

VARIABLE RESISTANCE TRAINING PROMOTES GREATER STRENGTH AND POWER ADAPTATIONS THAN TRADITIONAL RESISTANCE TRAINING IN ELITE YOUTH RUGBY LEAGUE PLAYERS

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ABSTRACT

Rivière, M, Louit, L, Strokosch, A, and Seitz, LB. Variable resistance training promotes greater strength and power adaptations than traditional resistance training in elite youth rugby league players. *J Strength Cond Res* 31(4): 947–955, 2017 –The purpose of this study was to examine the strength, velocity, and power adaptations in youth rugby league players in response to a variable resistance training (VRT) or traditional free-weight resistance training (TRAD) intervention. Sixteen elite youth players were assigned to a VRT or TRAD group and completed 2 weekly upper- and lower-body strength and power sessions for 6 weeks. Training programs were identical except that the VRT group trained the bench press exercise with 20% of the prescribed load coming from elastic bands. Bench press 1 repetition maximum (1RM) and bench press mean velocity and power at 35, 45, 65, 75, and 85% of 1RM were measured before and after the training intervention, and the magnitude of the changes was determined using effect sizes (ESs). The VRT group experienced larger increases in both absolute (ES = 0.46 vs. 0.20) and relative (ES = 0.41 vs. 0.19) bench press 1RM. Similar results were observed for mean velocity as well as both absolute and relative mean power at 35, 45, 65, 75, and 85% of 1RM. Furthermore, both groups experienced large gains in both velocity and power in the heavier loads but small improvements in the lighter loads. The improvements in both velocity and power against the heavier loads were larger for the VRT group, whereas smaller differences existed between the 2 groups in the lighter loads. Variable resistance training using elastic bands may offer a greater training stimulus than traditional free-weight

resistance training to improve upper-body strength, velocity, and power in elite youth rugby league players.

KEY WORDS elastic bands, bench press, velocity, force, accommodating resistance training

INTRODUCTION

Rugby league is a team collision sport that is intermittent in nature with frequent bouts of high-intensity activities (e.g., wrestling, tackling, and sprinting) separated by bouts of low intensity (e.g., jogging and walking) (8). Because of the nature of these activities, rugby league players require well-developed aerobic fitness, repeated sprint ability, speed, agility, muscular strength, and power to compete at the highest level (13). With respect to muscular strength and power, there is evidence to suggest that stronger and more powerful players are more likely to access higher divisions of play than their weaker counterparts (2). Furthermore, significant correlations between tackling ability and bench press strength ($r = 0.72$) and peak power during the plyometric push-up exercise ($r = 0.70$) have been reported in first-grade semi-professional rugby league players (23). Upper-body strength may also partially contribute to future career attainment as suggested by the large differences in absolute bench press strength observed between professional and academy rugby league players (24). Moreover, upper-body strength has also been shown to discriminate between selected and nonselected players, with players selected to compete in the first game of the season exhibiting higher relative bench press strength than the nonselected players (9). Finally, smaller increases in blood creatine kinase have been reported 24 hours postgame in subelite youth rugby league players displaying greater bench press strength, suggesting that a higher upper-body strength level is associated with reduced postgame fatigue (14). Collectively, these findings highlight the importance of developing high levels of upper-body strength and power in rugby league players.

A variety of resistance training methods are used in the strength and conditioning setting to improve muscular

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strength and power. One such method that is increasingly being used is variable resistance training (VRT), where elastic bands or chains are attached to both ends of a barbell to alter the kinematics of the lift (18). In any exercise with an ascending strength curve, a deceleration phase occurs toward the end of the concentric portion of the lift during which the muscles are not contracting optimally to accommodate the need for the weight to stop (7). Elastic bands can be used to provide a variable resistance that may enable the athlete overcome this deceleration phase and operate at near-maximal levels throughout a greater range of motion during the exercise, thus providing a greater loading and training stimulus. Examination of the scientific literature reveals that VRT may therefore offer a greater training stimulus than traditional free-weight resistance training (TRAD) to increase both strength and power. Anderson et al. (1) reported greater strength gains in 1 repetition maximum (1RM) bench press after 7 weeks of using VRT ($8.0\% \pm 6.7 \pm 3.4$ kg) when compared with using TRAD ($4.0\% \pm 3.3 \pm 2.7$ kg) in Division I-A athletes. Similarly, Joy et al. (16) demonstrated that VRT ($+7.7\%$) led to significantly greater improvements in 1RM bench press than TRAD ($+3.3\%$) after a 5-week intervention in Division II male basketball players. Additional support for the superiority of VRT has been provided by a recent meta-analysis including 7 studies and 235 individuals and reporting larger strength gains in the bench press exercise in VRT when compared with TRAD (weighted mean difference: 5.0 kg) (22). Although these studies suggest that VRT may improve upper-body strength to a greater extent than TRAD, no data are presently available comparing the respective effects of VRT and TRAD on upper-body power. Moreover, to the authors' knowledge, no attempt has been made to compare the upper-body strength and power adaptations between a VRT and TRAD in-season intervention in rugby players. This may have important

training implications for strength and conditioning coaches seeking to maximize the development of these 2 important physical qualities required for rugby players. Therefore, the purpose of this study was to examine the upper-body strength, velocity, and power adaptations in youth elite rugby league players in response to a 6-week in-season VRT or TRAD intervention. It was hypothesized that VRT would provide a superior training stimulus than TRAD and would therefore yield greater strength, velocity, and power adaptations.

METHODS

Experimental Approach to the Problem

Sixteen elite youth rugby league players volunteered for this study and were randomly allocated to either the variable resistance training group (VRT; $n = 8$; 1RM to body mass ratio = 1.2 ± 0.2 kg·kg⁻¹) or the traditional free-weight resistance training group (TRAD; $n = 8$; 1RM to body mass ratio = 1.3 ± 0.3 kg·kg⁻¹). Both groups completed 2 weekly upper- and lower-body sessions focusing on strength and power for 6 weeks during the competitive phase of the season. The training programs were identical except that the VRT group performed the bench press exercise with 20% of the prescribed load coming from elastic bands. To determine the effects of each training program, all players were tested for bench press 1RM as well as bench press mean velocity and mean power at different percentages (i.e., 35, 45, 65, 75, and 85% of 1RM) before and after their training intervention. They were familiarized with the testing procedures as they were part of their usual testing and lifting sessions. In addition to this investigation, all players took part in technical, tactical, and physical sessions including 4 hours of skill and tactical training, 1 hour of conditioning, and 30 minutes of injury prevention. A schematic representation of the study design is presented in Figure 1.

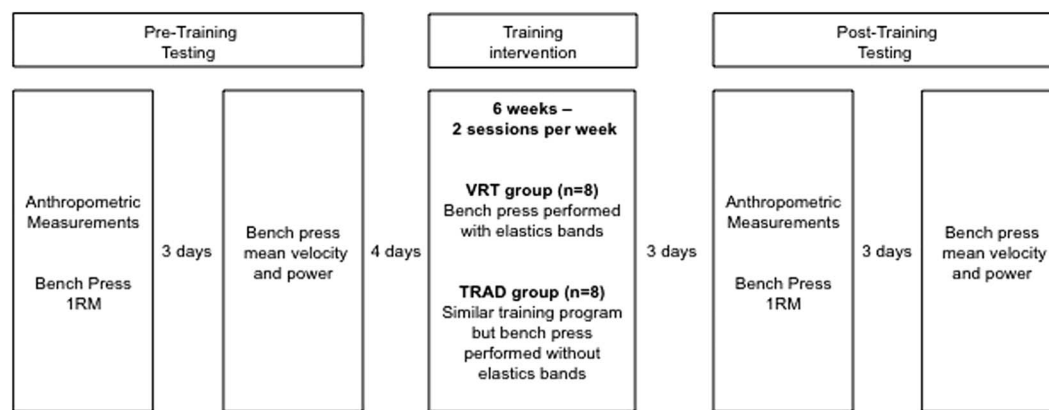


Figure 1. Schematic representation of the study design. 1RM = 1 repetition maximum; VRT = variable resistance training; TRAD = traditional.

Subjects

The participants were 16 elite youth rugby league players from the academy team of the Dragons Catalans rugby league club (age: 17.8 ± 0.9 years; height: 181.1 ± 8.3 cm; weight: 82.6 ± 10.9 kg; bench press 1RM: 100.6 ± 18.0 kg; bench press 1RM to body mass ratio: 1.2 ± 0.2 kg·kg⁻¹). Before participating in the training intervention, they were screened using medical history questionnaires and were excluded if they reported any recent musculoskeletal injuries. They were informed of the aims, benefits, risks, and procedures of the study. All players signed an informed

consent form, and all procedures in this investigation were conducted in accordance with the Declaration of Helsinki and approved by the Edith Cowan University Human Research Ethics Committee. All players under 18 years of age had written informed consent from a parent or guardian to participate in the study.

Testing Battery

Anthropometric Measurements. Body mass was measured using a calibrated Tanita scale (model BC-418MA, Tokyo, Japan). Before being weighed, the players were allowed to empty

TABLE 1. The 6-week training intervention.*†

Tuesday (strength)		Friday (power)	
	Sets × Reps @ %RM		Sets × Reps @ %RM
Week 1			
Bench press	3 × 4 @ 90	Snatch	6 × 2 @ 70
Clean		Bench press	
Supine chin-up		Pull up	
Front squat		Squat/CMJ‡	
Week 2			
Bench press	3 × 3 @ 85	Bench press	4 × 2 @ 75
Clean		Squat	
Military press		Supine chin-up	
Front squat		Step up	
		Bicep curls	
Week 3			
Bench press	3 × 2 @ 90	Bench press	3 × 2 @ 80
Squat		Clean	
Supine chin-up		Jerk	
Snatch force		CMJ	
Human plank			
OFF			
Week 4			
Bench press	3 × 4 @ 82	Bench press	6 × 2 @ 72
Deadlift		Bench row	
Military press		Squat	
Incline bench press		One arm rowing	
Hip thrust		Split squat	
High pull clean			
Week 5			
Bench press	3 × 3 @ 87	Bench press	4 × 2 @ 77
Deadlift		Bench row	
Military press		Squat	
Incline bench press		One arm rowing	
Hip thrust		Split squat	
High pull clean			
Week 6			
Bench press	3 × 2 @ 92	Bench press	3 × 2 @ 82
Front squat		Snatch	
Clean		Push press	
Supine chin-up		CMJ	

*RM = repetition maximum; CMJ = countermovement jump.

†Both groups completed the same training program except that the players in the variable resistance training group performed the bench press exercise with 20% of the prescribed load coming from elastic bands.

‡The 2 exercises were paired together with 10 s of rest in between.

their bladder and bowel if necessary. The height was measured using a calibrated Tanita stadiometer (model Leicester, Seca Ltd., Birmingham, United Kingdom). The intraclass correlation coefficient (ICC) for the body mass and height was 0.98 and 0.97, respectively.

One Repetition Maximum Bench Press Assessment. The bench press 1RM protocol was adapted from previous research (12). The players started with a standardized warm-up including wrist, elbow, and shoulder mobility drills for a total of 10 exercises and body weight push exercises including 8 push-ups, 6 clap push-ups, and 3 power push-ups. The players then performed a specific bench press warm-up consisting of 10 repetitions with a 20-kg unloaded bar and 6 repetitions at 40%, 4 repetitions at 60%, 2 repetitions at 80%, and 1 repetition at 90% of their estimated 1RM. One minute of recovery was given after the unloaded warm-up set, 2 minutes after the 40 and 60% sets, and 3 minutes after the 80% set. Three minutes after the final warm-up set, the players completed 1RM attempts, with 4 minutes of recovery between attempts, at increasing loads until they failed to complete a lift through. The last successful attempt was recorded as the player's 1RM. The loads were increased based on the player's perception of the previous attempt. Because all the participants were familiar with the bench press exercise, 3 attempts or fewer were required to determine their 1RM.

Bench Press Mean Velocity and Power Assessments. Bench press mean velocity and power were measured 3 days after the 1RM bench press assessment with an optical linear position transducer (GymAware; Kinetic Performance Technology, Canberra, Australia) that was attached to one extremity of the barbell. The players started with a warm-up including mobility drills and upper-body push movements as described in the 1RM bench press assessment. Mean velocity and power were then measured during 2 bench presses at 35 (ICC = 0.91), 45 (ICC = 0.93), 65 (ICC = 0.97), 75 (ICC = 0.96), and 85% (ICC = 0.94) 1RM. A 2-minute recovery period was given between each load. The highest mean velocity and power recorded at each load were considered for further analysis.

To ensure the correct technique during the bench press 1RM and maximal power assessments, the players were required to grasp the bar at a position slightly greater than shoulder width and maintain their feet flat on the floor and their head and trunk against the bench throughout the movement. The movement started with the arms fully extended over the chest; the barbell was then lowered until the bar touched the chest at the nipple level. One full repetition was completed when the participant returned the barbell to the fully extended arm position. The eccentric phase of the lift was performed at a controlled velocity (i.e., 2 seconds), whereas the concentric phase was executed at maximal intended velocity. No pauses were allowed at the bottom and top positions. The

players received verbal encouragement during each repetition to promote maximal effort.

Band Resistance Measurement. Two elastic bands (brand www.sci-sport.com) were looped over an unloaded standard Olympic bar (Eleiko, Halmstad, Sweden) and over a bench rack that was positioned on a force plate (model BP-4051040; AMTI, Newton, MA, USA). The players positioned themselves on the bench and the weight of the bench rack, barbell, and player was offset to ensure that only the resistance produced by the bands was measured. The players then unracked the bar and the resistance produced by the bands at both the top and bottom positions of the lift was measured. The bands were looped over the bar as many times as necessary to ensure that the average resistance across the entire range of motion was as close as possible as 20% of 1RM. The average resistance across the entire range of motion was $21.07 \pm 1.44\%$ of 1RM with the resistance representing 5.23 ± 0.21 and $36.91 \pm 2.34\%$ of 1RM at the bottom and top positions of the bench press, respectively.

Training Intervention

The 6-week training intervention took place during the competitive phase of the season with the first session on Tuesday, focusing on the development of strength, whereas power was the main focus of the second session on Friday. This configuration corresponds to a typical microcycle setup in professional rugby (10). The training program targeted both the upper- and lower-limb muscles with a primary focus on free-weight compound exercises that were supplemented with assistance exercises (Table 1). Within each session, the exercises typically progressed from compound exercises to assistance exercises. The VRT and TRAD groups performed the same training program (i.e., similar exercises, intensity, and volume as well as rest between sets and exercises); however, the bench press was executed with elastic bands in the VRT group. The bench press technique

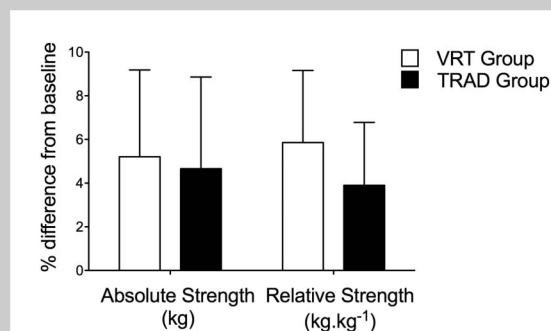


Figure 2. Percentage change in bench press absolute and relative strength after the training intervention. VRT = variable resistance training; TRAD = traditional.

TABLE 2. Bench press absolute and relative mean power, mean velocity before and after the training intervention, and corresponding changes for both the VRT and TRAD groups.*

	VRT				TRAD			
	Before	After	% changes	ES	Before	After	% changes	ES
Mean Abs. Power at 35% 1RM (W)	439 ± 74	462 ± 81	4.95 ± 4.96	0.27	466 ± 94	484 ± 141	2.70 ± 8.87	0.14
Mean Abs. Power at 45% 1RM (W)	514 ± 73	540 ± 76	4.99 ± 1.94	0.32	526 ± 106	539 ± 114	2.12 ± 3.42	0.10
Mean Abs. Power at 65% 1RM (W)	510 ± 94	547 ± 108	7.04 ± 4.03	0.34	539 ± 118	554 ± 107	3.39 ± 6.91	0.13
Mean Abs. Power at 75% 1RM (W)	472 ± 61	521 ± 76	10.26 ± 6.99	0.67	487 ± 128	505 ± 113	4.58 ± 10.41	0.14
Mean Abs. Power at 85% 1RM (W)	378 ± 95	444 ± 103	18.09 ± 9.08	0.62	393 ± 123	411 ± 85	10.41 ± 18.06	0.16
Mean Rel. Power at 35% 1RM (W·kg ⁻¹)	5.30 ± 0.64	5.60 ± 0.85	5.66 ± 6.00	0.42	5.61 ± 0.91	5.78 ± 1.42	2.01 ± 9.20	0.13
Mean Rel. Power at 45% 1RM (W·kg ⁻¹)	6.24 ± 0.76	6.60 ± 0.85	5.68 ± 2.74	0.42	6.36 ± 1.13	6.45 ± 1.14	1.38 ± 2.28	0.07
Mean Rel. Power at 65% 1RM (W·kg ⁻¹)	6.14 ± 0.76	6.61 ± 0.89	7.69 ± 3.02	0.55	6.48 ± 1.11	6.63 ± 1.01	2.61 ± 5.69	0.13
Mean Rel. Power at 75% 1RM (W·kg ⁻¹)	5.73 ± 0.64	6.36 ± 0.80	10.97 ± 7.25	0.81	5.84 ± 1.13	6.01 ± 0.93	3.75 ± 8.83	0.16
Mean Rel. Power at 78% 1RM (W·kg ⁻¹)	4.60 ± 1.12	5.42 ± 1.24	18.92 ± 10.26	0.66	4.67 ± 1.11	4.90 ± 0.75	7.32 ± 16.57	0.23
Mean Velocity at 35% 1RM (m·s ⁻¹)	1.38 ± 0.17	1.40 ± 0.17	1.77 ± 1.65	0.13	1.32 ± 0.12	1.35 ± 0.16	2.47 ± 8.32	0.21
Mean Velocity at 45% 1RM (m·s ⁻¹)	1.22 ± 0.12	1.28 ± 0.13	5.02 ± 1.79	0.48	1.17 ± 0.05	1.19 ± 0.07	2.12 ± 3.42	0.40
Mean Velocity at 65% 1RM (m·s ⁻¹)	0.85 ± 0.10	0.91 ± 0.11	6.94 ± 4.06	0.54	0.82 ± 0.08	0.85 ± 0.08	3.97 ± 6.18	0.36
Mean Velocity at 75% 1RM (m·s ⁻¹)	0.69 ± 0.03	0.76 ± 0.06	10.16 ± 6.84	1.44	0.63 ± 0.11	0.67 ± 0.11	7.15 ± 9.20	0.38
Mean Velocity at 85% 1RM (m·s ⁻¹)	0.48 ± 0.09	0.56 ± 0.08	17.92 ± 9.11	0.86	0.45 ± 0.10	0.48 ± 0.07	10.76 ± 15.92	0.38

*VRT = variable resistance training; TRAD = traditional; ES = effect size; Abs. = absolute; 1RM = 1 repetition maximum; Rel. = relative.

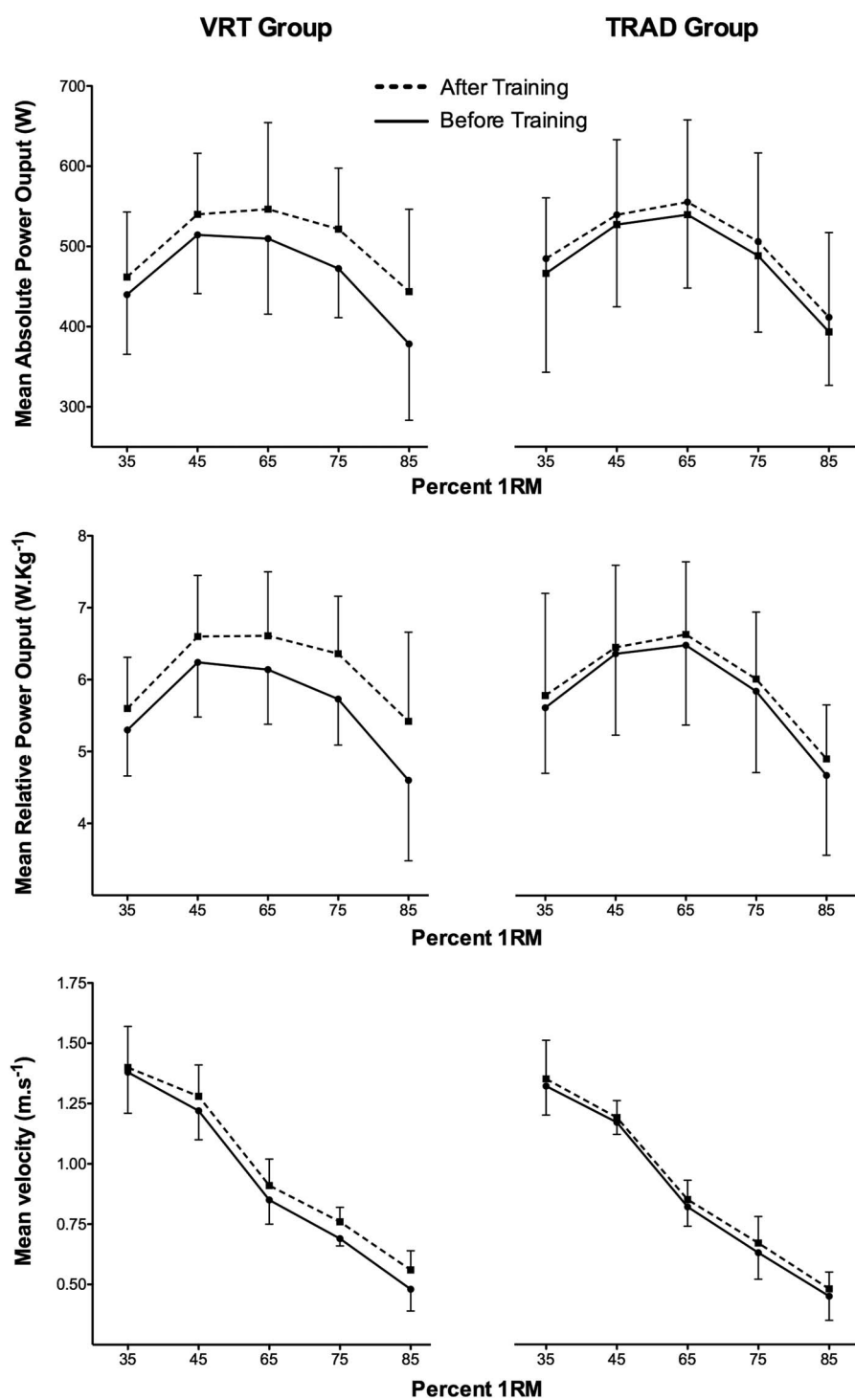


Figure 3. Mean absolute and relative power and mean velocity before and after the training intervention for both the VRT and TRAD groups. VRT = variable resistance training; TRAD = traditional; 1RM = 1 repetition maximum.

and repetition tempo were the same as the ones described in the bench press testing sessions above. All sessions were preceded by a 10-minute general warm-up including the same mobility routine described in the 1RM bench press assessment section and a lower-body mobility routine including knee-hug stretches, internal and external hip rotations, lateral shuffles, high knees, heel kicks, lunges and twist, and straight-leg marches. Furthermore, each resistance exercise was preceded by 3 warm-up sets of increasing intensity with the last warm-up set being performed at an intensity just below the target set. The players were required to complete at least 8 of the 12 sessions and take part in pretraining and posttraining testing sessions to be included in the analyses. Twenty-three players initially volunteered for this investigation. However, 1 player quit because of injury not connected with the training intervention and 6 others could not complete the posttraining testing session, leaving 16 players to be included in the data analyses. Furthermore, an academic study week was scheduled after week 3 of the training intervention causing the players to miss 1 week of training.

Statistical Analyses

Intraclass correlation coefficients were computed to determine the reliability of the anthropometric assessments and the bench press mean velocity and power. Effect sizes were calculated to determine the changes in bench press 1RM, mean velocity, and power before and after the 2 training interventions. These changes were considered trivial (<0.20 ; small, 0.20 – 0.50 ; medium, 0.5 – 0.8 ; large, 0.8 – 1.30 ; or very large, >1.30) (5). All statistical analyses were conducted using Stata 12 (Stata Corp, College Station, TX, USA) for Macintosh.

RESULTS

Bench Press 1 Repetition Maximum

Bench press 1RM increased by $5.21 \pm 3.97\%$ in VRT (before = 95.6 ± 9.6 kg; after = 100.6 ± 10.9 kg) and by 4.66 ± 4.20 in TRAD (pre = 105.6 ± 23.3 kg; before = 110.6 ± 24.7 kg) (Figure 2). The magnitude of the changes was small for both groups but larger in VRT (effect size [ES] = 0.46) when compared with TRAD (ES = 0.20). Relative bench press strength increased by $5.86 \pm 3.30\%$ in VRT (before = 1.2 ± 0.2 kg·kg⁻¹; after = 1.2 ± 0.2 kg·kg⁻¹) and by $3.90 \pm 2.88\%$ in TRAD (before = 1.3 ± 0.3 kg·kg⁻¹; after = 1.3 ± 0.3 kg·kg⁻¹). The magnitude of the changes was small in the VRT group (ES = 0.41) and trivial in the TRAD group (ES = 0.19).

Bench Press Mean Velocity

The magnitude of the changes in mean velocity for the VRT group was small at 35 and 45% 1RM, medium at 65% 1RM, very large at 75% 1RM, and large at 85% 1RM. The TRAD group experienced small changes at all loads (Table 2 and Figure 3).

Bench Press Mean Power

The magnitude of the changes in absolute mean power output for the VRT group was small at 35, 45, and 65% 1RM and medium at 75 and 85% 1RM. The TRAD group experienced trivial changes at all loads. With respect to relative mean power output, the magnitude of the changes of the VRT group was small at 35 and 45% 1RM, medium at 65 and 85% 1RM, and large at 75% 1RM. The TRAD group experienced trivial changes at 35, 45, 65, and 75% 1RM and small changes at 85% 1RM (Table 2 and Figure 3).

DISCUSSION

The purpose this study was to examine changes in upper-body strength; velocity and power after a 6-week in-season intervention using VRT or traditional resistance training (TRAD) in youth elite rugby league players. In agreement with our hypothesis, the analysis of the ESs reveals that greater training adaptations occurred after VRT, and the implications of this result are discussed below.

In this study, both the VRT and TRAD groups improved their bench press strength as well as their bench press velocity and power at 35, 45, 65, 75, and 85% 1RM; however, larger increases were observed in the VRT group. Although the difference was not statistically significant, it is important to note that the TRAD group was stronger and more powerful than the VRT group at baseline and was thus likely to gain less strength and power throughout the training intervention. Nonetheless, the results regarding strength are consistent with the findings of previous studies that compared changes in upper-body strength after VRT and TRAD interventions (1,16,22). With respect to velocity and power, the current results suggest that the gains seem to be larger after VRT when compared with TRAD. Although this study is the first to compare the effect of VRT and TRAD on upper-body velocity and power, making comparison with the literature rather challenging, a similar result was reported by Shoepe et al. (21), who observed that power during isokinetic knee extension was increased after a 24-week VRT intervention, whereas it remained unchanged after TRAD. There are a number of different factors that may explain the greater strength, velocity, and power gains observed after VRT. First, the additional resistance provided by the elastic bands was likely to increase the storage of elastic energy during the eccentric portion of the lift (6), which may have potentiated the concentric portion by releasing more kinetic energy (4,11). This better exploitation of the stretch-shortening cycle may have allowed a greater training stimulus to occur over time (27), resulting in greater strength, velocity, and power gains. Another explanation is that during the bench press exercise, force production is limited by the sticking point, which is the position where the moment arms are at a mechanical disadvantage (7). The use of variable resistances has been shown to reduce this mechanical disadvantage, therefore increasing muscle tension during the final part of the concentric portion of the lift (1).

Additionally, the addition of variable resistance minimizes the deceleration phase that typically occurs at the end of the concentric portion of the lift during free-weight resistance exercises (8). The result is a greater constant acceleration throughout the movement, which has been reported as a key factor to influence strength and power adaptations (3). A final explanation is that greater neuromuscular adaptations, including greater muscle electromyography activity (6) and recruitment of larger motor units (20) during the eccentric portion of a lift, may also occur during VRT, possibly leading to larger strength, velocity, and power gains than during free-weight resistance training. Taken collectively, these differences may account for the greater long-term strength, velocity, and power seen with VRT. The current results also indicate that both the VRT and TRAD groups experienced large velocity and power gains in the heavier loads, whereas small improvements were observed in the lighter loads. This result might be explained by the fact that the greatest increase in power output occurs at the loads used during training (15,17,19). Therefore, the 70–92% 1RM loads that were used in this study improved the ability of the players to express high velocity and power outputs against the loads at 65, 75, and 85% 1RM but had little influence on their ability to express high velocity and power outputs against the lighter loads at 35 and 45% 1RM. Another important finding of this study is that the improvements in both velocity and power against the heavier loads were larger for the VRT group when compared with the TRAD group, whereas smaller differences were observed between the 2 groups in the lighter loads. This finding regarding power may be explained by the fact that the VRT group experienced larger increases in bar velocity against the 65% ($ES = 0.54$ vs. 0.36), 75% ($ES = 1.44$ vs. 0.38) and 85% ($ES = 0.86$ vs. 0.38) 1RM loads, which ultimately led to larger gains in power output. Conversely, the difference in velocity gains between the 2 groups was smaller at the 35% ($ES = 0.13$ vs. 0.21 for the VRT and TRAD group, respectively) and 45% ($ES = 0.48$ vs. 0.40 for the VRT and TRAD group, respectively) 1RM loads, resulting in similar power adaptations against these loads. A greater rate of force development, which has been proposed to occur as a result of VRT (25,26), may have contributed to the increased bar velocity observed in the higher loads, allowing a higher power output to be reached.

Although ESs were calculated to determine the changes in bench press 1RM, mean velocity and power before and after the 2 training interventions, the small sample size could be considered a limitation of the study. However, the rugby team tested had only 23 players available at the beginning of the study, and 7 players could not take part in the posttesting sessions. Moreover, the training program was limited to 6 weeks only, so different results may have occurred with a longer training intervention.

In conclusion, this study indicates that VRT using elastic bands offers a greater training stimulus than TRAD to

improve upper-body strength, velocity, and power at different loads of 1RM after a 6-week in-season training intervention in elite youth rugby league players. Furthermore, it seems that both the VRT and TRAD groups experience large gains in both velocity and power in the heavier loads but small improvements in the lighter loads. Finally, the improvements in both velocity and power against the heavier loads are larger for the VRT group when compared with the TRAD group, whereas smaller differences exist between the 2 groups in the lighter loads.

PRACTICAL APPLICATIONS

The results of this study indicates that strength and conditioning professionals should consider using VRT to magnify the adaptations of the high-force portion of the force-velocity curve (i.e., maximum strength and strength-speed), whereas both VRT and TRAD may be used to impact the high velocity area of the curve (i.e., speed-strength). Furthermore, because VRT improves strength, velocity, and power to a greater extent than TRAD, it may also be of interest to use this training method when an athlete reaches the plateau that commonly occurs in strength and power performance. To optimize the benefits of a VRT program, it is essential to individualize the training program and correctly assess the resistance provided by the bands for each individual. In the context of rugby league training, VRT can then be implemented into a within-week loading pattern, including 2 whole-body sessions, with the first session targeting maximum strength and the second session focusing on power production. Additionally, by providing a different training stimulus, VRT may be a useful supplement to bring variety into the training program and hence increase athlete motivation and interest in workouts.

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