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The Effects of Unilateral Resistance Training on Muscular Strength, Power, and Measures of Core Stability in Resistance Trained Individuals

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ABSTRACT

Purpose: To examine the effects of unilateral resistance training on lower body power, muscular strength, and measures of core stability in resistance-trained college students. Methods: Participants (*N*=22; mean age= 19.9 ± 0.9 years) underwent 10 sessions of either unilateral (UL) or bilateral (BL) resistance training on three non-consecutive days per week for three weeks. Pre and post training outcome measures included one repetition maximum (1-RM) leg press for lower body strength, standing vertical jump (VJ) for lower body power, and double leg lowering (DLL), hip abduction isometric strength (HAIS), and Sorensen (SOR) tests for core stability. Results: There was a significant ($p \leq 0.05$) main effect of time across all variables, such that both groups improved scores on 1-RM leg press, VJ, DLL, HAIS, and SOR. Additionally, the magnitude of improvement (Cohen's *d*) was larger in UL for all variables except VJ, which was larger in the BL group. Conclusion: This study adds to the growing body of literature investigating the effects of UL resistance training in athletic populations. Similar improvements following UL or BL resistance training suggest that both methods can effectively enhance strength, power, and core stability. UL training may potentially yield greater improvement of core stability variables.

Keywords: resistance training, unilateral, core stability, maximal strength

INTRODUCTION

Resistance training (RT) is well established as a potent stimulus to enhance muscular strength and power, which are critical to athletic performance (1-3). Muscular strength (i.e., the maximal force voluntarily produced by a muscle) is primarily determined by fiber cross sectional area, motor unit recruitment, and fiber type distribution (4). Improvements in strength are most effectively obtained through RT at relative intensities ≥80% of one repetition maximum (1-RM) in sets of 1-6 repetitions (4). Muscular power, defined as the amount of work performed per unit of time (1), is associated with maximal strength but further depends on the rate of force development, which can be augmented through lighter workloads (30-60% 1-RM) emphasizing high velocity in the concentric phase of the exercise (5). Muscular strength and power have been identified as important performance determinants in high intensity and/or intermittent sports such as rugby, wrestling, basketball, soccer, and lacrosse (6-12). Furthermore, training derived improvements in both strength and power have been shown to enhance the performance of various sport-related movements such as sprinting (13), jumping (5), and changing direction (14-15). A sport-specific RT program is therefore crucial to optimize performance in high intensity and/or intermittent sports.

Bilateral resistance training (BL), which utilizes both sides of the body as prime movers in exercises such as the squat, deadlift, and bench press, are central to athletic RT programs (16). The bilateral nature and large muscle mass recruited in these exercises allow the use of heavy absolute loads to elicit high relative intensities (i.e., > 85% 1-RM). Compound (i.e., multi-joint) BL movements are advantageous over isolated, single joint lifts as they have larger gross motor unit recruitment (17-18) and utilize different muscle groups simultaneously, producing acute hormonal responses associated with increased strength (19-20). In contrast to BL, unilateral resistance training (UL) isolates one side of the body (17). Examples of UL resistance exercises include the Bulgarian split squat, single leg Romanian deadlift, and single arm dumbbell press. Due to a decreased base of support and smaller active muscle mass in unilateral exercises, less absolute weight is moved relative to BL to elicit a similar relative intensity (25). Still, this modality appears to elicit a similar acute response of anabolic hormones (19,20) and has previously conferred comparable strength gains (21-26) to BL, albeit in untrained populations. In addition to the potential to produce similar strength improvement to BL, UL may promote unique neuromuscular adaptations typically not obtained through BL alone (25). Training unilaterally has been observed to elicit strength enhancement or retention contralateral to the loaded limb, a neurological phenomenon known as cross education (27,28). This may act as a mechanism by which UL exercises can improve the bilateral deficit, characterized by a strength imbalance between opposing limbs in which the summed force output from both limbs unilaterally is greater than the force exerted bilaterally for a particular exercise (25,29). Additionally, UL appears to positively affect postural stability as well as overall balance and balance asymmetries (30-31). The decreased base of support during UL exercises imposes a greater demand for postural stabilization, which has been associated with greater activation of the core musculature (32,33), anatomically comprising muscles of the hip (e.g., hip abductors) as well as the deep and superficial muscles of the trunk (e.g., trunk flexors and extensors). Electromyographic analyses comparing UL to BL exercises demonstrate greater neural recruitment of core musculature during UL exercises (32-33), which is hypothesized to resist perturbation that would otherwise disrupt posture and to induce stability of the hips and trunk to enable energy transfer throughout the kinetic chain (34).

While considerable research is available on UL training in untrained populations (20-23,26,27,30-33), relatively few studies have involved athletes or resistance trained individuals, or have empirically examined strength, power, or measures of core stability as primary outcomes following UL. However, several potential benefits warrant further investigation of this training modality in athletic/trained individuals. Because UL inherently involves a lower absolute workload than BL while maintaining relative intensity (24) and reducing spinal loading forces (37,38), it may pose a lower risk of acute musculoskeletal injury and/or overtraining. Furthermore, the increased acute activation of core musculature during UL (30,31) could potentially provide athletic benefit if it results in superior strengthening of core musculature compared to BL. Core strength has been positively associated with performance of athletic activities including sprinting, compound lifting, tackling, wrestling take downs, and throwing (2, 39-42). It has also been observed that strengthening the muscles of the core complex can prolong the onset of fatigue and may reducing the likelihood of developing injuries which are likely to occur during athletic training/competition (43).

While these potential benefits could be attractive to athletes and coaches, a dearth of empirical evidence exists to warrant the recommendation of UL to athletic populations or habitual resistance trained participants. Furthermore, the potential of UL to engender comparable strength gains to BL has been insufficiently examined in athletes and resistance trained individuals. It is therefore unclear if the lower absolute workloads inherent to UL would have a lower impact on maximal strength and thus preclude its adoption as an integral component of RT programs for athletes in strength and power-based sports. Additionally, the unique neuromuscular adaptations and higher acute activation of core musculature during UL, in combination with its demand of a lower absolute workload at a given relative intensity, may pose a potential avenue for athletic/trained individuals to enhance muscular performance with lower injury risk. The purpose of this study was therefore to empirically investigate the effects of unilateral versus bilateral resistance training on muscular strength, power, and measurements of core stability in resistance trained individuals. It was hypothesized that trained participants undergoing a three-week UL exercise intervention would experience similar lower body strength gains and greater improvements in measures of core stability compared to those following a volume matched BL program.

METHODS

Study Design

This study used a mixed repeated measures design, with training condition/group serving as the between-subjects variable and time serving as the within-subjects variable. Twenty-three (N=23) university students (16 male, 7 female) were invited to participate in this three-week randomized controlled trial. Participants underwent baseline testing, an exercise intervention consisting of 10 resistance training sessions of either unilateral or bilateral closed chain exercises, and post-treatment testing. Measures taken at baseline and post-treatment consisted of anthropometrics and measures of lower body strength, power, and core stability.

Participants

Participants (N=23, 19.9±0.9 yr, 176.2±8.4 cm, 77.8±12.8 kg) were recruited from intercollegiate and club sport teams in Louisville, Kentucky using flyers and in-person meetings. To be included in the study, participants were required to fulfill the following criteria: resistance trained status (performing RT ≥3 d·wk^{-1} for ≥6 months), able to complete prescribed exercises with proper technique (4), and free of musculoskeletal injury for the past 6 months. Participants were excluded from the study if they missed >1 training session, reported the use of anabolic steroids and/or substances known to alter physical performance, performed RT outside of the study, or sustained a musculoskeletal injury preventing completion of the assigned exercises. Prior to any data collection and after being informed of the procedures and potential risks and benefits of participation, all participants provided written informed consent. All procedures were approved by the institutional review board of the university. Out of 23 initial participants, one was excluded due to not meeting inclusion criteria (training status), leaving *N*=22 to be included in the final analysis. Participant characteristics are presented in Table 1.

Procedures

Baseline Session/Initial Visits

Participants were asked to abstain from alcohol, caffeine, and RT 24 hours prior to testing. In addition, they were also instructed to keep a 24-hour dietary log the day before testing, to be submitted to the principal investigator. Participants visited the lab wearing athletic clothing to have their height, weight, body composition (via seven-site skin fold estimation equations), and thigh girth measured. After anthropometric measures were recorded, participants were instructed to exercise on a treadmill (Woodway Mercury, Waukesha, Wisconsin) for five minutes at a self-selected speed eliciting a rating of 11-13 on the Borg RPE Scale (46), which was recorded and used as a warm-up for subsequent training sessions. In the following order, they then completed a 1 repetition maximum (1-RM) leg press as an assessment of lower body strength (44), a vertical jump (VJ) to assess lower body power (44), and tests of double leg lowering (DLL), hip abductor isometric strength (HAIS), and the Sorensen test (SOR) as measures of core stability (45). Following baseline testing, participants were randomized into either a BL or UL conditional group using an online randomization tool (random.org).

Training Phase

Participants in the BL group were assigned back squats, conventional deadlifts, and weighted jump squats, whereas those in the UL group were prescribed exercises that served as unilateral counterparts: Bulgarian split squats, single leg Romanian deadlifts, and single leg weighted jump squats, respectively. These exercises targeted lower body strength with emphases on developing

Table 1. Participant Characteristics

	Unilateral (n=10)	Bilateral (n=12)	Total (n=22)
Age (yr)	19.9 ± 0.9	19.8 ± 0.8	19.8 ± 0.8
Height (cm)	176.2 ± 8.4	171.1 ± 8.7	173.4 ± 8.8
Weight (kg)	77.8 ± 12.8	74.0 ± 16.8	75.8 ± 14.8

Values are reported as means ± SD, *N*=22 the anterior kinetic chain (back squat/Bulgarian split squat) or posterior kinetic chain (conventional deadlift/single leg Romanian deadlift) (47). Trained research staff supervised exercise to ensure proper technique, in accordance with the guidelines of the National Strength and Conditioning Association (NSCA) (4).

The training phase of the study took place over a 22-day time span consisting of 10 sessions. The purpose of the first training session was to obtain 1-RM loads for the prescribed exercises. Each of the subsequent nine sessions (3 non-consecutive sessions per week for 3 consecutive weeks) consisted of 3 sets of 5 repetitions of each exercise at 80% of the measured 1-RM value, with 2 minutes recovery between sets. Each training session lasted approximately one hour and began with a standardized warm up of 5 minutes of treadmill exercise at the same speed performed prior to baseline testing, followed by the prescribed resistance exercises. If a participant failed to complete a set or maintain proper form, the load was decreased by 5%, and rounded down to the lower increment of 2.2 kg. The originally prescribed weight was resumed in the following session.

Immediately following each training session, participants were provided a beverage containing 500 mL water and 30g whey protein (Nutricost Whey Protein Concentrate, Pleasant Grove, Utah) (48). Consumption was verified before each participant departed the training site. Participants were otherwise instructed to abstain from any dietary supplementation not provided by the study, and to continue their normal dietary habits.

Post-Training Testing

Dietary logs collected prior to baseline testing were returned to the participants after their last training session with instructions to replicate the diet 24 hours prior to post treatment testing. Post-training testing sessions occurred 3-5 days after the completion of the final training session, and were scheduled within two hours of the time of the baseline testing appointment. Post-training measurements and procedures mirrored those at baseline.

Measures

Anthropometrics: Weight, Height, Body Composition, Thigh Circumference

Height and weight were measured with a stadiometer and calibrated balance beam scale (Seca, Chino, CA). Skinfold thickness was evaluated at seven standardized sites using Lange skinfold calipers (Beta Technology, Santa Cruz, CA). Thigh circumference was assessed at the midsection of the thigh, which was identified as half the distance between the greater trochanter and lateral femoral epicondyle. The same researcher administered all anthropometric measurements at baseline and post training.

Lower Body Power: Vertical Jump

The participants were instructed on the proper execution of the vertical jump (VJ) to ensure consistency between attempts. Participants initiated a countermovement to induce stretch-shortening contraction via close-chained flexion of the hips and knees, followed by whole body extension, and jumping to tap and move the highest possible vane on the Vertec© measurement device (Tandem Sports Vertical Challenger, Louisville, Kentucky) with the dominant hand. The Vertec© system was calibrated so that the lowest vane articulated the participant's distal tip of the third digit (i.e. middle finger) when standing directly underneath. The participants were allotted 1-3 practice attempts followed by three maximal effort attempts, with 2-3 minutes passive standing recovery in between. The highest height in centimeters (cm) was reported as the vertical jump score.

Lower Body Strength: 1-RM Leg Press.

The participants were continuously monitored and verbally cued as necessary to ensure proper leg press technique according to NSCA criteria (4). Three warm-up sets were allotted on the leg press (Hoist CF-3355, Cottage Grove, WI), at 50% predicted 1-RM for 8-12 repetitions, 75% 1-RM for 4-8 repetitions, and 90% 1-RM for 1-3 repetitions respectively. Participants then performed up to five single repetition attempts at increasing loads until failure, separated by three minutes rest. The highest successful weight (kg) was reported as the 1-RM.

Hip Abduction Strength: Hip Abduction Isometric Strength

Participants lay on one side on a treatment table with their position secured using nylon straps above the iliac crest and 2-3 inches above the lateral knee joint. A Microfet II Handheld Dynamometer (Hoggan Health Industries, West Jordan, Utah) was used to measure force as participants maximally abducted the superior leg against the dynamometer for 5 seconds. Participants were allowed three attempts, each separated by 15 seconds of passive recovery. The highest force output (kg) achieved out of three attempts was reported as hip abduction isometric strength (HAIS) (49).

Anterior Core Testing: Double Leg Lowering

Participants lay supine on a treatment table while a researcher used one hand to palpate the spinous processes of the L4 and L5 vertebrae and used the contralateral forearm to support the distal legs at test completion. To perform double leg lowering (DLL), a researcher passively lifted the participant's legs to 90 degrees hip flexion with the knees extended. Participants were then instructed to contract the lower abdominal musculature and compress the lumbar spine against the table while actively lowering the legs with knee extension maintained. The test was stopped when pressure from the participant's lower back decreased significantly from the primary investigator's hand, after which the participant was instructed to relax their legs to rest on the tester's forearm. The hip angle (degrees) was then obtained via goniometer (Blue Jay, Windham, New Hampshire). As in HAIS, the highest value achieved out of three attempts, each separated by 15 seconds, was reported as a value of anterior core strength (50).

Posterior Core Testing: Sorensen Test

Participants lay prone on a treatment table with the torso off the table from the point of the anterior superior iliac spine. The participant's legs were anchored to the table by nylon straps. Participants were instructed to contract their hip and back extensors to keep their chest above the plane of the table. This position was maintained as long as possible without dropping the chest below the plane of the table, at which point the test was concluded and the elapsed time (seconds) was recorded as a measure of posterior core strength (51).

Statistical Analysis

All data analyses were performed using SPSS Version 22 (SPSS, Chicago, IL), with statistical significance accepted at $p<0.05$. Data were first checked for missing items, outliers, and errors. Independent-samples t tests were then conducted to compare participant characteristics and baseline performance between groups. Main and interaction effects were examined using a 2 condition (unilateral vs. bilateral) by 2 time (pre, post training) repeated measures analysis of variance (ANOVA) for each outcome measure. Partial eta-squared (η_p^2) was used to quantify effect sizes for main and interaction effects. Small, moderate, and large effects were determined by η_p^2 values of= .01, .06, and .14, respectively (52). When detected by ANOVA, significant main or interaction effects were further analyzed using post hoc *t*-tests. Effect sizes (i.e., Cohen's *d*) were calculated for t-tests to further examine the magnitude of changes over time within each training condition. Effect sizes were classified as either small (d=0.2), moderate (d= 0.5), or large (d=0.8) (53).

RESULTS

Baseline characteristics did not significantly differ between groups, with the exception of his abduction isometric strength (HAIS), which was higher (p=0.016) in UL (34.4±16.0 kg) than BL (25.6±7.3 kg). Significant main effects of time ($p\leq0.03$) occurred in each outcome variable, indicating improvements across the study sample, whereas no significant interaction effects were observed ($p\geq0.10$). Participants in both groups demonstrated improvements in leg press 1-RM (Cohen's d=0.86 UL, 0.61 BL), DLL (Cohen's d=0.92 UL, 0.55 BL), SOR (Cohen's d=0.90 UL, 0.36 BL) VJ (Cohen's d=0.23 UL, 0.57 BL). When comparing effect sizes between groups, UL exhibited larger magnitudes of change compared to the BL condition, with the exception of improvements in the VJ, in which the effect size was greater in BL. Statistical values for all main and interaction effects are presented in Table 2. Mean values of the primary outcome variables and their associated effect sizes, by total sample and per condition, are reported in Table 3.

Table 2. Time + Interaction Effects for Primary Outcomes

Variables	Time Effects				Time x Group Effects		
	M^{α}	$F_{1,20}$	*P*	η_p^2	$F_{1,20}$	*P*	η_p^2
Vert Jump (cm)	59.4	8.349	0.009	0.295	2.365	0.140	0.106
Leg Press (kg)	337.27	81.982	0.000	0.804	2.869	0.106	0.125
DLL (degrees)	39.20	9.752	0.005	0.328	1.604	0.220	0.074
HAIS	31.55	5.604	0.028	0.219	1.817	0.193	0.083
Sorenson	101.98	17.404	0.001	0.478	2.290	0.147	0.108

α, Estimated marginal means; η_p^2, partial eta-squared

Table 3. Descriptive Statistics + Effect Sizes of Study Variables

Variable	Baseline M (SD)	Follow Up M (SD)	Cohen's *d*
	VJ (cm)		
-UL	60.96 (10.24)	63.50 (11.35)	0.23
-BL	52.71 (17.58)	61.04 (10.77)	0.57
-Total	56.46 (14.99)	62.15 (10.85)	0.62
	1 RM Leg Press (kg)		
-UL	315.91 (92.52)	407.72(119.01)	0.86
-BL	281.82 (99.11)	356.97 (107.00)	0.61
-Total	297.31 (95.47)	373.35 (114.45)	1.02
	DLL (degrees)		
-UL	37.8 (17.00)	51.85 (13.27)	0.92
-BL	30.75 (12.71)	36.69 (8.68)	0.55
-Total	33.95 (14.88)	43.58 (13.21)	0.97
	HAIS (kg)		
-UL	34.45 (8.43)	39.38 (6.88)	0.64
-BL	25.59 (7.28)	26.94 (8.85)	0.19
-Total	29.61 (8.86)	32.60 (10.08)	0.44
	Sorenson (seconds)		
-UL	88.2 (23.92)	115.3 (35.20)	0.90
-BL	94.13 (40.02)	108.55 (40.22)	0.36
-Total	91.44 (33.06)	111.76 (367.13)	0.82

Values are reported as means ± SD, *N*=22

DISCUSSION

The results of the present study add to the small pool of empirical data available in trained individuals on the neuromuscular adaptations following unilateral resistance training. The present study empirically investigated the effects of a three-week UL intervention, versus a corresponding BL program, on lower body power, muscular strength, and measurements of core stability in resistance trained individuals. We hypothesized similar strength increases between groups, but greater enhancement of core stability in UL. In support of our hypotheses, a three-week UL intervention yielded similar improvements in lower body strength and power relative to a BL program of equal volume (i.e., sets x repetitions). Furthermore, UL produced a greater magnitude of change in in HAIS, a measure of the isometric force output of the hip abductors, and DLL and SOR; measures of anterior and posterior core stability, in comparison to BL. By contrast, the BL group demonstrated a greater magnitude of change in lower body power. Together these results suggest that UL may offer an RT modality for athletes which can elicit similar lower body strength gains to BL, while requiring comparatively lighter absolute loads and potentially offering the benefit of enhanced core stability.

Multiple studies have observed that UL elicits similar strength gains to BL in untrained individuals (21-26). However, little research on strength development following UL has been available in trained/athletic populations. Athletes in power/strength sports rely on maximal force development for the performance of sport specific tasks such as jumping, running, sprinting, and changing direction (3). Thus, any potential attenuation of strength development due to a lower absolute load utilized during UL could impair athletic performance and therefore preclude the use of UL as the main component of athletic strength and conditioning programs. Prior to the present investigation, Speirs et al. (35) presented evidence that UL can offer similar strength gains to BL in resistance trained rugby players. Exposure to five weeks of linearly progressed Bulgarian split squats or bilateral back squats twice weekly produced similar increases in back squat and Bulgarian split squat 1-RM, 40-m and 10-m sprint times, and agility (35). A more recent study conducted by Appleby et al. (54) likewise examined resistance trained rugby players who performed either the bilateral back squat or unilateral step up over an 8-wk training period, finding similar strength increases in both exercises between conditions. A greater effect size also occurred in step up strength following UL, while the effect size in bilateral squat strength was similar between conditions (54). In the current study, participants who underwent either three weeks of UL or BL obtained statistically similar increases in maximal lower body strength, as measured by leg press 1-RM. Furthermore, UL participants showed a larger magnitude of change in 1-RM leg press (Cohen's d = 0.86 UL, 0.61 BL) despite moving lower absolute loads. The present findings concur with these studies (35,54), suggesting that like untrained counterparts, resistance trained individuals may be able to utilize UL to obtain improvements in lower body strength comparable to those following BL. This agreement occurred despite the shorter timeframe of our intervention (three weeks) relative to the 5-8 wk duration of previous interventions (35,54). The present study therefore adds the novel finding that similar strength development between UL and BL can occur as early as three weeks, even in athletic/resistance trained individuals. Together, these studies collectively lend support to the implementation of UL in this population without sacrificing the lower body strength gains attainable through BL.

In addition to the ability of UL to increase lower body strength with a lower absolute weight relative to BL, this modality has been hypothesized to confer greater stimulation of "core" muscles which maintain multiplanar whole-body stability and resist perturbation to the lumbopelvic region of the body (34,45). Development of core stability is imperative for athletes due to its contribution to a wide variety of sport-specific movements (2) and its potential to lessen musculoskeletal injury risk (55). By contrast, core stability deficits have been implicated in greater musculoskeletal injury risk (45). Multiple studies have demonstrated greater EMG activity during UL relative to BL in core musculature, particularly the gluteus medius, a primary hip abductor (32,33). Novel empirical data from the current study appear to reflect the greater stimulus UL imposes on core musculature as UL participants exhibited a larger effect size for the improvement in HAIS, DLL, and SOR. As such, UL may potentially enhance core stability more effectively than BL, which could have meaningful implications in in athletic injury prevention. However, our study did not assess the occurrence of musculoskeletal injury following the training intervention, precluding our ability to infer upon this possibility. Continuing experimental research will therefore be necessary to determine if chronic unilateral training can provide a meaningful reduction in the prevalence of musculoskeletal injury in trained/athletic populations.

Contrasting the greater magnitude of change in bilateral strength, HAIS, DLL, and SOR following UL, BL participants displayed a larger effect size for improvement in lower body power, as measured through the bilateral vertical jump (VJ). Power is a recognized performance determinant across multiple sports, but especially in those such as rugby, lacrosse, and wrestling which require power during take downs, tackling, and checking. Although a smaller effect on lower body power following UL could warrant concern, VJ performance cannot be generalized to represent power in all sport specific movements. While bilateral power production is crucial in specific instances such as spiking a volleyball, numerous power dependent movements such as sprinting, changing direction, or unilateral jumping (e.g., a basketball layup) are performed unilaterally. McCurdy et al. (17) previously compared the effect of UL versus BL RT on lower body power during both UL and BL jump performance. Untrained participants completing eight-weeks of plyometric training plus either UL or BL RT improved similarly in the bilateral VJ, while UL participants showed greater improvement in the unilateral VJ (17). Gonzallo and colleagues (56) compared the effects of combining plyometric training with UL versus BL RT on performance measures in basketball players, and showed greater improvements in single-leg power output and agility following UL. Therefore, although BL produced a larger effect size for bilateral lower body power in the current study, previous research suggests that this finding unlikely represents a universal UL effect on total lower body power. Additional research is necessary to elucidate if UL training sacrifices maximal enhancement of bilateral power in trained individuals.

Several limitations are to be noted while interpreting the results of this study. Compared to previous empirical studies on UL resistance training in trained subjects, our sample size of 22 participants was smaller than the n=38 investigated by McCurdy et. al (23) but comparable to the n=18 of Spiers et al. (38). Although our 3-week intervention was shorter than those of McCurdy et al. (23) and Spiers et al. (38), which lasted 8 and 5 weeks, respectively, our participants' thrice weekly training frequency cumulatively resulted in a single session less than the latter study. While the current findings add to the literature regarding the short term (i.e., ≤ 8 weeks) effects of UL on strength, power, and measures of core stability, future studies should implement longer interventions to observe potential longer term adaptations to UL in trained individuals. While participants were restricted from engaging in RT outside the intervention, athlete participants (rugby, volleyball, and soccer) were permitted to continue their customary sport activities (e.g., weekly practices and games). Ongoing investigations will achieve greater internal validity if they are able to obtain access to participants with more homogenous training status and/or to impose greater control over participants' overall conditioning regimen. Daily nutrition was not controlled, but participants consumed a standard 30g protein supplement following each session (48) and replicated their diet 24-hr preceding pre and post testing. Lastly, while our intervention longitudinally compared unilateral versus bilateral training, maximal strength and power were only tested bilaterally to reduce the burden of pre and post training testing on our participants. However, this limited our ability to detect between group differences in the development of bilateral versus unilateral strength and power between the divergent training approaches. As such, ongoing experimental studies in trained populations should seek data elucidating the comparative development of maximal strength and power between unilateral and bilateral RT by testing these variables in both contexts at baseline and post training.

CONCLUSION AND APPLICATIONS

The current study compared the effects of unilateral versus bilateral RT on lower body muscular strength, power, and measures of core stability in trained individuals. Both modalities produced statistically similar enhancement of maximal bilateral strength and power, as well as multiple measures of core stability. However, UL produced a larger magnitude of effect in maximal lower body strength and each measure of core stability (isometric hip abduction, double leg lowering, Sorensen test), while BL showed a larger effect on lower body power. The current data support the use of UL by trained individuals as an effective alternative to develop lower body muscular strength with lower absolute loads than BL. Furthermore, UL may offer greater development of core stability than BL, but additional research is necessary to ascertain this effect. Strength and conditioning professionals may consider implementing lower body unilateral resistance training without risking attenuated strength development. Ongoing empirical research on the effects of UL in athletic populations is warranted to further elucidate the potential performance and injury preventive benefits of this RT modality.

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