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A Comparison of Bilateral vs. Unilateral-biased Strength and Power Training Interventions on Measures of Physical Performance in Elite Youth Soccer Players

Abstract

The aim of the present study was to compare the effects of bilateral and unilateral-biased strength and power training programs on measures of physical performance in male youth soccer players. Twenty-three elite youth players (age: 17.6 ± 1.2 years) were randomly assigned to either a unilateral (*n* = 11) or a bilateral (*n* = 12) group, who completed a strength and power intervention, twice per week for 6-weeks. The unilateral group completed rear foot elevated split squats (RFESS), single leg countermovement jumps (SLCMJ), single leg drop jumps (SLDJ) and single leg broad jumps (SLBJ). The bilateral group intervention performed back squats, countermovement jumps (CMJ), drop jumps (DJ) and broad jumps (BJ). A 2 x 2 repeated measures ANOVA showed no between-group differences. However, within-group differences were evident. The bilateral training group showed significant ($p < 0.05$) improvements in back squat strength (*d* = 1.27; %Δ = 26.01), RFESS strength (*d* = 1.64; %Δ = 23.34), BJ (*d* = 0.76; %Δ = 5.12), 10 m (*d* = -1.17; %Δ = 4.29) and 30 m (*d* = -0.88; %Δ = 2.10) performance. The unilateral group showed significant ($p < 0.05$) improvements in RFESS strength (*d* = 1.40; %Δ = 33.29), SLCMJ on the left leg (*d* = 0.76; %Δ = 9.84), SLBJ on the left leg (*d* = 0.97; %Δ = 6.50), 10 m (*d* = -1.50; %Δ = 5.20), and 505 on the right leg (*d* = -0.78; %Δ = 2.80). Standardised mean differences showed that bilateral training favoured improvements in back squat strength and unilateral training favoured improvements in RFESS strength, SLDJ on the right leg and 505 on the right leg. These results show that although both training interventions demonstrated trivial to large improvements in physical performance, the notion of training specificity was evident with unilateral training showing greater improvements in unilateral test measures.

Key Words: Off-season; jumping; speed; change of direction speed.

Introduction

Soccer is a high-intensity, intermittent sport which requires players to sprint, change direction, jump and experience multiple physical duels during match-play (30). Time motion analysis data have shown that elite soccer players cover on average 10-11km (25), can jump up to 15 times (21), and change direction 1200-1400 times (3) in a single match. Given that many of these intermittent actions are high-intensity in nature, it stands to reason that strength and power training serves as useful modes of training for soccer players, to help prepare them for the demands of the game. Increases in bilateral strength and power have shown improvements in related actions such as change of direction speed (CODS) (23), linear speed (8), and jump height (10). Similarly, evidence exists showing the benefits of unilateral training for improved CODS (28), jumping (18) and linear speed (19). Thus, with both bilateral and unilateral training having been shown to improve various markers of athletic performance, it would be useful for coaches to know whether one training modality is more effective than the other, so that training programmes can be prioritised accordingly.

Gonzalo-Skok et al. (12) compared the effects of six-week unilateral versus bilateral training interventions on single leg output, inter-limb asymmetry, bilateral deficit, CODS, linear sprinting, and jump height. The bilateral group (*n* = 11) completed 3 sets of back squats, with repetitions continuing until power output dropped by > 10%. In addition, 2 sets of 5 repetitions were completed for bilateral drop jumps (DJ), horizontal DJ, countermovement jumps (CMJ) and broad jumps all in addition to their normal strength training programme (which consisted of eccentric strength, balance and coordination exercises). The unilateral group (*n* = 11) completed 3 sets of rear foot elevated split squats (RFESS), with repetitions continuing until power output dropped by > 10%. Two sets of 5 repetitions were completed for the same jumps, but performed unilaterally. Again, this was performed in addition to the aforementioned normal strength training programme. Results showed that both groups improved in maximal power, linear sprinting and CMJ tests; however, the bilateral group reduced the bilateral deficit 29.2% more than the unilateral group. In contrast, the unilateral group reduced asymmetry 53.0% more than the bilateral group, showed greater improvements in CODS on the left leg (2.6%) and mean power on both limbs during the RFESS exercise (12.3-12.8%). Although not a true unilateral exercise (20), these data show that the RFESS could be a viable alternative to traditional back squat training when aiming to enhance CODS and power output unilaterally.

Speirs et al. (28) compared the effects of the back squat and RFESS only in a twice per week strength program for 5-weeks on strength, sprinting (40m) and CODS (pro-agility) in elite international academy rugby players. Their results showed a main effect for time pre to post-intervention for; back squat (ES

= 0.84-0.92), RFESS (ES = 0.89-0.94), 40m (ES = 0.47-0.67), pro-agility (ES = 0.77-0.89), but no meaningful differences between groups. These data suggest that both training methods exhibited similar benefits on strength, linear speed and CODS, and somewhat disagree with the findings from Gonzalo-Skok et al. (12). Similar results were shown in a recent study by Appleby et al. (1), who investigated the effects of a bilateral (back squat) and unilateral (step ups) resistance training groups against a control group during an 8-week training intervention and a 3-week maintenance phase in developmental rugby players. Results showed that both intervention groups improved in one-repetition maximum (1RM) strength for back squat (ES: 0.79 $\pm$ 0.40) and 1RM average step ups (ES: 0.63 $\pm$ 0.17), with neither being significantly better than the other. Given the conflicting findings in the literature, further research is warranted to establish which training modality (bilateral or unilateral) is more effective for improving athletic performance.

Bogdanis et al. (6) also compared a bilateral (n = 8) and unilateral (n = 7) plyometric training intervention performed twice per week for 6-weeks. The groups performed a range of plyometric exercises (e.g., CMJ, DJ, broad jumps, and their associated single leg versions), and jump performance was assessed via the CMJ, DJ, and maximal isometric leg press strength and rate of force development (RFD) on each leg separately and both together. Results showed that the unilateral group improved more than the bilateral group for; CMJ (19.0 $\pm$ 7.1%, $p < 0.001$), maximal isometric force (23.8 $\pm$ 9.1%, $p < 0.009$) and rate of force development (RFD) from 0-50 (34%) and 50-100 ms (36%), indicating the superiority of unilateral training for improving jumping, isometric force production and RFD compared to bilateral training. Similar results were shown by Fisher and Wallin (11), who compared bilateral (n = 7) versus unilateral (n = 8) lower body resistance and plyometric training, performed twice per week for 6-weeks in collegiate male rugby players. Groups performed either back squats or single leg squats as the resistance exercise and a range of plyometric exercises (e.g., forward and lateral CMJ, box jumps or their associated single leg versions). Results showed large improvements in CODS performance for the unilateral group (ES range = 1.48-1.86) and small to moderate improvements for the bilateral group (ES range = 0.25-1.16). In contrast, the bilateral group showed noticeably better improvements in 10 m sprint performance (ES = 0.7) compared to the unilateral group (ES = 0.1). Collectively, these data show the efficacy of both bilateral and unilateral training methods for the enhancement of athletic performance. However, given no clear trend exists as to whether one method is better than the other, further comparisons are warranted in an attempt to inform practitioners about the effectiveness of each method.

Therefore, the primary aim of the present study was to determine whether bilateral and unilateral strength and power training improves measures of physical performance in male youth soccer players. A secondary aim was to compare both training interventions in an attempt to determine which training method was superior at improving measures of physical performance. Given, the conflicting findings in the literature, developing a true hypothesis was challenging; however, it was thought that the unilateral strength and power training, may be more likely to transfer to unilateral test measures, supporting the notion of specificity (2,7)

Methods

Experimental Approach to the Problem

This study used the pre-season period in the build up to the 2019-2020 soccer season, to conduct two strength and power training interventions for academy soccer players, at a professional soccer club in the UK. With a randomized crossover design, players were either selected to be part of a bilateral or RFESS training group, investigating the effects on bilateral and unilateral strength and jumps, and linear and CODS performance. All players performed a standardized warm-up procedure, consisting of a single set of 10 repetitions of bodyweight squats, 5 repetitions on each leg of linear and lateral lunges, spidermans and inchworms mobility exercises. After this, three practice trials were provided for each jump, sprint and CODS test, at 50, 75 and 100% of perceived maximal effort. For testing, day 1 consisted of the CMJ, single leg CMJ (SLCMJ), DJ, single leg DJ (SLDJ), speed (10 and 30m) and CODS (505) tests. Seventy-two hours later, day 2 consisted of predicted 1RM strength for back squats and RFESS, with the same process conducted during post-intervention testing. Subjects were instructed to refrain from any exercise for 24 hours before testing at both time points. After pre-intervention testing, subjects were randomly assigned to one of two groups: either a unilateral (*n* = 11) or a bilateral (*n* = 12) group, consisting of either bilateral or unilateral strength and power exercises twice per week for 6 weeks. All measurements were then repeated after the completion of the 6-week intervention.

Subjects

Twenty-three level academy male football players (age: 17.6 $\pm$ 1.2 years, body mass: 77.3 $\pm$ 7.91 kg, height: 179.6 $\pm$ 7.27 cm) were recruited and provided informed consent to take part in this study. All subjects were from a category 2 soccer academy and participated in structured technical soccer training, on average, six times per week and structured strength and power training in the weight room twice per week (Table 1). Inclusion criteria required subjects to have a minimum of two year's resistance training experience, be free from any injuries for a minimum of 4-weeks prior to pre-testing and attend all training sessions throughout their respective intervention. This study was approved by the *deleted for peer review* research and ethics committee.

Procedures

Training Intervention. Training was conducted during a typical academy level football pre-season preparation phase (Table 1), which normally involves six football sessions per week (60-90 minutes of duration, including football position specific drills, technical, tactical and physical sessions), two lower body resistance training sessions per week in which the participants completed a periodized, volume-load matched strength and power program of back squats or RFESS (bilateral or unilateral group, respectively), alongside DJ, CMJ and broad jumps, again, either bilaterally or unilaterally, depending on the group (Table 2). Participants completed their interventions under the guidance of at least one accredited strength and conditioning coach to assist with technique and performance monitoring. Barbell loads were prescribed as a percentage of the 1RM obtained at baseline testing.

***** Insert Tables 1 and 2 about here *****

One Repetition Maximum Testing (1RM). After completion of a barbell warm up (two sets of 8 repetitions with just the bar), the PUSH™ 2.0 Band was placed on the barbell before the participant performed 5 sets of 3 repetitions of self-selected submaximal loads with each set increasing in load (e.g., 3 reps at: 40, 60, 70, 85, 100kg). Participants were instructed to move in a controlled manner during the eccentric phase of the lift and then move as fast as possible during the concentric phase of the exercise, with a 3-minute rest period between sets. The recorded metric was mean concentric velocity, with the best repetition per set subsequently used for further analysis, to determine predicted 1RM loads. All subjects were required to achieve a 90° angle between the femur and the tibia while performing the both RFESS and back squat testing (26), which was controlled with a resistance band being tied to either side of the squat rack and subjects were required to touch the band to complete the required depth for a successful repetition.

Bilateral and Unilateral Countermovement Jumps (CMJ). Subjects performed the jumps using a contact mat (Just Jump system, Probotics, Huntsville, Alabama, USA). They were instructed to step onto the contact mat with hands placed on hips for the duration of the test. For all unilateral jumps, the non-jumping leg was slightly flexed with the foot hovering at mid-shin level and no additional swinging of this leg was allowed during trials. All jumps were initiated by performing a countermovement to a self-selected depth before accelerating vertically as fast as possible into the air. The testing leg (unilateral) and legs (bilateral) were required to remain fully extended throughout the flight phase of the jump before landing back onto the contact mat as per the set up. Each trial was separated by 45s of rest, with jump height (calculated from the flight time method) being the recorded metric. Two trials were performed for each test and the trial with the greatest jump height was subsequently used for further analysis.

Bilateral and Unilateral Drop Jumps (DJ). Subjects performed the jumps using a contact mat (Just Jump system, Probotics, Huntsville, Alabama, USA) and started by standing on a box of 30 cm (bilateral) or 15 cm (unilateral) selected as the chosen height to drop from based on previous research (24). With hands fixed on hips throughout the duration of the test, subjects stood on the designated test leg and were instructed to step off the box and land on the contact mat below, with either both legs or one leg depending on the test measure in question. Upon landing, participants were then instructed to "jump as high as you can, whilst spending as little time on the ground as possible" in line with previous research (16,17). Each trial was separated by 45s rest, with the recorded metric being reactive strength index (RSI), quantified using the equation: flight time/ground contact time (17). Two trials were performed for each test and the trial with the greatest RSI was considered for further analysis.

Bilateral and Unilateral Broad Jumps. The broad jump test was performed using a standard measuring tape which was fixed to a matted floor. Subjects were instructed to set up behind the start line with feet shoulder width apart (bilateral) or with the non-jumping leg slightly flexed with the foot hovering at mid-shin level (unilateral). Due to the challenging nature of landing from horizontal jumps, the use of an arm swing was allowed during all trials. Subjects were instructed to bend their knees to a self-selected depth before accelerating horizontally and explosively as far as possible. Distance was measured from the start line to the point of the landing heel, with subjects required to 'stick the landing' for three seconds. If this criteria was not adhered to, the trial was deemed void and retaken after a 45s rest period. Two trials were performed for each test and the trial with the greatest was used for further analysis.

10m and 30m sprints. Dual beam electronic timing games (Brower Timing Systems, Draper, UT, USA) were positioned at a height of 1 m on the start line, 10 and 30 m, enabling multiple splits to be measured during a single sprint. Players started the test in a staggered two-point stance with toes positioned 30 cm behind the start line, in order to not break the beam of the timing gates prior to the initiation of the test. When ready, subjects sprinted all the way through the final set of timing gates, allowing 10 and 30 m split times to be recorded to the nearest hundredth of a second. Two trials were performed on an outdoor 4G synthetic surface and separated by a 3-minute rest period, with the fastest trial considered for further analysis.

505 Change-of-Direction Speed Test. A distance of 15 m was measured out and electric timing gates (Brower Timing Systems, Draper, UT, USA) positioned at the 10 m mark, while the 15 m point was positioned on the goal line to ensure that players had an obvious target as they approached the turning point. Players sprinted 15 m on the 4G synthetic and performed a 180° turn, off both right and left legs, with a total of two trials completed for each leg. Time started when players broke the electronic beam at the 10 m mark and finished after sprinting back through the timing gates, having completed the 180° turn. Subjects were required to place the outside foot passed the goal line for a successful trial. Two trials were performed for each test with a 3-minute rest period and the fastest trial was used for data analysis. The COD deficit was also calculated for each leg using the formula: fastest 505 time – fastest 10m time, suggested to provide a more accurate representation of each player's true COD ability (22).

Statistical Analysis

All data were initially recorded as mean and standard deviations (SD) in Microsoft Excel. Thereafter, the data was transferred to SPSS (version 25.0; SPSS, Inc., Armonk, NY, USA). All data was checked for normality using the Shapiro-Wilk test, and within-session reliability of test measures computed using an average measures two-way random intraclass correlation coefficient (ICC) with absolute agreement, inclusive of 95% confidence intervals (relative reliability), and the coefficient of variation (CV) (absolute reliability). Interpretation of ICC values was in accordance with previous research by Koo and Li (15), where values > 0.9 = excellent, 0.75-0.90 = good, 0.5-0.74 = moderate, and < 0.5 = poor. CV values were considered acceptable if < 10% (9).

Differences from pre to post-intervention were determined through a paired samples *t*-test for each group individually and a 2 x 2 (group x time) repeated measures ANOVA was conducted to quantify whether the bilateral or unilateral training intervention was significantly different across two time points, with statistical significance set at $p < 0.05$. Magnitude of change was quantified using Cohen's *d* effect sizes: $(Max_{pre} – Max_{post})/SD_{pooled}$, with values interpreted in line with a suggested scale by Hopkins et al. (13) where < 0.20 = trivial; 0.20-0.60 = small; 0.61-1.20 = moderate; 1.21-2.0 = large; > 2.01 = very large.

Results

A Shapiro-Wilk test revealed that all data were normally distributed ($p > 0.05$). Reliability data are presented for both time points in Table 3. Relative reliability ranged from moderate to excellent for all metrics at both time points, and all CV values were < 10% and therefore, deemed acceptable (9). The repeated measures ANOVA showed no meaningful between-group differences. Descriptive data, accompanying effect sizes and percentage change are presented in Table 4 for the bilateral group, and Table 5 for the unilateral group. For the bilateral group, significant improvements were seen for 1RM back squat, 1RM RFESS, BJ, 10 m and 30m, with no significant differences found for the other performance measures. For the RFESS group, significant improvements were found for 1RM RFESS, SLCMJ left leg, SLBJ left leg, 10m and 505 right leg. No other significant differences found. Standardised mean differences between groups are presented in Figure 1 and show that bilateral training favoured greater improvements in back squat strength, whilst unilateral training favoured improvements in RFESS strength, SLDJ and 505 performance on the right leg.

***** Insert Tables 3-5 about here *****

***** Insert Figure 1 about here *****

Discussion

The aims in the present study were two-fold: 1) to determine whether bilateral and unilateral strength and power training improved measures of physical performance and, 2) to determine if either modality were superior for performance in elite youth male soccer players. Results showed that both training modalities improved various markers of athletic performance with the unilateral group significantly improving in six different testing measures (1RM BS, 1RM RFESS, SLCMJ left, SLBJ left, 10m and 505 right), and the bilateral group significantly improving in five test measures (back squat, RFESS, BJ, 10m and 30m). Therefore, these data suggest that both interventions were effective at improving certain performance markers, with specificity of intervention often showing greater benefit for comparable test protocols.

Pre and post-intervention data for the bilateral group is displayed in Table 4. Strength measures displayed a large magnitude of change and percentage improvement both bilaterally and unilaterally; 1RM back squat (ES = 1.27; CI = 0.39 to 2.15; Δ% = 26.01) and RFESS (ES = 1.64; CI = 0.72 to 2.57; Δ% = 23.34). Whilst challenging to fully explain, previous research by Speirs et al. (28) has shown similar results, with elite academy rugby athletes. Training interventions required players to undertake two strength training sessions per week, for five weeks, with one group ($n = 9$) performing back squats and the second group (*n* = 9) the RFESS. Results showed that both training methods were equally effective at improving both back squat and RFESS 1RM loads. Thus, it would appear that bilateral strength training may have a positive carryover to more than just bilateral strength alone. Linear speed also showed significant improvement from pre to post in the bilateral group, with a moderate ES across both the 10m (ES = 1.17; CI = 0.30 to 2.03; Δ% = 4.29) and 30m (ES = 0.88; CI = 0.05 to 1.72; Δ% = 2.10) tests. This does not seem surprising given prior research has shown that increases in maximal strength are associated with improvements in sprint times (8,27). Thus, it seems somewhat likely that increases in force production would transfer to improvements in linear speed, as seen in the present study for both training groups.

Pre and post-intervention data for the unilateral group is displayed in Table 5. Significant improvements in strength were evident, but only for the RFESS, which showed a large increase from pre to post (ES = 1.40; CI = 0.47 to 2.34; Δ% = 33.29). In contrast, only a small improvement in 1RM back squat strength was evident for the unilateral training group. These results can likely be explained by the notion of specificity, which is increasingly becoming acknowledged as a fundamental factor when prescribing training exercises (2,7). Thus, in the present study, it seems likely that the unilateral group made substantially better improvements during the RFESS compared to the bilateral group, because they trained this way for 6-weeks. These results are in part supported by previous research, whereby Appleby et al. (1) showed that training unilaterally for 8 weeks (using the barbell step up exercise) resulted in greater improvements in 1RM step up strength for the unilateral group compared to the bilateral group (ES = 0.36-0.41). Another significantly large improvement which occurred in the unilateral training group was a reduction in acceleration times; 10m (ES = 1.50; CI = 0.55 to 2.45; Δ% = 5.20). In addition, significant improvements in 505 time were evident, but only on the right limb (ES = 0.78; CI = -0.09 to 1.64; Δ% = 2.80) and for the SLBJ, but only on the left limb (ES = 0.97; CI = 0.08 to 1.85; Δ% = 6.50). Although not all unilateral test measures significantly improved, these data do support the notion that unilateral strength and power training, may be more likely to transfer to unilateral test measures. This further supports the notion of specificity (2,7) and serves as useful information for practitioners who need to develop physical competency unilaterally. This seems especially relevant for team sport athletes, who often perform movement patterns unilaterally (e.g., sprinting, changing direction and kicking).

When viewing the standardised mean differences (Figure 1), it is hard to clearly identify which training modality is better for improving measures of athletic performance, as the majority of confidence intervals overlap the grey shaded area (indicating positive and negative trivial results). However, one key take home message from these results, is that strength seems to be dependent on training specificity, which is in line with previous research (29,31,32). In addition, the SLDJ and 505 (on the right limb) appear to be more positively influenced by unilateral training, which again falls in line with the notion of training specificity. However, bilateral and unilateral vertical and horizontal jumping seem to be influenced to the same degree from both training interventions. Thus, it is suggested that both bilateral and unilateral strength and power training are as equally effective at improving CMJ and broad jump performance (noting that small % improvements were made for both test measures, bilaterally and unilaterally), and is also in agreement with previous comparable research (12,28). Additionally, mean body mass was 77.3 kg across the sample and the mean load for the RFESS was 100 kg, prior to the training intervention. Thus, the athletes undertaking the unilateral training intervention, showed reasonable strength levels (1.29 per kg of body mass) during the RFESS exercise. Although somewhat anecdotal, if athletes are unable to demonstrate high levels of strength unilaterally, then similar results to the present study should likely not be expected. In such a scenario, it is still suggested that unilateral training is integrated into programming (especially for team sport athletes), and that practitioners recognise that the adaptive response from unilateral training methods are likely to take longer.

There are a couple of limitations to the present study which should be acknowledged. Firstly, a third group which used a combination of bilateral and unilateral would have served as useful comparison to determine whether there were any meaningful advantages over singling out bilateral or unilateral training methods. Thus, future research should aim to compare three different training approaches, where possible. Secondly, the current investigation only lasted six weeks, which may have potentially been too short to exhibit meaningful improvements in some of the test measures. Although the opportunity for consistent and prolonged training in the off-season is somewhat restricted in professional soccer clubs, future research should aim to investigate training interventions over a longer period (e.g., 8-12 weeks), whereby players are tested across different phases of training with different intensity and workloads.

Practical Applications

The present study shows that both bilateral and unilateral strength and jump training programmes are effective at improving measures of physical performance, which provides two key take-home messages for practitioners. Firstly, these findings demonstrate the significant improvements that academy soccer players can obtain when following a structured strength and jumping programme during the short pre-season period. It may appear prudent to recommend that strength training (in particular) should be prioritised during this part of the off-season, which should help to improve players' robustness. Second, these data support previously published literature, indicating that both bilateral and unilateral training methods provide similar benefits for athletic performance enhancement. Knowing this provides practitioners with a wider variety of options when programming for enhanced physical adaptation, which may offer increased variety when designing training programmes over time.

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Table 1. Typical training week for during pre-season in elite academy soccer players.

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Morning	Soccer training	Gym + Soccer training	-	Gym + Soccer training	Soccer training	Match	-
Afternoon	-	Technical soccer skills	-	Technical soccer skills	-	-	-

Table 2. Periodised strength and power interventions for the bilateral and unilateral training groups.

Bilateral Training Group	Unilateral Training Group
Weeks 1-2	
Back Squat (4 x 6 @ 75% 1RM)	Rear Foot Elevated Split Squat (4 x 6 each leg @ 75% 1RM)
Drop Jump (4 x 3 from 30 cm box)	Single Leg Drop Jump (4 x 3 each leg from 15 cm box)
Countermovement Jump (4 x 3)	Single Leg Countermovement Jump (4 x 3 each leg)
Broad Jumps (4 x 3)	Single Leg Broad Jump (4 x 3 each leg)
Weeks 3-4	
Back Squat (4 x 6 @ 80% 1RM)	Rear Foot Elevated Split Squat (4 x 6 each leg @ 80% 1RM)
Drop Jump (4 x 4 from 30 cm box)	Single Leg Drop Jump (4 x 4 each leg from 15 cm box)
Countermovement Jump (4 x 4)	Single Leg Countermovement Jump (4 x 4 each leg)
Broad Jumps (4 x 4)	Single Leg Broad Jump (4 x 4 each leg)
Weeks 5-6	
Back Squat (4 x 6 @ 85% 1RM)	Rear Foot Elevated Split Squat (4 x 6 each leg @ 85% 1RM)
Drop Jump (4 x 5 from 40 cm box)	Single Leg Drop Jump (4 x 5 each leg from 20 cm box)
Countermovement Jump (4 x 5)	Single Leg Countermovement Jump (4 x 5 each leg)
Broad Jumps (4 x 5)	Single Leg Broad Jump (4 x 5 each leg)

Table 3. Coefficient of variation (CV) and intraclass correlations coefficients ([ICC] 95% confidence intervals) during pre and post-intervention testing.

Fitness Test	Pre-intervention		Post-intervention	
	CV (%)	*ICC (95% CI)*	*CV (%)*	*ICC (95% CI)*
CMJ	2.01	0.95 (0.89-0.98)	2.45	0.95 (0.89-0.98)
SLCMJ-L	2.51	0.96 (0.91-0.98)	2.89	0.81 (0.60-0.91)
SLCMJ-R	2.52	0.95 (0.89-0.98)	3.38	0.77 (0.53-0.89)
BJ	2.99	0.82 (0.64-0.92)	2.85	0.82 (0.63-0.92)
SLBJ-L	3.14	0.78 (0.43-0.91)	2.00	0.88 (0.73-0.95)
SLBJ-R	2.22	0.88 (0.75-0.94)	2.49	0.85 (0.68-0.94)
RSI	7.69	0.74 (0.50-0.88)	7.41	0.73 (0.46-0.87)
SLRSI-L	6.27	0.64 (0.33-0.82)	8.49	0.59 (0.21-0.82)
SLRSI-R	6.38	0.74 (0.50-0.88)	7.23	0.78 (0.54-0.89)
10m	1.41	0.78 (0.30-0.92)	1.56	0.64 (0.31-0.83)
30m	0.63	0.92 (0.50-0.98)	0.74	0.86 (0.69-0.94)
505-L	1.09	0.80 (0.48-0.95)	2.31	0.57 (0.21-0.79)
505-R	1.06	0.87 (0.55-0.97)	2.02	0.59 (0.25-0.80)

CMJ = countermovement jump; SLCMJ = single leg countermovement jump; L = left; R = right; BJ = broad jump; SLBJ = single leg broad jump; RSI = reactive strength index; SLRSI = single leg reactive strength index; m = metres.

Table 4. Mean ± standard deviations data for the *bilateral training group*, with accompanying effect sizes (95% confidence intervals) and percentage changes between pre to post-intervention.

Fitness Test	Mean ± Standard Deviation		Effect Size (95% CI)	Percentage Change
	Pre-intervention	*Post-intervention*		
1RM Back Squat (kg)	113.75 ± 28.85	143.33 ± 15.93*	1.27 (0.39 to 2.15)	26.01
1RM RFESS (kg)	81.96 ± 12.15	101.08 ± 11.12*	1.64 (0.72 to 2.57)	23.34
CMJ (cm)	56.37 ± 5.14	58.13 ± 4.50	0.36 (-0.44 to 1.17)	3.12
SLCMJ-L (cm)	35.73 ± 5.70	38.46 ± 2.33	0.63 (-0.19 to 1.45)	7.62
SLCMJ-R (cm)	34.89 ± 4.08	36.11 ± 1.76	0.39 (-0.42 to 1.20)	3.49
BJ (cm)	224.67 ± 14.20	236.17 ± 16.10*	0.76 (-0.07 to 1.59)	5.12
SLBJ-L (cm)	197.00 ± 17.59	203.58 ± 10.45	0.45 (-0.36 to 1.27)	3.34
SLBJ-R (cm)	192.92 ± 15.66	202.58 ± 8.32	0.77 (-0.06 to 1.60)	5.01
RSI	2.67 ± 0.45	2.76 ± 0.39	0.21 (-0.59 to 1.02)	3.53
SLRSI-L	1.16 ± 0.09	1.23 ± 0.11	0.70 (-0.13 to 1.52)	5.74
SLRSI-R	1.18 ± 0.20	1.19 ± 0.21	0.05 (-0.75 to 0.85)	0.70
10m (s)	1.71 ± 0.06	1.64 ± 0.06*	-1.17 (0.30 to 2.03)	4.29
30m (s)	4.09 ± 0.10	4.01 ± 0.08*	-0.88 (0.05 to 1.72)	2.10
505-L (s)	2.34 ± 0.07	2.33 ± 0.07	-0.14 (-0.66 to 0.94)	0.36
505-R (s)	2.33 ± 0.06	2.32 ± 0.09	-0.13 (-0.67 to 0.94)	0.61
CODD-L (s)	0.63 ± 0.08	0.70 ± 0.08*	-0.87 (-1.71 to -0.04)	10.30
CODD-R (s)	0.62 ± 0.08	0.68 ± 0.10	-0.66 (-1.48 to 0.16)	9.52

* significantly different to pre-intervention ($p < 0.05$).

CI = confidence intervals; RFESS = rear foot elevated split squat; kg = kilograms; CMJ = countermovement jump; SLCMJ = single leg countermovement jump; L = left; R = right; cm = centimetres; BJ = broad jump; SLBJ = single leg broad jump; RSI = reactive strength index; SLRSI = single leg reactive strength index; m = metres; s = seconds.

Table 5. Mean ± standard deviations data for the *unilateral training group*, with accompanying effect sizes (95% confidence intervals) and percentage changes between pre to post-intervention.

Fitness Test	Mean ± Standard Deviation		Effect Size (95% CI)	Percentage Change
	Pre-intervention	*Post-intervention*		
1RM Back Squat (kg)	136.82 ± 24.11	149.55 ± 21.62	0.56 (-0.30 to 1.41)	9.30
1RM RFESS (kg)	100.77 ± 22.57	134.42 ± 25.17*	1.40 (0.47 to 2.34)	33.29
CMJ (cm)	60.79 ± 8.30	61.78 ± 7.81	0.12 (-0.71 to 0.96)	1.63
SLCMJ-L (cm)	33.53 ± 4.52	36.83 ± 4.18*	0.76 (-0.11 to 1.62)	9.84
SLCMJ-R (cm)	35.48 ± 5.12	37.87 ± 3.54	0.54 (-0.31 to 1.39)	6.74
BJ (cm)	243.64 ± 19.96	249.64 ± 19.07	0.31 (-0.53 to 1.15)	2.46
SLBJ-L (cm)	198.73 ± 11.39	211.64 ± 15.08*	0.97 (0.08 to 1.85)	6.50
SLBJ-R (cm)	199.64 ± 23.05	212.09 ± 20.97	0.57 (-0.29 to 1.42)	6.24
RSI	2.42 ± 0.37	2.54 ± 0.41	0.31 (-0.53 to 1.15)	4.84
SLRSI-L	1.04 ± 0.12	1.15 ± 0.17	0.75 (-0.12 to 1.61)	10.11
SLRSI-R	1.16 ± 0.12	1.14 ± 0.18	-0.13 (-0.97 to 0.71)	-1.49
10m (s)	1.70 ± 0.06	1.61 ± 0.06*	-1.50 (-2.49 to -0.51)	5.20
30m (s)	4.01 ± 0.08	3.94 ± 0.11	-0.73 (-1.63 to 0.18)	1.81
505-L (s)	2.34 ± 0.07	2.30 ± 0.07	-0.57 (-0.28 to 1.42)	1.52
505-R (s)	2.34 ± 0.09	2.27 ± 0.09*	-0.78 (-0.09 to 1.64)	2.80
CODD-L (s)	0.64 ± 0.09	0.69 ± 0.11	0.50 (-0.35 to 1.35)	8.22
CODD-R (s)	0.64 ± 0.11	0.67 ± 0.12	0.26 (-0.58 to 1.10)	3.53

* significantly different to pre-intervention ($p < 0.05$).

CI = confidence intervals; RFESS = rear foot elevated split squat; kg = kilograms; CMJ = countermovement jump; SLCMJ = single leg countermovement jump; L = left; R = right; cm = centimetres; BJ = broad jump; SLBJ = single leg broad jump; RSI = reactive strength index; SLRSI = single leg reactive strength index; m = metres; s = seconds.

Figure 1. Standardised mean differences comparing the effectiveness of bilateral vs. unilateral training interventions.