccer match-play on unilateral jump performance and inter-limb asymmetries. Our second aim was to examine associations between asymmetry and commonly reported external load variables collected during competition. It was hypothesised that reductions in unilateral jump performance and increases in inter-limb asymmetry would be evident acutely following games, and significant relationships between asymmetry and GPS data would also be evident.

Methods

Experimental Approach to the Problem

This study used a repeated measures design throughout the 2018-2019 soccer season, investigating the effects of five competitive soccer matches on unilateral jump performance and inter-limb asymmetries in a single team of elite male academy soccer players. Players performed SLCMJ and single leg drop jumps (SLDJ) on match days two hours before kick-off and then repeated both jump tests approximately 10 minutes' post-match. All tests were conducted in the club's gymnasium, under the same testing conditions. Global Positioning Systems (GPS) data were also collected during each game. Players were only included in the data analysis for each match if they were an 'outfield' player, and played a minimum of 60 minutes (1,13).

Subjects

Eighteen elite academy soccer players (age: 16.89 ± 0.32 years; height: 1.79 ± 0.04 m; body mass: 74.12 ± 5.07 kg) from a Category 2 academy of a professional soccer club in the English Championship volunteered to participate in the present study. All players were familiar with procedures having conducted these as part of routine fitness testing at the club in the previous two years, and were free from injury each time they were tested and in the preceding two weeks. Parental consent, participant ascent, and clearance from the clubs medical staff were obtained prior to testing. Ethical approval was granted by the London Sport Institute research and ethics committee at Middlesex University, London, UK.

Procedures

All testing protocols were replicated for each match throughout this study. Players performed a standardized warm up which included 5-minutes on a stationary bike at a self-selected speed, followed by a range of dynamic stretches. Specifically, a single set of 10 repetitions for forward and lateral lunges, inchworms, spidermans and bodyweight squats were performed, followed by three practice trials of each jump test (on each leg) at 60, 80 and 100% of perceived maximal effort in an attempt to minimize individual differences in technique for each player. Three minutes of rest was provided between the last practice trial and the start of the first jump test and 30-seconds of rest was provided between trials during the data collection process, with all testing performed in a randomized order. Post-match testing, players removed their shin guards and replaced their football boots with the same footwear used during pre-match testing. No warm up procedures were repeated during post-match testing.

Single Leg Countermovement Jump (SLCMJ). Players were instructed to step onto a single uniaxial force platform (PASPORT force plate, PASCO Scientific, California, USA) sampling at 1000 Hz, with their designated test leg and hands placed on hips which were required to remain in the same position for the duration of the test. All players were instructed to "jump as high as possible" for every trial. The jump was initiated by performing a countermovement to a self-selected depth before accelerating vertically as explosively as possible into the air. The test leg was required to remain fully extended throughout the flight phase of the jump before landing back onto the force plate as per the set up. The non-jumping leg was slightly flexed with the foot hovering at approximately mid-shin level and no additional swinging of this leg was allowed during trials. Recorded metrics included jump height, peak force (propulsive) and concentric impulse, with definitions for their quantification in line with suggestions by Gathercole et al. (21) and Chavda et al. (12). Jump height was defined as the maximum height achieved calculated from velocity at take-off squared divided by 2*9.81 (where 9.81 equals gravitational force). Peak force was defined as the maximum force output during the propulsive phase of the jump and concentric impulse was defined as the net force multiplied by the time taken to produce it, i.e., the area under the force-time curve. The first meaningful change in force was established when values surpassed five standard deviations (SD) of each participant's body mass (33). The force plate was calibrated prior to each data collection and all force traces were extracted unfiltered, and subsequently copied into a custom-made spreadsheet previously suggested for further analysis (12). Each athlete performed two trials on each leg with an average score taken on each side to compute the inter-limb asymmetry value.

Single Leg Drop Jump (SLDJ). The SLDJ was performed using the OptoJump™ measurement system (Microgate, Bolzano, Italy) sampling at 1000 Hz, with athletes required to step off an 18 cm box; this height chosen in line with previous research using this test (6,9,30). With hands fixed on hips, participants were required to step off the box with their designated test leg which subsequently landed on the floor between the optimal measurement system below. Upon landing, participants were instructed to "minimize ground contact time and jump as high as possible" thereafter in line with previous suggestions (6,9,30). Recorded metrics included jump height (calculated from the flight time method), ground contact time (GCT) (time spent in contact with the ground after initial landing prior to take-off) and RSI, quantified using the equation flight time/GCT (6,9,30). Two jumps were performed on each leg with each side averaged to calculate an inter-limb asymmetry score.

Global Positioning System (GPS) data. GPS data was obtained using Catapult OptimEye X4 units (OptimEye X4, Firmware 6.70, Catapult Innovations) operating at 10 Hz for each match. For each player, units were positioned inside wearable garments, positioned between the scapulae underneath the soccer shirt. Recorded metrics from the software included total distance in meters (m), explosive distance (m) defined as the combined high-intensity accelerations and decelerations covered at > 3 $m \cdot s^{-2}$ (36), HSR (m) defined as the individual percentage of maximum velocity ranging from 60-90%, and player load, defined as the cumulative high-intensity actions recorded throughout the match as a resultant of the accelerometer data (10). Individual thresholds for HSR were defined from the maximal velocity obtained during three previously recorded maximal effort 50 m sprints. All metrics were also made 'relative' and quantified in m per minute ($m \cdot min^{-1}$), with the exception of player load.

Statistical Analysis

All data were initially recorded as means and SD in Microsoft Excel and later transferred to SPSS (version 25.0; SPSS, Inc., Armonk, NY, USA). Normality of the data was assessed using a Shapiro-Wilk test. Within-session reliability of test measures was computed pre and post-match using an average measures two-way random intraclass correlation coefficient (ICC) with absolute agreement and 95% confidence intervals, and the coefficient of variation (CV). Interpretation of ICC values was in accordance with previous research by Koo and Li (27), where values > 0.9 = excellent, 0.75-0.9 = good, 0.5-0.75 = moderate, and < 0.5 = poor. The CV was calculated via the formula: (SD[trials 1–3]/average[trials 1–3]*100) with values ≤ 10% suggested to be considered acceptable (16).

Wilcoxon signed-rank tests were conducted to determine whether unilateral test or asymmetry scores were significantly different between pre and post-match, with statistical significance set at $p < 0.05$. The magnitude of change was also calculated between pre and post-match using Cohen's *d* effect sizes (ES): $(Mean_{pre} – Mean_{post})/SD_{pooled}$. These were interpreted in line with Hopkins et al. (25) where < 0.2 = trivial; 0.2-0.6 = small; 0.6-1.2 = moderate; 1.2-2.0 = large; 2.0-4.0 = very large; and > 4.0 = near perfect. Spearman's *r* correlations were conducted to determine the relationship between post-match asymmetry and the change in asymmetry (from pre to post) with GPS variables, with statistical significance set at $p < 0.05$.

Inter-limb asymmetries were quantified as a percentage difference between limbs using the formula: (100/(maximum value)*(minimum value)*-1+100), as proposed by Bishop et al. (7). In order to determine the direction of asymmetry, an 'IF function' was added on to the end of the formula in Microsoft Excel: *IF(left<right,1,-1) (6,9). Previous research has highlighted the importance of reporting asymmetry in conjunction with test variability so that practitioners can determine what is considered 'real' (7,19). Thus, players reporting a change in asymmetry greater than the pre-match CV, were also identified as showing a real change.

Finally, Kappa coefficients were calculated to determine the levels of agreement for how consistently an asymmetry favoured the same side (between pre and post matches) when comparing the different time points measured. The Kappa coefficient describes the proportion of agreement between two methods after any agreement by chance has been removed (14), and were interpreted in line with suggestions from Viera and Garrett (42), where ≤ 0 = poor, 0.01-0.20 = slight, 0.21-0.40 = fair, 0.41-0.60 = moderate, 0.61-0.80 = substantial, and 0.81-0.99 = almost perfect.

Results

Owing to the repeated measures design in the present study, the starting team was rarely the same for all five matches; thus, 18 players were included. Only a single player competed in all 5 matches, five players competed in 4 matches, five players in 3 matches, three players in 2 matches and four players in 1 match. Table 1 shows mean pre and post-match jump scores and test reliability data pooled for all five games. The SLCMJ showed good to excellent reliability (ICC: 0.84-0.95) and acceptable variability (CV ≤ 7.58%), and for the SLDJ, test reliability was also good to excellent (ICC: 0.81-0.93) with acceptable variability across all matches (CV ≤ 6.71%).

For the SLCMJ, significant reductions in jump height ($p < 0.01$; ES: -0.67; 13.3% reduction) and concentric impulse ($p < 0.01$; ES: -0.68 to -0.69; 10.8-11.2% reduction) were seen on both limbs post-match, but not peak force (ES: -0.05 to -0.13; 1.1-3.1% reduction). For the SLDJ, significant reductions in jump height ($p < 0.01$; ES: -0.57; 8.7% reduction) and RSI ($p < 0.01$; ES: -0.39 to -0.58; 4.4-7.5% reduction) were shown on both limbs post-match.

** INSERT TABLE 1 ABOUT HERE **

Table 2 shows mean GPS data and in line with previous research (22) shows that high variability was seen between games with a CV range of 9.7-33.0% for all metrics. Significant correlations were shown for post-match RSI asymmetry and explosive distance ($r = 0.29$; 95% CI = 0.01-0.53; $p < 0.05$), relative explosive distance ($r = 0.34$; 95% CI = 0.07-0.56; $p < 0.05$), HSR ($r = 0.35$; 95% CI = 0.08-0.57; $p < 0.05$), and relative HSR ($r = 0.44$; 95% CI = 0.19-0.64; $p < 0.01$). No other significant correlations were present. Table 3 shows Kappa coefficients and descriptors for each game indicating how consistently asymmetry favoured the same limb between pre and post-match. For the SLCMJ, levels of agreement for jump height were poor to moderate (Kappa: -0.20 to 0.60), fair to substantial for peak force (Kappa: 0.23 to 0.62), and poor to moderate for concentric impulse (Kappa: -0.54 to 0.40). For the SLDJ, jump height showed fair to substantial levels of agreement (Kappa: 0.21 to 0.62) and slight to moderate values were evident for RSI (Kappa: 0.14 to 0.60).

** INSERT TABLES 2 & 3 ABOUT HERE **

Owing to the individual and variable nature of asymmetry, mean pre and post asymmetry data and individual player responses are shown in Figures 1-5. Players showing a change in asymmetry (between pre and post-match) greater than the pre-match CV values, have been signified by a dashed line and varied substantially between matches. Out of 10 players in any given match, real changes in asymmetry ranged from: 1-6 (SLCMJ height), 3-8 (peak force), 2-6 (concentric impulse), 3-7 (SLDJ height) and 3-6 (RSI).

** INSERT FIGURES 1-5 ABOUT HERE **

Discussion

The primary aim of the present study was to determine the acute effects of repeated soccer match-play on single leg jump performance and inter-limb asymmetries. The second aim was to examine associations between asymmetry and external load variables collected during competition. Results showed significant reductions in SLCMJ height and concentric impulse, and SLDJ height and RSI. No meaningful changes in asymmetry were evident at the group level. However, individual responses were highly variable, with some players showing changes greater than the test variability, although these were inconsistent across the different games and test metrics. Finally, significant weak to moderate relationships were evident between post-match RSI asymmetry and explosive distance and HSR metrics only.

The findings of the present study show that single leg jump performance is detrimentally affected by competitive soccer match-play. This seems logical given that competition has previously been shown to produce an acute fatigue response (2,26,39). This is in part supported by Bromley et al. (11) who showed that SLCMJ peak force and concentric impulse were impaired post-match in elite academy soccer players. However, Bromley et al. (11) showed that SLCMJ height was not sensitive enough to detect meaningful changes post-match, which is in contrast to the results of the present study. Further to this, the present study did not find meaningful changes in peak force, but did for jump height and concentric impulse in the SLCMJ. Although challenging to fully explain, previous research has shown that impulse, rather than peak force, is a key determinant of jump height (35). Thus, it stands to reason that significant reductions in both jump height and concentric impulse were evident. Further to this, although reductions in peak force were trivial, confidence intervals showed that changes ranged from small reductions to small increases (-0.53 to 0.35). Thus, individual analysis is key when aiming to understand changes in jump performance. Given multiple matches were assessed, these data denote a meaningful representation of the variable nature of acute responses shown in unilateral jump performance after competitive matches.

The SLDJ also showed meaningful reductions in jump performance for jump height and RSI on both limbs post-match and confidence intervals also showed that individual changes ranged from trivial reductions to moderate increases (-0.98 to 0.01). To the authors' knowledge, this is the first study to use the SLDJ to detect changes in jump performance post-match in elite academy soccer players. As such, comparing to equivalent studies is challenging. However, Oliver et al. (32) reported that the bilateral DJ was more sensitive than the bilateral CMJ and squat jump (SJ) tests, at detecting reductions in performance after a 42-minute treadmill protocol designed to simulate the movement intensities in soccer. All three tests showed significant reductions in jump height, but the DJ also showed significant increases in impact ground reaction force. This suggested a reduced ability to attenuate forces on landing which could be attributed to the significant reduction in muscle activity also observed from the electromyography measurements of the vastus lateralis, biceps femoris, gastrocnemius and soleus muscles during this test. Similarly, Gathercole et al. (20) used bilateral DJ, CMJ and SJ tests to detect changes in jump performance at 0, 24 and 72 hours after a Yo-Yo intermittent running protocol in 11 collegiate team sport athletes. When comparing ES data from the present study to Gathercole et al. (20) at the 0-hour time point, reductions in jump height were greater for bilateral CMJ (ES = -1.1) and DJ (ES = -0.9) testing. In addition, Gathercole et al. (20) also showed large reductions in peak force (ES = -1.3) immediately post-testing. This potentially indicates that bilateral testing may be more sensitive at detecting changes in jump performance than single leg tests post-competition. However, Gathercole et al. (20) used a single fatiguing protocol, while the present study used a repeated measures design. Furthermore, given our findings did show significant reductions in jump height and concentric impulse (SLCMJ) and jump height and RSI (SLDJ), both tests used in the present study can be considered useful when aiming to detect changes in single leg jump performance across competitive soccer matches.

Despite reductions in jump performance, no meaningful changes in asymmetry were noted for any metric. This is likely due to the high between-subject variability as shown by the varied individual player response (Figures 1-5), and low agreement between pre/post-match limb dominance (Table 3). Previous research has suggested that asymmetry should be reported on an individual basis (6,8) and relative to test variability (7,19). On the group level, there was a trend of increased SLCMJ and SLDJ height asymmetry, with mean increases shown in 4 out of 5 (Figure 1) and 5 out of 5 (Figure 4) matches respectively. All other test metrics showed mixed results, with no consistent pattern. Individual responses were highly variable, with some players showing very large increases post-match, whilst others actually reduced the imbalance compared to pre-game testing. However, no consistent pattern or frequency of how many participants showed changes greater than the test variability was seen across each test and metric reported. From a practical perspective, this makes it challenging to suggest that monitoring asymmetry post soccer competition is advantageous.

The direction of asymmetry (left or right dominance) was also determined in the present study to quantify how consistently asymmetry favoured the same limb between pre and post-match. SLCMJ peak force showed the greatest consistency in limb dominance with fair to substantial levels of agreement. Intuitively, this makes sense because it was the only SLCMJ metric not to show significant changes in jump performance (Table 1). Thus, with less change in scores evident in comparison to jump height and concentric impulse, it seems logical that limb dominance was also more consistent for peak force. However, with impulse being a key determinant of jump height (35), it could be argued that despite greater consistency, monitoring peak force alone during jumping tests may not provide meaningful information for coaches.

SLDJ height asymmetry also showed fair to substantial levels of agreement, and greater consistency than RSI. However, it is worth noting that for both tests, substantial changes in the direction of asymmetry were evident pre to post-match, being ‘poor’ for multiple metrics in multiple matches (Table 3). These data reinforce the concept of asymmetry being highly variable across tasks, metrics, and in response to soccer match-play, with no consistent pattern present. Thus, with the observed inconsistencies as to which limb is dominant across the different test metrics and matches analyzed, caution should be applied if coaches wish to monitor jumping asymmetry on the group or individual level pre and post-soccer competition.

Likely as a consequence of the varied response in asymmetry seen pre to post-match, the only significant relationships indicated were between post-match RSI asymmetry and explosive distance (r = 0.29-0.34), and HSR (r = 0.35-0.44). These relationships are positive, indicating that larger post-match asymmetries in RSI are associated with increased distance covered explosively and at high speeds. Although challenging to fully explain, it is plausible that HSR and explosive distance are more closely associated with RSI asymmetries because all three of these considered metrics are based on time (i.e., athletes need to perform all of these tasks as fast as possible). Thus, the significant associations with RSI asymmetry may be due to subsequent changes in velocity across both running and jump tasks. This also may serve as a potential reason why associations were not found with the SLCMJ which is a slower movement when compared to the SLDJ, although further research is needed to fully corroborate this theory. Furthermore, it is important to remember that the strength of these relationships were weak to moderate, and agreement in the direction of asymmetry pre to post-match for RSI was only ‘fair’ across all matches (Kappa = 0.40). As for the change in asymmetry, both jump tests showed no significant relationships with GPS data, most likely due to individual player variation for both asymmetry and in-game soccer actions. Therefore, it seems plausible to suggest that the change in asymmetry is largely independent of in-game soccer movement patterns such as distance covered, explosive distance and HSR. Thus, to inform player readiness, these data indicate that unilateral jump metrics are more appropriate than asymmetry, which is likely too variable to inform the monitoring process.

A couple of limitations also need to be acknowledged in the present study. Firstly, data was reported as left and right, rather than dominant and non-dominant. Previous research has shown that limb dominance can vary between tasks (17). Thus, reporting test scores as left and right was done in an attempt to provide consistency between jump tests. However, limb dominance can also be described within the context of the preferred kicking limb, especially in soccer. Therefore, if practitioners undertake similar investigations in future, this could be considered during subsequent data interpretation if desired. Secondly, the present study chose to report propulsive based jump metrics in an attempt to understand the response to repeated soccer match-play. Future research may wish to consider eccentric and landing based data as well, which may provide further useful information during the temporal recovery period.

Practical Applications

The present study shows that the majority of unilateral jump metrics commonly measured during both the SLCMJ and SLDJ are sensitive to change post-match in elite academy soccer players. In contrast, inter-limb asymmetry showed little consistency with highly variable changes between pre and post-competition, especially at an individual level. Thus, practitioners can confidently use unilateral jump testing to detect acute changes following soccer match-play, but should be cautious in their use of inter-limb asymmetry to inform decision-making during the temporal recovery period.

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Table 1. Mean scores ± standard deviations (SD), effect sizes, coefficient of variation (CV) and intraclass correlation coefficient (ICC) data for pre and post-game jump testing (data pooled from 5 games).

Test/Metric	**Mean ± SD**			**CV (%)**		**ICC (95% CI)**	
	Pre	*Post*	*Effect Size (95% CI)*	*Pre*	*Post*	*Pre*	*Post*
SLCMJ:							
Jump height-L (m)	0.15 ± 0.03	0.13 ± 0.03*	-0.67 (-1.07 to -0.26)	5.66	5.79	0.93 (0.87-0.96)	0.95 (0.92-0.97)
Jump height-R (m)	0.15 ± 0.03	0.13 ± 0.03*	-0.67 (-1.07 to -0.26)	7.44	7.58	0.92 (0.84-0.95)	0.91 (0.85-0.95)
Peak force-L (N)	740.4 ± 184.8	717.3 ± 162.5	-0.13 (-0.53 to 0.26)	7.04	6.30	0.92 (0.86-0.96)	0.92 (0.86-0.96)
Peak force-R (N)	718.5 ± 177.9	710.3 ± 172.3	-0.05 (-0.44 to 0.35)	5.85	6.28	0.95 (0.90-0.97)	0.95 (0.91-0.97)
CON imp-L (N·s)	113.1 ± 20.4	100.4 ± 16.3*	-0.69 (-1.09 to -0.28)	5.36	4.60	0.94 (0.89-0.96)	0.93 (0.88-0.96)
CON imp-R (N·s)	112.1 ± 19.5	100.0 ± 15.8*	-0.68 (-1.09 to -0.28)	5.24	7.01	0.94 (0.84-0.97)	0.84 (0.72-0.91)
SLDJ:							
Jump height-L (m)	0.23 ± 0.03	0.21 ± 0.04*	-0.57 (-0.97 to -0.17)	4.17	5.39	0.93 (0.87-0.96)	0.92 (0.86-0.95)
Jump height-R (m)	0.23 ± 0.03	0.21 ± 0.04*	-0.57 (-0.97 to -0.17)	4.12	6.14	0.90 (0.82-0.94)	0.91 (0.84-0.95)
RSI-L	1.37 ± 0.15	1.31 ± 0.16*	-0.39 (-0.78 to 0.01)	4.22	5.63	0.88 (0.78-0.93)	0.83 (0.70-0.90)
RSI-R	1.33 ± 0.15	1.23 ± 0.19*	-0.58 (-0.98 to -0.18)	4.81	6.71	0.84 (0.72-0.91)	0.81 (0.67-0.89)

* significant at $p < 0.01$; CI = confidence intervals; SLCMJ = single leg countermovement jump; SLDJ = single leg drop jump; L = left; R = right; m = metres; N = Newtons; CON = concentric; N·s = Newton seconds; RSI = reactive strength index.

Table 2. Mean global positioning system (GPS) data for each recorded game (data shown in metres and metres per minute).

GPS Metric	CV (%)	Game 1	Game 2	Game 3	Game 4	Game 5
Distance (m)	14.1	10045.3 ± 1245.0	9717.7 ± 1819.1	9937.8 ± 1848.2	9439.0 ± 1225.9	9376.5 ± 1034.4
Distance ($m \cdot min^{-1}$)	9.7	117.0 ± 6.6	114.7 ± 19.2	112.5 ± 14.3	108.4 ± 8.0	107.8 ± 6.3
Exp. distance (m)	23.8	334.9 ± 71.2	323.2 ± 65.7	289.1 ± 71.3	298.8 ± 95.0	258.7 ± 56.4
Exp. distance ($m \cdot min^{-1}$)	21.3	4.0 ± 0.9	3.9 ± 0.8	3.3 ± 0.7	3.4 ± 1.0	3.0 ± 0.7
HSR (m)	33.0	785.7 ± 192.2	695.4 ± 240.6	743.0 ± 243.9	661.6 ± 269.8	656.6 ± 225.3
HSR ($m \cdot min^{-1}$)	29.2	9.2 ± 1.9	8.2 ± 2.5	8.5 ± 2.5	7.6 ± 2.8	7.6 ± 2.6
Player Load	16.7	922.5 ± 161.0	989.5 ± 209.1	994.9 ± 138.8	887.6 ± 170.0	897.2 ± 140.2

Exp. = explosive; HSR = high speed running.

Table 3. Kappa coefficients and descriptive levels of agreement for the direction of asymmetry (data pooled from 5 games and shown for each individual game).

Asymmetry Metric	All Matches	Game 1	Game 2	Game 3	Game 4	Game 5
SLCMJ:						
Jump height	0.25 (Fair)	0.23 (Fair)	0.60 (Moderate)	-0.20 (Poor)	0.20 (Slight)	0.40 (Fair)
Peak force	0.47 (Moderate)	0.60 (Moderate)	0.62 (Substantial)	0.38 (Fair)	0.23 (Fair)	0.40 (Fair)
CON impulse	-0.13 (Poor)	-0.54 (Poor)	0.00 (Poor)	-0.36 (Poor)	0.00 (Poor)	0.40 (Fair)
SLDJ:						
Jump height	0.46 (Moderate)	0.35 (Fair)	0.60 (Moderate)	0.21 (Fair)	0.62 (Substantial)	0.40 (Fair)
RSI	0.40 (Fair)	0.14 (Slight)	0.38 (Fair)	0.60 (Moderate)	0.40 (Fair)	0.55 (Moderate)

SLCMJ = single leg countermovement jump; SLDJ = single leg drop jump; RSI = reactive strength index.

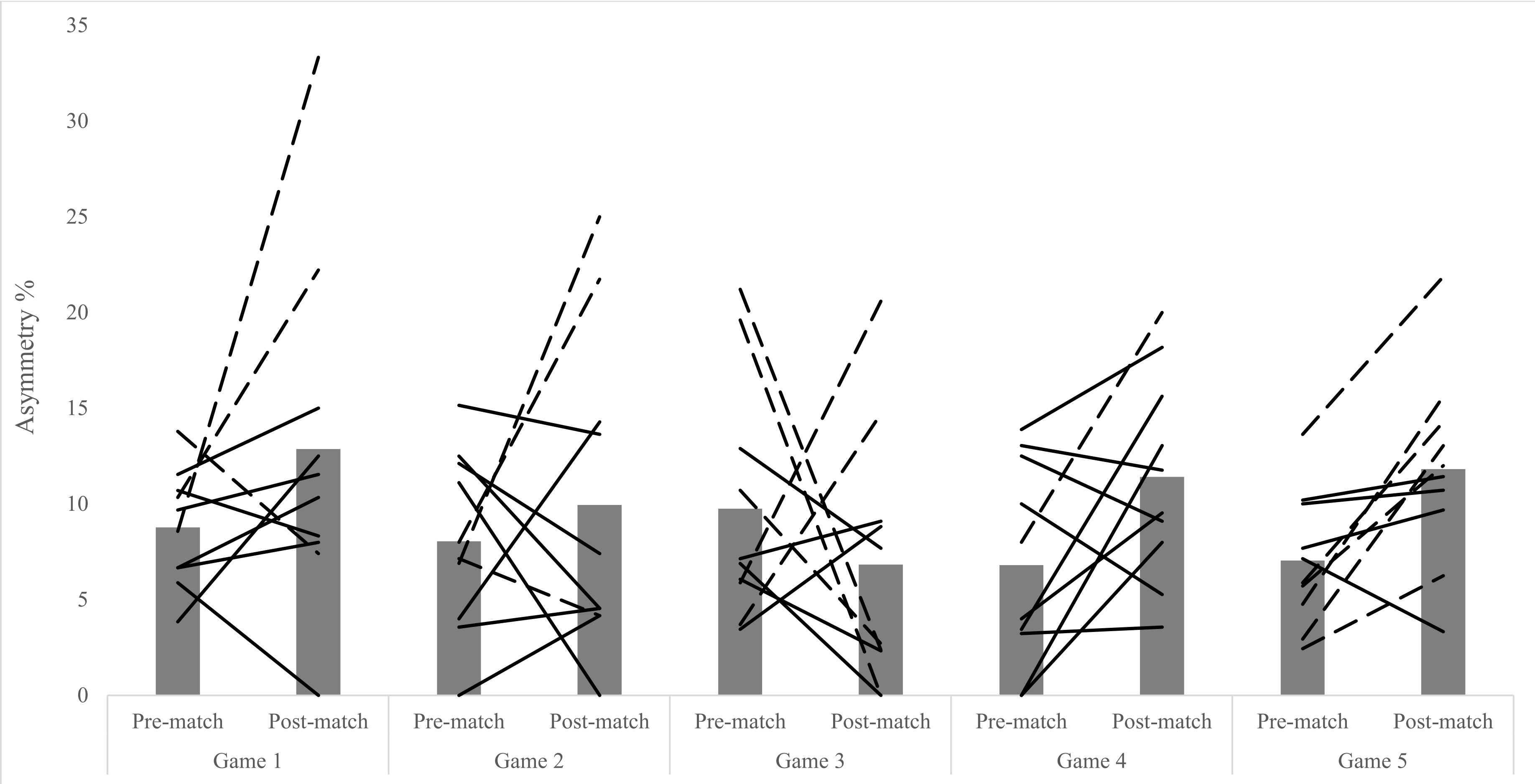

Figure 1. Mean and individual inter-limb asymmetry data for jump height during the single leg countermovement jump test across 5 games. Dashed lines indicate a change in asymmetry greater than the pre-match coefficient of variation.

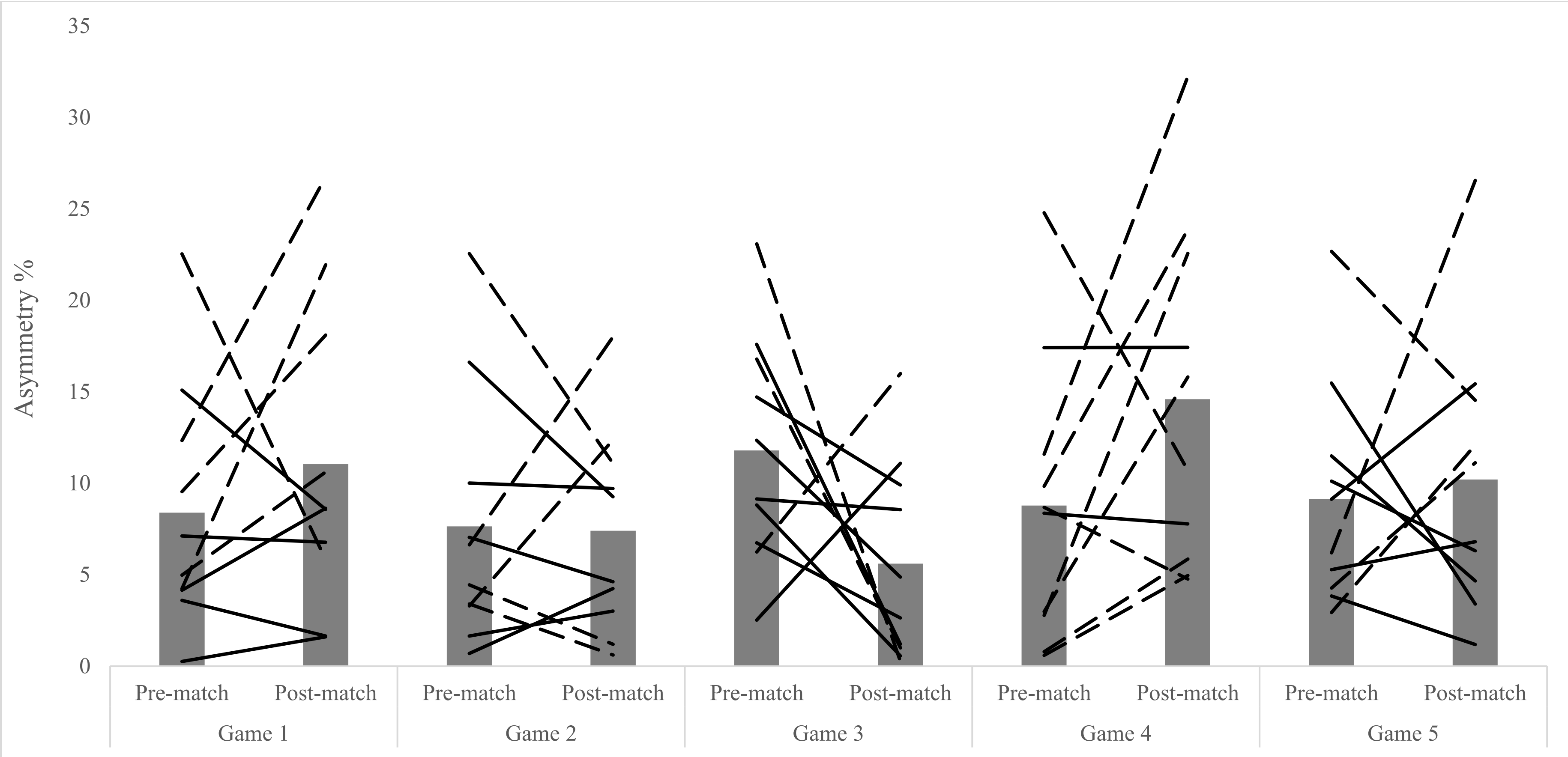

Figure 2. Mean and individual inter-limb asymmetry data for peak force during the single leg countermovement jump test across 5 games. Dashed lines indicate a change in asymmetry greater than the pre-match coefficient of variation.

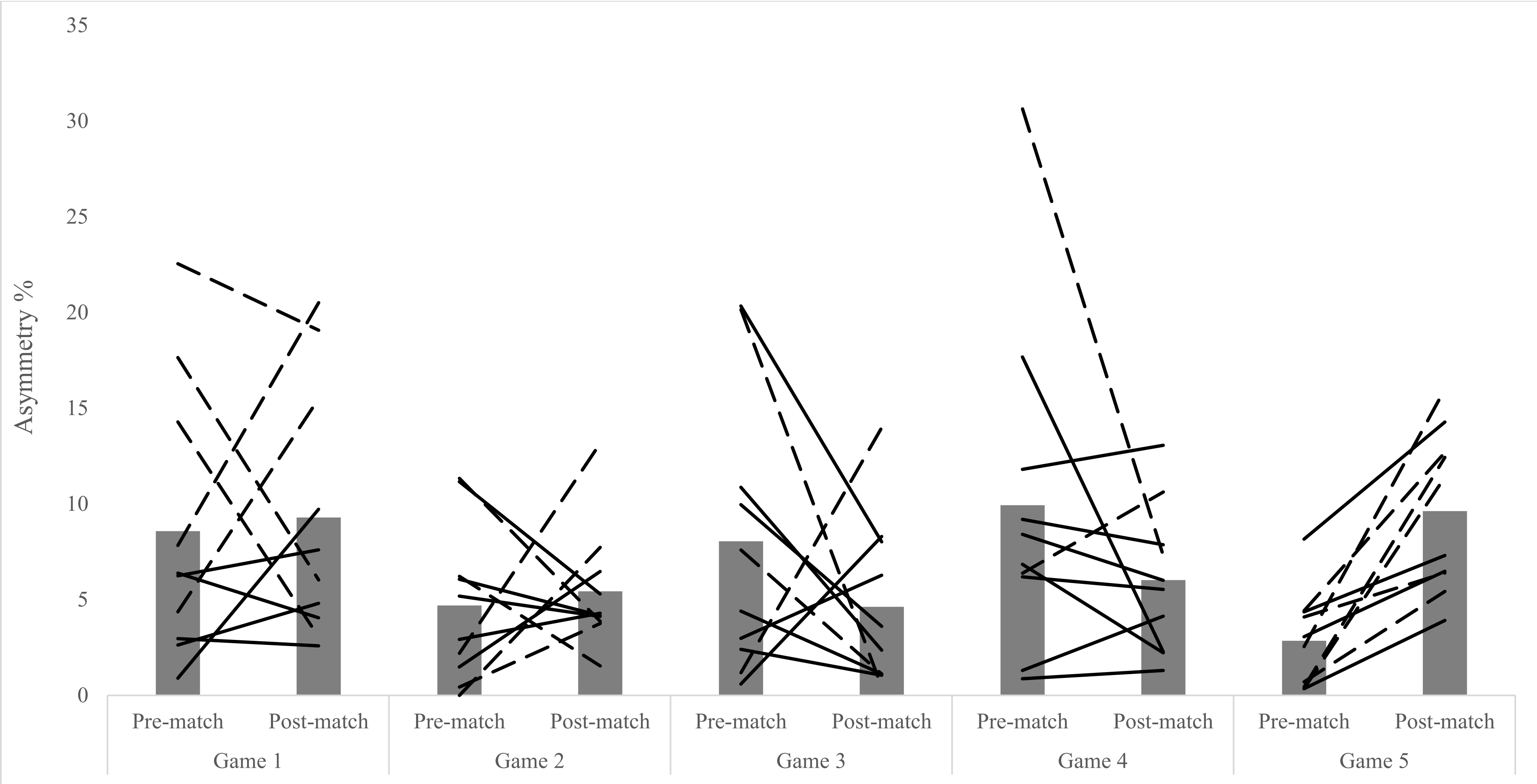

Figure 3. Mean and individual inter-limb asymmetry data for concentric impulse during the single leg countermovement jump test across 5 games. Dashed lines indicate a change in asymmetry greater than the pre-match coefficient of variation.

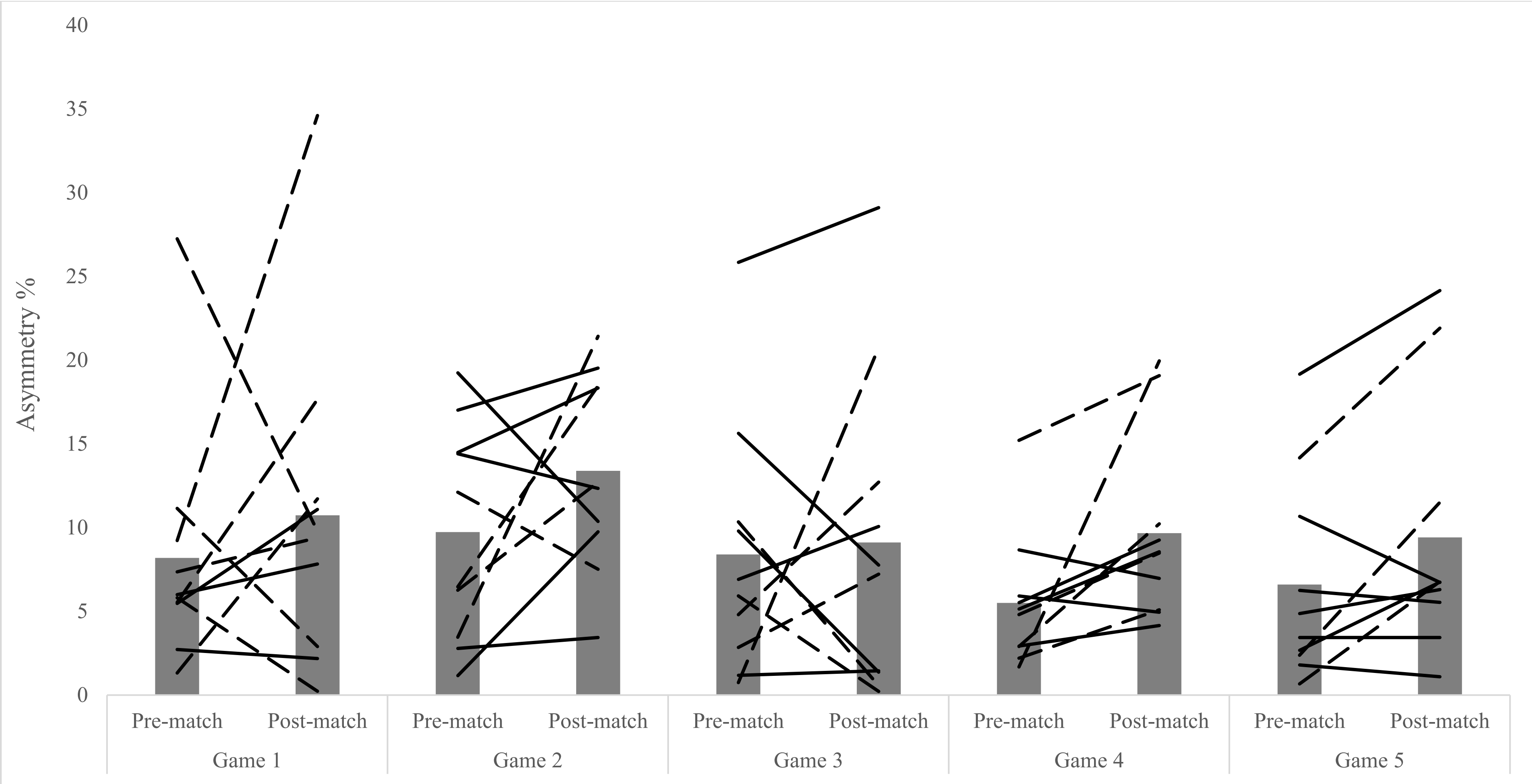

Figure 4. Mean and individual inter-limb asymmetry data for jump height during the single leg drop jump test across 5 games. Dashed lines indicate a change in asymmetry greater than the pre-match coefficient of variation.

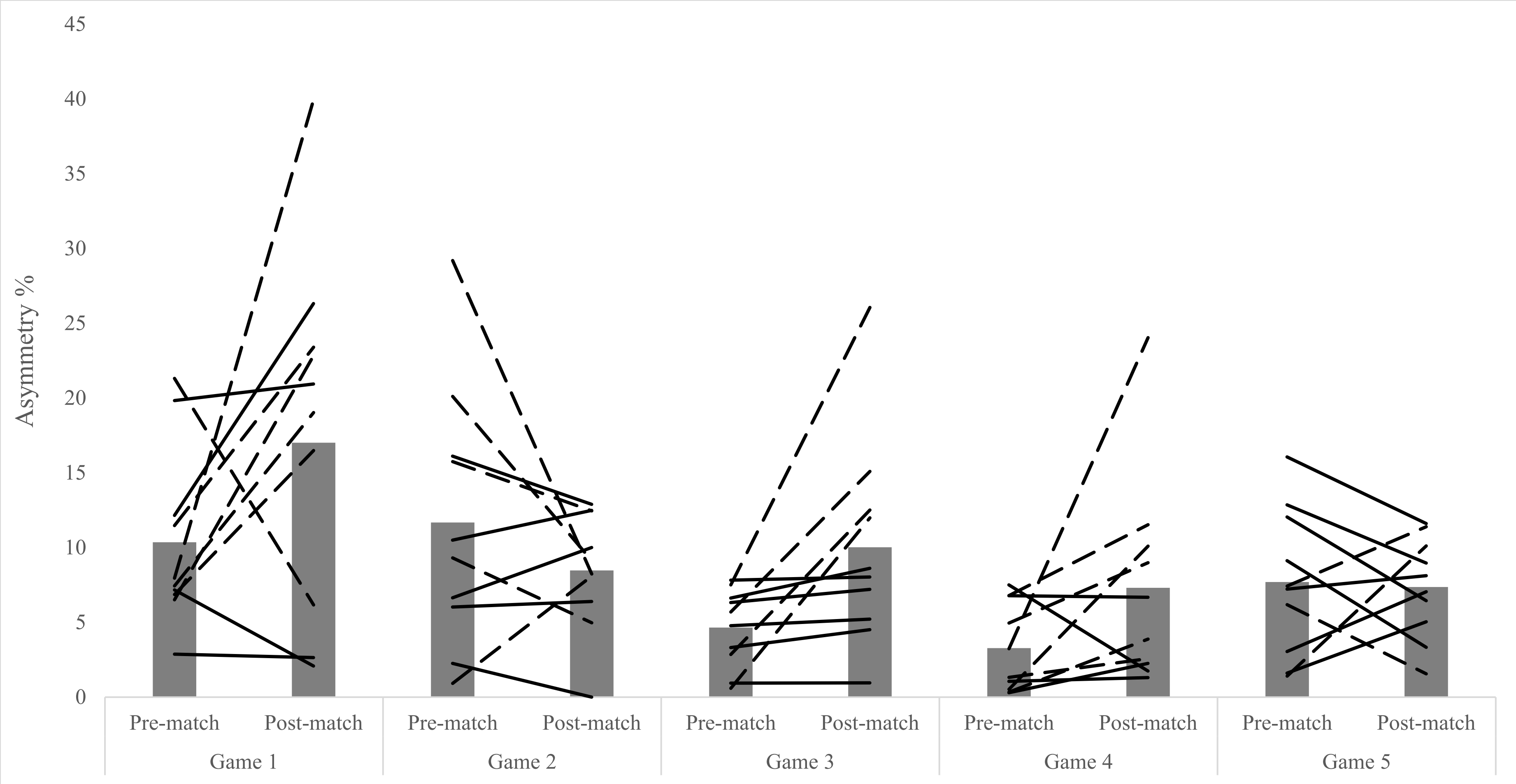

Figure 5. Mean and individual inter-limb asymmetry data for reactive strength index during the single leg drop jump test across 5 games.

Dashed lines indicate a change in asymmetry greater than the pre-match coefficient of variation.