

Muscle Fatigability After Hex-Bar Deadlift Exercise Performed With Fast or Slow Tempo

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Purpose: To examine the differences in muscle fatigability after resistance exercise performed with fast tempo (FT) compared with slow tempo (ST). **Methods:** A total of 8 resistance-trained males completed FT and ST hexagonal-barbell deadlifts, consisting of 8 sets of 6 repetitions at 60% 3-repetition maximum, using a randomized crossover design. Each FT repetition was performed with maximal velocity, while each repetition during ST was performed with a 3-1-3 (eccentric/isometric/concentric) tempo (measured in seconds). Isometric maximal voluntary contraction, voluntary muscle activation, and evoked potentiated twitch torque of the knee extensors were determined using twitch interpolation before, during (set 4), and after exercise. Displacement–time data were measured during the protocols. **Results:** The mean bar velocity and total concentric work were higher for FT compared with ST (995 [166] W vs 233 [52] W; 0.87 [0.05] m/s vs 0.19 [0.05] m/s; 4.8 [0.8] kJ vs 3.7 [1.1] kJ). Maximal voluntary contraction torque, potentiated twitch, and voluntary muscle activation were significantly reduced after FT (−7.8% [9.2%]; −5.2% [9.2%], −8.7% [12.2%]) and ST (−11.2% [8.4%], −13.3% [8.1%], −1.8% [3.6%]). **Conclusion:** The decline in maximal voluntary force after both the FT and ST hexagonal-barbell deadlifts exercise was accompanied by a similar decline in contractile force and voluntary muscle activation.

Keywords: resistance exercise, contractile function, voluntary activation, athletic performance, sport science

It is well accepted that resistance exercise is a potent stimulus for developing skeletal muscle mass and strength.¹ Additionally, the manipulation of resistance-training variables, such as load, repetitions lifted, or lifting velocity, stimulates specific adaptations.² For instance, lifting maximal or submaximal loads, such as <85% of 1-repetition maximum (RM), an individual can vary the lifting tempo of each repetition for a given exercise. It has been proposed that intentionally slowing the repetition tempo reduces the momentum in a lift at a given load, thereby increasing the mechanical tension on the working muscles.³ Increasing mechanical tension throughout a lift mediates intracellular anabolic signaling, promoting a greater hypertrophic response.² In contrast, maximum dynamic effort resistance exercise, in which the athlete moves the resistive load with maximum velocity, has been shown to drive specific adaptations, such as enhanced rate of force development, which is crucial for improving general and sports-specific skills, such as running, jumping, and throwing.⁴ In their meta-analysis, Schoenfeld et al² calculated the effect sizes for “fast and heavy,” “fast and light,” “medium,” and “slow” repetitions and found no significant differences between any of these categories, concluding that a wide range of repetitions and durations could (and should) be used by coaches. They did, however, recommend that repetitions >10 s seemed less effective.

Performance fatigability is defined as a decline in an objective measure of performance over time and can be quantified by reductions in voluntary muscle force or changes in voluntary muscle activation (VA).⁵ Performing bouts of resistance exercise induce performance fatigability, and ensuring that performance fatigability is appropriately managed is important to optimize

adaptations to training.⁶ Therefore, knowledge of the development of performance fatigability after resistance exercise performed with different lifting tempos has important implications for the prescription of training programs, as the magnitude of performance fatigability could dictate the nature of subsequent training bouts.

Previous research that has measured changes in contractile function and VA during resistance exercise has largely focused on the influence of load intensity, and many of these studies have not controlled for volume load (VL).^{7–11} Additionally, very few studies have examined the influence of lifting tempo (ie, muscle action velocity).¹² With this in mind, Tran et al¹² evaluated the effects of 3 fatiguing protocols designed to manipulate concentric time under tension (TUT) or VL. Maximal voluntary contraction (MVC) and potentiated twitch (Pt) torque of the elbow flexors decreased by 19.2% and 57.2% after sets of 10 repetitions performed with a 5-s concentric phase. Additionally, MVC and Pt decreased by 12.8% and 11.8%, respectively, after a second protocol consisting of the same VL as the first protocol but with only a 2-s concentric phase. Finally, MVC and Pt decreased by 15% and 30.3% after a third protocol consisting of the same TUT but 50% VL (5 repetitions performed with a 10-s concentric phase). These findings suggest that prolonged tension elicits greater contractile stress, resulting in larger contractile dysfunction compared with VL.

The described study provides valuable insight into changes in contractile function and VA during resistance exercise and suggests that TUT is more influential than VL. These findings agree with previous observations that demonstrate that the magnitude of the resistive load is more influential than the volume of the work completed.¹³ Despite these observations, the use of single-joint exercise (ie, elbow flexion) is not representative of the primary (multijoint) exercises employed in athletic training programs, such as the back squat and the hexagonal barbell deadlift (HBD). Accordingly, investigating contractile function and VA after such multijoint exercises, which may cause larger disturbances to general homeostasis, is of interest to coaches. This warrants

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further investigation, and on this basis, our study aimed to describe the influence of single bouts of VL-controlled slow-tempo (ST) and fast-tempo (FT) training resistance exercise on changes in contractile function and voluntary activation in athletic males. The MVC, VA, and Pt measurements were made before, during, and immediately after exercise. **It was hypothesized that both protocols would induce performance fatigability; however, the ST protocol would induce larger muscle fatigability due to longer TUT.**

Methods

Participants

A total of 8 resistance-trained males (age 23 [2.7] y; height 1.77 [0.04] cm; body mass 79.5 [6.9] kg) who had been engaging in resistance exercise for at least 2 y and training for more than 2 sessions per week, volunteered to participate in this study. All participants were well accustomed to performing the HBD with correct technique and laboratory exercise testing and were free of cardiorespiratory, neurological, or neuromuscular disorders.

All participants were informed of the purpose of the study, experimental procedures, and associated risks prior to participation and exercise testing. All participants gave verbal and written informed consent, which was approved by the University of Essex Ethics Committee, in line with the Declaration of Helsinki.

Experimental Design

A within-group repeated-measures design in which the participants performed 2 protocols, ST and FT, in a randomized and counter-balanced order, separated by 5 to 8 d, was employed. For each protocol, before, during (after set 4), and after exercise, the measurements of MVC torque, VA, Pt torque, and blood lactate concentrations were measured.

Muscular Strength Testing and Familiarization

Three to seven days prior to the start of the study, the participants completed muscular strength testing to evaluate each participant's 3RM performance for the HBD exercise. The HBD is a variant of the traditional, or straight barbell, deadlift, which is performed by stepping inside a hexagonal-shaped frame (ie, barbell) and squatting down to grasp the handles on the apparatus. In this position, with knees and hips flexed, the participant aims to stand erect with the load in hand, before lowering the bar back to the floor in a controlled manner. The participants were instructed to avoid any lower-body exercise 48 h prior to any visit and any exercise the day before a visit. Before testing, the participants performed nonspecific, individual joint mobilization drills, followed by a specific warm-up consisting of submaximal HBD repetitions of single sets of 10, 5, 3, and 1 repetition(s) at 50%, 70%, 80%, and 90% of the estimated 3RM. After this, the participants rested for 3 to 5 min and performed 3 attempts (3- to 5-min recovery) to determine the actual 3RM. A 3RM was chosen because of its relative safety when compared with 1RM testing. The initial mean HBD 3RM was 192 (19.3) kg (2.4 [0.2] normalized per kilogram of body mass).

After strength testing, the participants were familiarized with all of the laboratory procedures. Particular attention was paid to the isometric MVC of the knee extensors, with the participants repeating the procedure until they were able to maintain a stable plateau in torque for 3 to 4 s. Furthermore, the participants were also fully familiarized with direct muscle stimulation, while care was taken to ensure they could still produce stable plateaus in torque while expecting muscle stimulation, which could cause some intimidation.¹⁴

Exercise Protocol

Resistance exercise tempo is expressed as 3 digits whereby the first number represents time (in seconds) to complete the concentric action, the second number is the isometric transition phase between concentric and eccentric actions, and the third is the time to complete the eccentric action. The ST protocol was performed with a tempo of 3-1-3, while the FT was performed at the maximal speed while controlling the eccentric action to avoid rebounding the weights off the ground. For both protocols, 8 sets of 6 repetitions, with a 2-min recovery between sets, were performed at 60% of 3RM. A 3RM was used here, as this related back to the initial strength testing performed prior to the study. The VL was defined as (sets × repetitions × load). During the ST protocol, the participants were instructed to keep time with a metronome and/or timer displayed via a personal laptop computer, while a linear positioning transducer (LPT; GymAware, version 1.2.5; Kinetic Technology, Canberra, ACT, Australia), connected to a tablet device (Apple Ipad Air, iOS 7; Apple Inc, Cupertino, CA), displaying real-time feedback of the mean barbell velocity for each repetition, was shown to participants during the FT protocol. The tether of the LPT was attached to the same side of the barbell throughout the entire protocol. Repetition height, as measured by the GymAware apparatus, shows an average of a 0.15-m difference between the ST and FT conditions. In the FT condition, some plantar flexion and shoulder elevation were apparent as the participants attempted to decelerate the load at the top of the lifting movement. Measurements of blood lactate concentrations and muscle force were taken before, during (after set 4), and after each protocol.

Before Exercise

MVC, VA, and Pt torque were obtained to quantify muscle performance. Two self-adhesive rectangular (5 × 9 cm) electrodes (Valu-trode; Axelgaard Manufacturing Co, Ltd, Fallbrook, CA) were placed on the leg and were connected to a high-voltage, constant-current stimulator (stimulator model DS7AH; Digitimer Ltd, Welwyn Garden City, UK), which delivered pair rectangular pulses of 200 μs at 100 Hz. The electrodes were placed on clean, shaved skin 5 to 10 cm below the inguinal crease and 5 to 10 cm above the superior border off the patella over the belly of the vastus lateralis, rectus femoris, and vastus medialis. Briefly, direct muscle stimulation (as opposed to nerve stimulation) was employed since it may cause less discomfort and ensures the delivery of a supramaximal stimulus.¹⁵ Supramaximal stimulation was ensured by increasing the stimulation intensity by 25 mA until a plateau occurred in twitch amplitude. The stimulation intensity was then increased by 25%. The same stimulation intensity was used for the same participant throughout the intervention. Voluntary activation was derived from the ratio of the superimposed twitch and the twitch produced in a relaxed potentiated muscle and was expressed as

$$VA = 100 (1 - \text{superimposed twitch} / Pt)$$

To determine MVC, the participants performed 3 maximal isometric contractions of the knee extensors interspersed by a 1-min rest after a standardized warm-up of 10 submaximal repetitions. Strong verbal encouragement was given to all participants during each MVC to provide motivation. An electrical stimulus was delivered during the plateau of each MVC and 3 to 5 s following the relaxation of each MVC. Potentiated twitches were used since these have been shown to be more sensitive to fatigue than unpotentiated twitches.¹⁴

After the MVC testing, a specific warm-up for the HBD exercise was conducted by performing 2 sets of 10 repetitions, first, with the empty barbell (40 kg) and, second, with 50% of the load to be lifted in the trial. This was followed by a final set of 6 repetitions at 75% of the load to be lifted in the trial. After the warm-up, the participants were seated and given a 3-min rest before the start of the protocol. During the rest period, capillary blood samples were obtained from the earlobe and collected into capillary tubes (20 μ L) and placed into a 1-mL hemolyzing solution for an assessment of blood lactate at rest (Biosen C-line; EKF Diagnostics, Barleben, Germany).

During Exercise

Muscle function was assessed midway during the protocol, after set 4. A single acceptable MVC was performed to minimize the effect on further task performance. An acceptable MVC was considered if (1) the torque trace exhibited a clear plateau prior to superimposed stimulation, (2) the superimposed stimulus was delivered when the voluntary torque was at or very close to its peak for that contraction, and (3) the participant perceived that their effort was maximal at the time of stimulation. In addition, throughout the protocol, the displacement–time data from each repetition of every set were measured using the LPT previously described.

After Exercise

Within 1 to 2 min of exercise cessation, the MVC testing was repeated to capture the effects of the exercise protocol on muscle performance characteristics.¹⁶ Lastly, ~5 min after exercise cessation, a further capillary earlobe blood sample was taken.

Statistical Analysis

From the 3 MVC measurements before and after the exercise protocol, the greatest MVC and Pt were selected for data analysis. Statistical analyses were carried out using SPSS (version 20.0; IBM Corp, Armonk, NY). The differences between the performance measures derived from the LPT device were analyzed by paired *t* tests, and a 2-way repeated measures analysis of variance was performed (protocol \times time) to compare the differences for MVC, Pt, and VA between exercise bouts. When the assumption of sphericity was violated, the degrees of freedom were corrected (Greenhouse–Geisser). In the case of a significant interaction effect, a post hoc test (Bonferroni) was applied. The significance level was set at 0.05. The critical value of *P* was 2 tailed. The effect sizes (Hedge *g*) were interpreted using previously outlined ranges: trivial ($g < 0.2$), small ($0.2 \leq g < 0.5$), moderate ($0.5 \leq g < 0.8$), and large ($g \geq 0.8$).^{17,18} A small, but not trivial, effect size (≥ 0.2) was considered to be meaningful.¹⁹ The statistical power of the recruited sample size ($n = 8$) would yield a power of at least 80% at alpha level .05 where the effect size (*g*) was ≥ 0.93 .

Results

Resistance Exercise Characteristics

The means, SDs, *P* value, effect sizes, and confidence intervals for mean repetition velocity, total concentric height, and mean repetition height of the FT and ST protocols are presented in Table 1. Compared with ST, FT resulted in higher barbell velocity (0.87 m/s vs 0.19 m/s), total concentric work (4.8 kJ vs 3.7 kJ), and repetition height (0.53 m vs 0.38 m).

MVC, Pt, and VA Measurements

Before, during, and after exercise, the MVC, Pt, VA, and blood lactate concentration values from the FT and ST protocols are presented in Figure 1 and Table 2. There was a main effect of time for MVC ($F = 15.69$; $P < .001$), Pt ($F = 9.94$; $P = .01$), and VA ($F = 2.22$; $P = .04$). The after-exercise differences between FT and ST were small for MVC ($ES = 0.22$), moderate for Pt ($ES = 0.75$) and VA ($ES = -0.30$), and large for blood lactate ($ES = -1.51$).

The post hoc tests revealed that MVC declined after set 4 ($P = .046$) and after exercise ($P = .01$). Pt declined after exercise only ($P = .03$). Blood lactate increased after set 4 ($P < .001$) and after exercise ($P = .001$). Individual responses to MVC, Pt, and VA can be seen in Figure 1. Additionally, the set-by-set response for the mean barbell velocity for FT and ST are shown in Figure 2.

Discussion

To the authors' knowledge, this is the first study to measure changes in VA and contractile function during and after VL-equated HBD exercise performed with different lifting tempos in resistance-trained men. As expected, there were differences between the FT and ST protocols in barbell velocity. The main finding was that a single, structured bout of FT HBD exercise, as well as ST HBD exercise, resulted in a progressive decline in MVC torque, which was associated with small impairments of both voluntary activation and contractile function. This study provides novel information on a resistance exercise prescription for resistance-trained males and suggests that undertaking FT and ST training may exert similar effects on contractile function and VA.

In the present study, changes in MVC torque, VA, and contractile function were measured during (after set 4) and immediately after exercise and compared with before-exercise levels. Both FT and ST induced declines in MVC torque (-5.7% [8.4%] vs -6.2% [11.8%]) after the fourth set, while FT resulted in a -7.8% (9.2%) reduction at exercise cessation compared with -11.2% (8.4%) after the ST protocol, though these differences were not significant. These findings are slightly lower than previous studies that report approximately -13% to 19% reductions in MVC after single bouts of elbow flexions of varying loads and TUT,¹² but

Table 1 Mean Bar Velocity, Total Concentric Work, and Repetition Height for FT and ST

	FT	ST	<i>t</i>	df	<i>P</i>	<i>g</i>	95% CI
Velocity, ^a m/s	0.87 (0.05)	0.19 (0.05)	7	34.1	<.001	12.76	8.23 to 17.29
Total concentric work, ^a kJ	4.57 (0.8)	3.65 (1.1)	7	3.4	<.02	0.9	-0.12 to 1.93
Repetition height, ^a m	0.53 (0.03)	0.38 (0.04)	7	10.24	<.001	4.01	2.31 to 5.71

Abbreviations: CI, confidence interval; FT, fast tempo; *g*, Hedge *g* effect size; ST, slow tempo. Note: Values are presented as mean (SD); $n = 8$; positive *g* favors FT.

^a Significant effect of protocol.

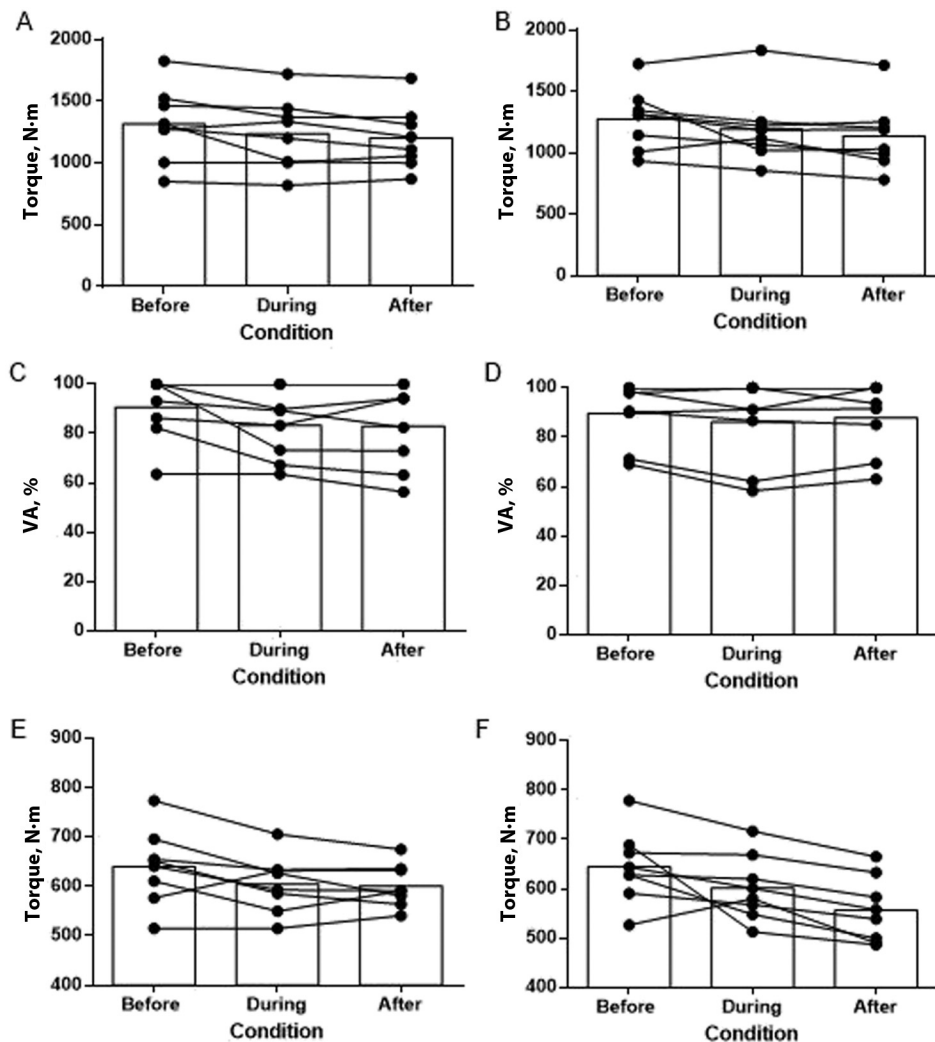


Figure 1 — Individual before-, during-, and after-exercise values: (A) maximal voluntary contraction for FT, (B) maximal voluntary contraction for ST, (C) VA for FT, (D) VA for ST, (E) potentiated twitch torque for FT, and (F) potentiated twitch torque for ST. FT indicates fast tempo; ST, slow tempo; VA, voluntary activation.

Table 2 Before-, During-, and After-Assessment Values for FT and ST

		FT; $\Delta\%$ from baseline	ST; $\Delta\%$ from baseline	Effect size (CI)
Maximal voluntary contraction,* N·m	Before	1317 (303)	1277 (250)	0.14 (−0.84 to 1.12)
	During	1238 (289) ^a ; −5.7	1196 (288) ^a ; −6.2	0.14 (−0.84 to 1.12)
	After	1202 (255) ^a ; −7.8	1139 (281) ^a ; −11.2	0.22 (−0.076 to 1.2)
Potentiated twitch torque,* N·m	Before	640 (77)	645 (74)	−0.06 (−1.04 to 0.92)
	During	605 (58)	602 (66)	0.05 (−0.93 to 1.03)
	After	602 (44) ^a ; −5.2	557 (67) ^a ; −13.3	0.75 (−0.26 to 1.76)
Voluntary activation,* %	Before	91 (13)	90 (13)	0.07 (−0.91 to 1.05)
	During	83 (14)	86 (17)	−0.18 (−1.16 to 0.8)
	After	83 (17); −8.7	88 (14); −1.8	−0.3 (−1.29 to 0.68)
Blood lactate,*,** mmol/L	Before	1.9 (0.7)	2.0 (0.9)	−0.12 (−1.10 to 0.86)
	During	3.5 (1.7) ^a	7.0 (2.7) ^a	−1.47 (−2.57 to −0.36)
	After	4.2 (2.5) ^a	8.6 (3.0) ^a	−1.51 (−2.62 to −0.4)

Abbreviations: CI, confidence interval; FT, fast tempo; ST, slow tempo. Note: Values are presented as mean (SD) before, during, and after; N = 8; positive *g* favors FT.
^a Within-protocol post hoc difference compared with before-exercise values.

*Significant time effect from before to after, $P < .05$. **Significant interaction effect (protocol \times time), $P < .05$.

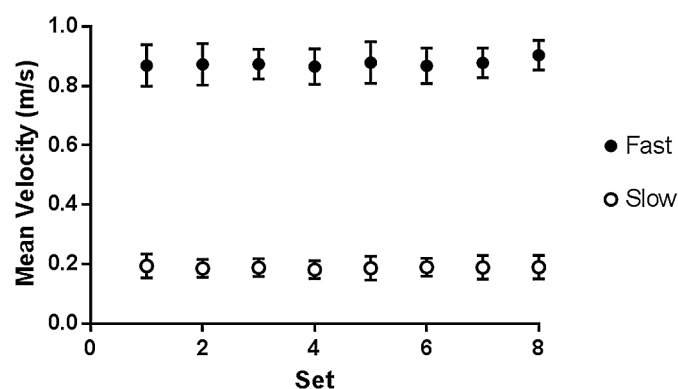


Figure 2 — Set-by-set grouped mean barbell velocity for fast-tempo and slow-tempo protocols.

are similar to observations made after lower-body multijoint resistance exercise (approximately -9% to 13%).^{8,11}

The progressive reduction in Pt torque (-5.2% [9.2%] vs -13.3% [8.1%]) after FT and ST HBD exercise demonstrates that the contractile properties of the muscle fibers and excitation-coupling process became impaired.²⁰ In addition to contractile dysfunction, impairment of nervous system function was observed after both protocols. Maximal VA ($\sim 90\%$) of the quadriceps in the nonfatigued state was in line with previous observations.^{21,22} The results suggest that voluntary activation may have declined after both the FT and ST HBD exercise, suggesting that a reduced number of motor units were voluntarily recruited or the firing rates of the active units were not maximal. It has been suggested that reduced VA during exercise may serve to protect the neuromuscular system via muscle afferent feedback systems.²³ As such, FT and ST HBD exercise may be associated with small after-exercise impairments of VA (-8.7% [12.2%] vs -1.8% [3.6%]). However, these results should be treated with caution due to the high variance.

As expected, there were differences between the FT and ST protocols in barbell velocity. Interestingly, although the resistance exercise was volume controlled, there was a difference in the total concentric work performed between the protocols. This may be explained by the method used to calculate concentric work by the LPT used for this study. Briefly, the LPT calculates mechanical work by multiplying the force required to move the load, by the distance traveled by the load. In practice, it is assumed that the force involved is equal to the load being lifted and that all repetitions are performed with the same range of motion, and so mechanical work may be estimated by multiplying the load by the total number of performed repetitions, referred to as VL.²⁴ However, during the FT protocol, due to the nature of lifting with maximum intent, the increased momentum of the load frequently lifted the participant's heels from the ground. Therefore, the increased distance traveled by the load could go some way to explaining the difference in total concentric work performed.

The exercise in this study was characterized by multijoint resistance exercise performed using an HBD with different lifting tempo schemes. The protocol design employed in this study was composed of 8 sets of 6 repetitions performed at 60% of $3RM$, with a 2-min rest. Importantly, the FT protocol was performed with maximal effort, whereas the ST protocol was performed with a 3-1-3 tempo, producing longer TUT per repetition. These schemes were designed to align with common practice within the athletic training

prescription. For example, although much debate exists regarding the mechanisms that promote skeletal muscle growth after resistance training,^{25–30} ST (3-1-3) training, conducted with moderate loads $\sim 50\%$ $1RM$, is as effective for muscular hypertrophy and strength gains as normal tempo training (1-0-1) conducted with moderate loads $\sim 80\%$ $1RM$ in single-joint²⁹ and multijoint³⁰ resistance exercise. However, based on the cited evidence, it must be highlighted that for low-load training to result in similar hypertrophic responses to heavier load training, a lifter must train to volitional fatigue.³¹ Practitioners may prescribe ST training during rehabilitation programs or to develop connective tissue strength, as well as to improve control and body awareness. Indeed, it is interesting to note that the higher blood lactate concentrations induced by ST might represent an appropriate avenue for the stimulation of hypertrophic gains.³² This is in contrast to resistance training with the intention to move the load with maximal speed, which has been shown to drive specific adaptations such as enhanced rate of force development³³ resulting in greater increases in jump and sprint performance.³⁴ In light of these differing findings, practitioners might adopt ST as a viable way of increasing the muscle cross-sectional area, while FT may be more suitable for the attainment of the neural responses associated with increased force output.³⁵ Nevertheless, a combination of these types of training also seems to be a viable way to increase muscular size,³⁵ and coaches must remain aware that some evidence suggests that the habitual performance of resistance exercise to volitional failure at normal speeds can result in suboptimal skeletal fiber adaptations³⁶ and, in turn, can exert a detrimental effect on performance adaptations.^{24,37,38} In light of this, coaches must closely consider the specificity of the training response with high force, low velocity movements and low force, high velocity movements transferring more readily to tasks that share a high level of equivalence with these particular protocols.³⁹ In this way, protocol-specific responses could be replicated over time to achieve chronic adaptations to the applied stimuli. This means that the prescribing coach must have an acute understanding of the idiosyncratic characteristics of different training tempos, performed to volitional fatigue.

The low sample size and associated reduced statistical power are limitations of this study. The difficulty in recruiting available individuals who were suitably well-trained proved challenging, undermining our sample size and the potential generalizability of the results. This means that our participants may not necessarily represent the average characteristics of the population from which they are derived, meaning the fatigue responses observed could vary if this study were to be replicated in the future. This could occur due to multiple variable factors relating to training habits, lifestyle, or current physical condition. Accordingly, the results should be viewed with caution. Additionally, a limitation of this study, and other twitch interpolation studies, is the number of factors that may affect the accuracy of the twitch interpolation technique, contributing to some measurement error typically present in estimates of VA. Additionally, measurement of contractile function and VA at 24 h after exercise may have allowed useful conclusions on the recovery of these outcomes after performing this type of exercise. However, a follow-up measurement was not considered due to the nonexhaustive nature of the study design and low reductions in the MVC expected, allowing for full recovery at 24 h after exercise.^{40,41} Future studies should address the effect of structured bouts of consecutive concurrent training, as well as the effect of these protocols on muscle actions at different velocities.

Practical Applications

Decrements in voluntary activation and contractile function are similar after performing 8 sets of 6 repetitions of FT and ST HBD exercise. However, the greater blood lactate concentrations during ST could indicate that that method is effective in increasing muscular size through the creation of greater levels of metabolic stress than those seen in FT. To induce hypertrophy-related adaptations in athletes, coaches could utilize ST, while neural qualities could be targeted with the use of FT. However, a combination of both training types might be most effective when coaches desire a more comprehensive set of responses to prepare for the multidimensional demands of sport.

Conclusion

In conclusion, this study provides novel information for athletes, coaches, and practitioners seeking to use the HBD exercise to induce neural and morphological changes. Both impairment of voluntary activation and contractile dysfunction contributed to the performance fatigability observed after FT and ST HBD exercise, but adaptations to these protocols could ultimately differ due to the contrast in metabolic responses between them. This work provides further understanding on the influence of resistance exercise on performance fatigability and may help coaches with the preparation of athletic training programs. Future studies may reveal whether this remains the case when using greater resistance-training volumes. Additionally, more work is needed to identify the mechanisms responsible for loss of nervous system function after FT resistance exercise. Specifically, the relationship between mode-specific fatigue and the associated training effects is an area of interest in this regard.

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