*International Journal of Sports Physiology and Performance*, 2021, 16, 232-242
https://doi.org/10.1123/ijspp.2019-0999

Human Kinetics
ORIGINAL INVESTIGATION

# Superior Changes in Jump, Sprint, and Change-of-Direction Performance but Not Maximal Strength Following 6 Weeks of Velocity-Based Training Compared With 1-Repetition-Maximum Percentage-Based Training

**Harry G. Banyard, James J. Tufano, Jonathon J.S. Weakley, Sam Wu, Ivan Jukic, and Kazunori Nosaka**

***Purpose:*** To compare the effects of velocity-based training (VBT) and 1-repetition-maximum (1RM) percentage-based training (PBT) on changes in strength, loaded countermovement jump (CMJ), and sprint performance. ***Methods:*** A total of 24 resistance-trained males performed 6 weeks of full-depth free-weight back squats 3 times per week in a daily undulating format, with groups matched for sets and repetitions. The PBT group lifted with fixed relative loads varying from 59% to 85% of preintervention 1RM. The VBT group aimed for a sessional target velocity that was prescribed from pretraining individualized load–velocity profiles. Thus, real-time velocity feedback dictated the VBT set-by-set training load adjustments. Pretraining and posttraining assessments included the 1RM, peak velocity for CMJ at 30%1RM (PV-CMJ), 20-m sprint (including 5 and 10 m), and 505 change-of-direction test (COD). ***Results:*** The VBT group maintained faster (effect size [ES] = 1.25) training repetitions with less perceived difficulty (ES = 0.72) compared with the PBT group. The VBT group had *likely* to *very likely* improvements in the COD (ES = −1.20 to −1.27), 5-m sprint (ES = −1.17), 10-m sprint (ES = –0.93), 1RM (ES = 0.89), and PV-CMJ (ES = 0.79). The PBT group had *almost certain* improvements in the 1RM (ES = 1.41) and *possibly* beneficial improvements in the COD (ES = –0.86). *Very likely* favorable between-groups effects were observed for VBT compared to PBT in the PV-CMJ (ES = 1.81), 5-m sprint (ES = 1.35), and 20-m sprint (ES = 1.27); *likely* favorable between-groups effects were observed in the 10-m sprint (ES = 1.24) and nondominant-leg COD (ES = 0.96), whereas the dominant-leg COD (ES = 0.67) was *possibly* favorable. PBT had small (ES = 0.57), but *unclear* differences for 1RM improvement compared to VBT. ***Conclusions:*** Both training methods improved 1RM and COD times, but PBT may be slightly favorable for stronger individuals focusing on maximal strength, whereas VBT was more beneficial for PV-CMJ, sprint, and COD improvements.

***Keywords:*** load–velocity profile, load–velocity relationship, resistance training, resistance training load monitoring, strength training

Traditional percentage-based resistance training (PBT) involves prescribing submaximal loads calculated from a 1-repetition-maximum (1RM) assessment. Strength and conditioning coaches can utilize PBT methods to periodize training load and volume to accommodate for recovery and improve sports performance tasks, like jumping and sprinting.[1] Even though this programming strategy is simple, practical, and can be managed with relative ease when training many athletes, it does not account for physical and psychological stressors that can affect an individual's day-to-day performance.[2] To address this problem, research has shown that individualizing sessional training load can help further optimize the daily training stress required to maximize training adaptation.[3] For example, Helms et al[3] found that using an athlete's rating of perceived exertion (RPE) to prescribe training load may further enhance maximal strength gains, as participants lifted higher loads compared with the PBT methods. Although RPE-based methods are valid and reliable, they may be problematic since they are subjective and coaches may prefer to utilize more precise objective methods, particularly with well-trained and elite athletes. Therefore, an approach that uses instantaneous repetition feedback to monitor and objectively prescribe training loads could optimize adaptation while allowing for a greater control over fatigue induced by training.

Recent advancements in commercially available technology such as linear position transducers (LPTs) allow for objective data to be collected in real-world training environments, meaning that immediate kinetic and kinematic outputs can be provided during resistance training. Notably, velocity data can be used to objectively manipulate training load and volume within a session, depending on how an athlete is performing on that day (ie, velocity-based training [VBT]).[4] There are 3 distinct benefits of monitoring velocity during resistance training. First, instantaneous velocity feedback can motivate an individual to maintain maximum effort when exercising,[5–7] which may enhance training adaptations.[8] Second, monitoring velocity can assist with identifying velocity ranges/targets and corresponding training loads, which may enhance training specificity.[4,9,10] Third, due to the stability of the velocity recorded against absolute loads,[11,12] any fluctuations in velocity beyond the normal

Banyard and Wu are with the Dept of Health Science and Biostatistics, Swinburne University of Technology, Melbourne, VIC, Australia. Banyard and Nosaka are with the Centre for Exercise and Sports Science Research (CESSR), School of Medical and Health Sciences, Edith Cowan University, Perth, WA, Australia. Tufano is with the Faculty of Physical Education and Sport, Charles University, Prague, Czech Republic. Weakley is with the School of Behavioural and Health Sciences, Australian Catholic University, Brisbane, QLD, Australia, and Carnegie Applied Rugby Research (CARR) Centre, Inst for Sport, Physical Activity and Leisure, Carnegie School of Sport, Leeds Beckett University, Leeds, United Kingdom. Jukic is with the Sport Performance Research Inst New Zealand (SPRINZ), Auckland University of Technology, Auckland, New Zealand. Banyard (hbanyard@swin.edu.au) is corresponding author.

variation observed between training sessions is likely to reflect acute or chronic fatigue or gains in strength.[4,13] For these reasons, monitoring velocity during resistance training sessions may be useful when aiming to tailor training prescriptions individually.

As mentioned previously, a VBT method exists that involves adjusting training loads to achieve a certain number of repetitions at a target velocity, which is established from an individualized load–velocity profile (LVP) regression equation.[4,12] This VBT method is based on research showing that velocity can accurately determine a %1RM value throughout the entire load–velocity relationship ($r$ = .97–.99).[9,13] This infers that relative strength levels (%1RM) can be determined on any particular day, according to the repetition velocity. Moreover, coaches can prescribe sessional target velocities and modify their athletes' training load if the velocity targets are not met according to their individualized LVP. As this VBT method is objective and able to account for day-to-day variation in individual performance, it may allow coaches to further individualize and optimize training compared with PBT, where training load is typically predetermined by the coach, depending on the training phase and goals of the individual.

To date, only 2 studies have investigated the training effects of this VBT method compared with a PBT program.[14,15] Dorrell et al[14] conducted a 6-week training study (2 training sessions per week) and found that the VBT group had moderate improvements in maximal strength and jump height compared with the PBT group, who had only small improvements in maximal strength and trivial increases in jump height. Notably, Dorrell et al[14] had a VBT group train with group average velocity zones, which makes this method easy to administer for coaches with a large group of athletes. However, recent research recommends that individualized LVPs should be created instead of group velocity zones due to the large interindividual variability in the velocity associated with a given % 1RM.[11,16] Furthermore, group velocity zones may limit the training stress for certain athletes if they are unable to maintain repetition velocity within the prescribed group average velocity zone.

Orange et al[15] had 27 elite junior rugby league players perform a 7-week resistance training intervention (2 sessions per week) during the competitive season and reported very similar changes in maximal strength, sprint times, and countermovement jump (CMJ) height between the VBT and PBT groups. They found that both groups had small improvements in their back squat 1RM, slower sprint times, and only the VBT group improved their squat velocity at 60%1RM on their individualized LVP. Although the Orange et al[15] study is extremely practically useful, it is not clear if the paucity of differences between the groups was entirely due to the VBT protocol. For example, the majority of the training exercises did not utilize VBT methods, and the intervention was not a periodized mesocycle. Other factors that were not quantified may have also influenced adaptation between groups, such as uncontrolled on-field training load differences outside of the resistance training sessions. Thus, to assess the true effects of individualized LVPs, we must first compare this VBT method with PBT in a periodized training intervention and control for external factors that could influence adaptation, such as training outside of the intervention. Therefore, the aim of this study was to compare the changes in maximal strength, CMJ, and sprint tasks following a periodized intervention of PBT or VBT with individualized LVPs. The individualized nature of the VBT method led us to hypothesize that this training method would result in a greater magnitude of adaptation for all performance tests compared with PBT methods.

# Methods

## Participants

A total of 24 resistance-trained males (VBT: age 25.5 [5.0] y, height 180.7 [8.5] cm, body mass 84.7 [6.8] kg, 1RM squat/body mass 1.61 [0.17]; PBT: age 26.2 [5.1] y, height 181.4 [7.4] cm, body mass 84.2 [7.7] kg, 1RM squat/body mass 1.60 [0.15]) were recruited for this study, and there were 0 participant dropouts. To control for external factors that could influence the training intervention, all participants consented to not performing any additional external training outside of this study. All volunteers were free from injury or illness, had a minimum 1RM full-depth back squat of at least 1.5 times their own body mass, and had performed the back squat for at least 2 years with a frequency of at least 1 squat training session per week for the last 6 months. All participants read the information letter and signed an informed consent form. Edith Cowan University's ethical review board granted ethical approval for the present study.

## Experimental Design

This was a 6-week free-weight full-depth back squat training study with an additional week of preintervention and postintervention measures (Figure 1). In brief, week 1 consisted of 4 sessions, with 24 hours separating each session, including a familiarization session, 1RM assessment, LVP assessment, and jump/sprint session. All testing sessions were repeated during week 8, with the exception of the familiarization session.

The training groups were counterbalanced using the participants' pretest 1RM then assigned into either the VBT (n = 12) or

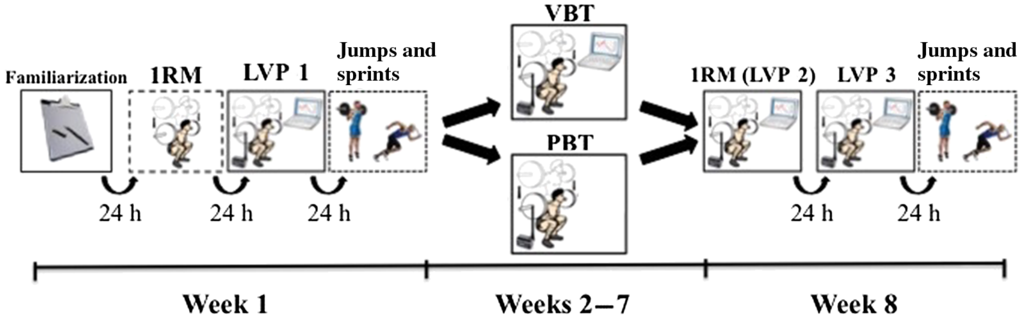



**Figure 1** — Overall experimental study design timeline. 1RM indicates 1-repetition maximum; LVP, load–velocity profile; PBT, percentage-based training; VBT, velocity-based training group.

PBT (n = 12) group. For the squat intervention, the participants were trained 3 times per week, at least 48 hours apart (ie, Monday, Wednesday, and Friday), for a total of 18 sessions. Except for the loading prescription, which was fixed during each session for the PBT group but adjustable between sets within each session for the VBT group, all aspects of the training study were identical between groups (warm-up, rest periods between sets, number of repetitions within a set, and number of sets). A summary of the resistance training loads for the 2 groups can be seen in Table 1. The PBT group trained with loads that descended from session to session during the week (heaviest to lightest) but ascended from week to week, except for the final week of training, where the same loads were prescribed as week 1 (Table 1). The VBT intervention was very similar, but the target velocities ascended from session to session during the week and descended from week to week, with the final week of training having the same target velocities as week 1 (Table 1).

## Familiarization of Jump, Sprints, and COD Tasks

The participants entered the laboratory, read the information letter, and completed a medical questionnaire and informed consent form. Their age, height, and body mass were recorded before a light warm-up, followed by 3 barbell (20 kg) CMJs and 5 barbell squat repetitions. The CMJ and squat repetitions were performed to ensure that the strict technique requirements of the study were adhered to. Following this, three 20-m sprint efforts and 6 change of direction (COD) efforts (3 efforts at turning with each leg) were performed. After the familiarization session, all participants met the inclusion criteria and were allowed to continue in the study.

## 1RM Assessment

The participants performed all repetitions using a 20-kg barbell (Eleiko®, Halmstad, Sweden) and an LPT (GymAware Power Tool; Kinetic Performance Technologies, Canberra, Australian Capital Territory, Australia) that was attached 65 cm right of barbell center to collect data in every session.[17,18] The validity ($r = .99$, coefficient of variation [CV] = 2.2%) of the LPT utilized in the present study to measure the mean velocity (MV) has previously been established.[18] The participants performed a warm-up consisting of 5-minute pedaling on a cycle ergometer (Monark 828E cycle ergometer; Monark Exercise AB, Vansbro, Dalarna, Sweden) at 60 revolutions per minute and 60 W, 3 minutes of dynamic stretching, and 10 full-depth bodyweight squats performed with maximal concentric effort. The participants then commenced the 1RM assessment, composed of sets estimated at 20%1RM (3 repetitions), 40%1RM (3 repetitions), 60%1RM (3 repetitions), 80%1RM (1 repetition), and 90%1RM (1 repetition).[19] This was then followed by 1RM attempts, where the last successful lift with correct technique and full depth was classified as the participants' 1RM. Passive rest was given between the submaximal sets (2 min) and 1RM attempts (3 min). The participants were always required to keep the barbell on the superior aspect of the trapezius muscle, with their feet in contact with the ground. The eccentric phase of the squat was performed with a controlled and self-selected speed (mean eccentric velocity = 0.48–0.67 $m \cdot s^{-1}$), but once full knee flexion was achieved, the participants were verbally encouraged to perform the concentric phase of the lift as fast as possible. This same squat technique was used in both groups and for all squat repetitions performed throughout the study (warm-up and training/testing repetitions). The warm-up loads (20%1RM–90%1RM) lifted during the postintervention 1RM session (LVP 2) were based off the preintervention 1RM load. Finally, the repetitions performed during the preintervention 1RM session were also used to familiarize the participants with maximal concentric velocity effort across the relative load spectrum (20%1RM–100%1RM).

## LVP Assessment

Previous research has found that MV in the free-weight back squat is reliable at 20%1RM, 40%1RM, 60%1RM, 80%1RM, and 90%1RM, but not at 100%1RM.[12] Thus, individualized LVPs were developed using MV from 20%1RM to 90%1RM (Figure 2). During week 1, the relative loads (20%1RM–90%1RM) lifted in LVP 1 were based off the preintervention 1RM. For the postintervention 1RM in week 8, which was also used as LVP 2, the warm-up relative loads (20%1RM–90%1RM) were also based off the preintervention 1RM (Figure 1). This was done to observe the changes in MV with the same absolute loads between LVP 1 and LVP 2, which can be seen in Table 1 as the pretesting and posttesting measures, respectively. However, for the LVP 3 session, the relative loads lifted (20%1RM–90%1RM) were based off the postintervention 1RM. This was done to compare the MV changes with the same relative load between LVP 1 and LVP 3.

The participants performed the same warm-up protocols as the 1RM assessment. The warm-up was then followed by back squat sets using 20%1RM (3 repetitions), 40%1RM (3 repetitions), 60%1RM (3 repetitions), 80%1RM (1 repetition), and 90%1RM (1 repetition). Two minutes of passive recovery was given between sets. For sets that included more than 1 repetition (ie, 20%1RM, 40%1RM, and 60%1RM), the repetition with the fastest MV was included for the LVP regression equation (Figure 2).[12] Figure 2 demonstrates how the individualized LVPs were constructed by plotting MV against relative load and then applying a line of best fit to the data. A linear regression equation was then calculated and used to convert a relative load table into an MV table (Figure 2). The individualized MV table was then used to determine daily training loads during VBT.

## Jump and Sprint Testing Session

***Loaded CMJ.*** The participants performed the same warm-up protocols as the 1RM assessment, which was then followed by 3 bodyweight CMJ repetitions that were performed with maximal concentric effort. The participants then performed 3 repetitions of the free-weight barbell CMJ, loaded with 30% of the preintervention back squat 1RM (separated by 1-min rest periods). The CMJ technique required the participants to stand upright with feet approximately shoulder width apart and with hips and knees fully extended. The barbell was positioned across the superior aspect of the upper trapezius at all times. The participants were instructed to descend into a self-selected depth and immediately follow with a jump for maximum height. For the postintervention loaded CMJ assessment, the same absolute load from preintervention was utilized (30% of preintervention back squat 1RM). Peak velocity (PV) during the loaded CMJ repetitions was monitored with an LPT (GymAware Power Tool; Kinetic Performance Technologies), and the CMJ with the fastest PV was used for further analysis. Verbal encouragement was provided so that maximum effort was given, but the PV-CMJ data (feedback) were not provided.

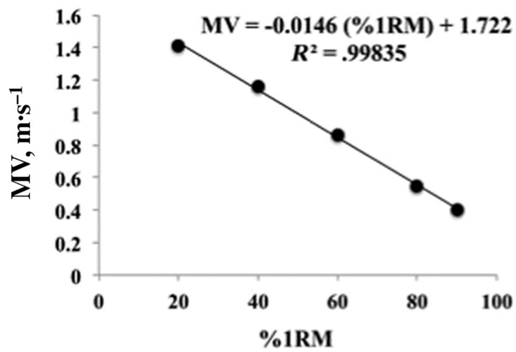
***20-m Sprint.*** Following the loaded CMJs, the participants performed repeated warm-up jogging efforts followed by 2 sets

## Table 1 Descriptive Characteristics of the VBT and PBT Programs

| Training variable | Group | Session 1 | Session 2 | Session 3 | Session 4 | Session 5 | Session 6 | Session 7 | Session 8 | Session 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Average repetition load, % 1RM | VBT | 66.3 (3.1) | 62.2 (2.0) | 57.1 (3.8) | 71.3 (5.1) | 65.9 (6.6) | 59.3 (2.5) | 75.0 (5.5) | 70.6 (5.9) | 67.3 (2.0) |
| | PBT | 68 | 64 | 59 | 72 | 68 | 64 | 77 | 72 | 68 |
| Average repetition velocity, m·s$^{-1}$ | VBT | 0.80 (0.07) | 0.84 (0.06) | 0.88 (0.11) | 0.75 (0.08) | 0.80 (0.07) | 0.84 (0.08) | 0.70 (0.06) | 0.75 (0.07) | 0.80 (0.07) |
| | PBT | 0.70 (0.06) | 0.75 (0.09) | 0.78 (0.08) | 0.67 (0.08) | 0.69 (0.07) | 0.76 (0.09) | 0.63 (0.06) | 0.61 (0.08) | 0.68 (0.09) |
| Average repetition velocity deviation, % | VBT | −0.9 (3.0) | −0.7 (4.4) | −1.5 (5.4) | 0.3 (2.1) | −0.2 (1.7) | −0.6 (4.4) | 0.1 (3.1) | −0.2 (2.2) | −0.2 (1.9) |
| | PBT | −12.3 (6.2) | −10.7 (6.1) | −11.4 (3.4) | −10.8 (6.7) | −13.2 (4.9) | −9.8 (4.5) | −9.1 (2.9) | −18.5 (5.3) | −15.0 (5.9) |
| Session RPE | VBT | 4.9 (1.0) | 4.5 (1.0) | 4.0 (1.3) | 5.5 (1.0) | 5.2 (1.2) | 4.8 (1.4) | 6.0 (1.0) | 5.3 (1.1) | 4.7 (1.2) |
| | PBT | 5.4 (1.4) | 4.9 (1.3) | 4.5 (1.2) | 6.0 (1.1) | 5.9 (1.3) | 5.7 (1.3) | 6.8 (0.8) | 5.9 (1.0) | 5.5 (1.2) |

| Training variable | Group | Session 10 | Session 11 | Session 12 | Session 13 | Session 14 | Session 15 | Session 16 | Session 17 | Session 18 | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Average repetition load, % 1RM | VBT | 79.8 (8.4) | 75.9 (6.5) | 70.8 (10.2) | 82.2 (7.0) | 77.5 (1.6) | 72.4 (4.6) | 69.5 (3.2) | 65.3 (2.8) | 62.2 (2.3) | 69.2 (6.9) |
| | PBT | 81 | 77 | 72 | 85 | 81 | 77 | 68 | 64 | 59 | 70.9 (7.3) |
| Average repetition velocity, m·s$^{-1}$ | VBT | 0.66 (0.07) | 0.70 (0.08 | 0.74 (0.07) | 0.62 (0.06) | 0.65 (0.07) | 0.70 (0.06) | 0.80 (0.07) | 0.84 (0.08) | 0.89 (0.07) | 0.76 (0.08) |
| | PBT | 0.56 (0.07) | 0.64 (0.07) | 0.65 (0.06) | 0.58 (0.06) | 0.56 (0.06) | 0.61 (0.06) | 0.73 (0.08) | 0.79 (0.08) | 0.83 (0.11) | 0.66 (0.08) |
| Average repetition velocity deviation, % | VBT | 1.3 (3.6) | 0.5 (4.4) | 0.2 (2.6) | −0.4 (1.4) | −0.4 (5.0) | 0.4 (1.9) | −0.4 (2.3) | −0.3 (2.5) | −0.4 (3.4) | −0.2 (5.2) |
| | PBT | −15.5 (7.8) | −8.1 (3.4) | −12.8 (2.4) | −6.1 (3.4) | −14.1 (5.4) | −12.9 (6.6) | −8.4 (3.7) | −5.6 (3.4) | −6.4 (4.1) | −13.6 (6.8) |
| Session RPE | VBT | 6.1 (1.1) | 5.9 (1.1) | 4.9 (1.2) | 6.7 (1.1) | 6.2 (1.2) | 5.4 (1.1) | 5.0 (1.0) | 4.3 (1.0) | 3.8 (.3) | 5.1 (1.2) |
| | PBT | 7.5 (1.0) | 7.0 (1.0) | 6.1 (1.0) | 8.5 (0.8) | 7.8 (1.1) | 6.8 (1.1) | 4.9 (1.1) | 4.2 (1.1) | 3.7 (1.2) | 6.0 (1.3) |

Abbreviations: %1RM, percentage of 1-repetition maximum; average repetition load, the average repetition load lifted during each session; average repetition velocity, the average mean velocity for repetitions performed during each session; average repetition velocity deviation, the average repetition velocity deviation expressed as a percentage of mean repetition velocity from the individualized load–velocity profile (LVP 1); PBT, percentage-based training group that trained with prescribed training loads; RPE, rating of perceived exertion; session RPE, the group mean of the RPE for each session; VBT, velocity-based training group that trained with adjustable training loads.




Load velocity profile

| %1RM | MV |
|---|---|
| 20 | 1.41 |
| 40 | 1.16 |
| 60 | 0.86 |
| 80 | 0.55 |
| 90 | 0.40 |

**Converting relative load table into a MV table**

Example at 85%1RM: $MV = -0.0146\ (85) + 1.722$
$MV = 0.48\ m{\cdot}s^{-1}$

Relative load table, %1RM

| Repetitions | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Maximum | 100 | 95 | 92 | 90 | **86** | 83 | 81 | 79 | 77 | 75 |
| Heavy + | 99 | 94 | 91 | 89 | **85** | 82 | 80 | 78 | 76 | 74 |
| Heavy | 94 | 89 | 86 | 85 | **81** | 78 | 76 | 74 | 72 | 71 |
| Moderate + | 89 | 85 | 82 | 80 | **77** | 74 | 72 | 70 | 69 | 67 |
| Moderate | 84 | 80 | 77 | 76 | **72** | 70 | 68 | 66 | 65 | 63 |
| Light + | 79 | 75 | 73 | 71 | **68** | 66 | 64 | 62 | 61 | 59 |
| Light | 74 | 70 | 68 | 67 | **64** | 61 | 60 | 58 | 57 | 56 |
| Very light + | 69 | 66 | 63 | 62 | **59** | 57 | 56 | 55 | 53 | 52 |

Mean velocity table, m·s$^{-1}$

| Repetitions | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Maximum | 0.26 | 0.34 | 0.38 | 0.41 | **0.47** | 0.51 | 0.54 | 0.57 | 0.60 | 0.63 |
| Heavy + | 0.28 | 0.35 | 0.39 | 0.42 | **0.48** | 0.52 | 0.55 | 0.58 | 0.61 | 0.64 |
| Heavy | 0.35 | 0.42 | 0.46 | 0.49 | **0.54** | 0.58 | 0.61 | 0.64 | 0.67 | 0.69 |
| Moderate + | 0.42 | 0.49 | 0.53 | 0.55 | **0.60** | 0.64 | 0.67 | 0.70 | 0.72 | 0.75 |
| Moderate | 0.50 | 0.56 | 0.59 | 0.62 | **0.67** | 0.70 | 0.73 | 0.75 | 0.78 | 0.80 |
| Light + | 0.57 | 0.63 | 0.66 | 0.68 | **0.73** | 0.76 | 0.79 | 0.81 | 0.83 | 0.86 |
| Light | 0.64 | 0.70 | 0.73 | 0.75 | **0.79** | 0.83 | 0.85 | 0.87 | 0.89 | 0.91 |
| Very light + | 0.71 | 0.76 | 0.80 | 0.82 | **0.86** | 0.89 | 0.91 | 0.93 | 0.95 | 0.97 |

**Figure 2** — An example of converting a relative load table into an MV table using an LVP obtained from a representative participant. 1RM indicates 1-repetition maximum; LVP, load–velocity profile; MV, mean velocity.

of 20-m progressive running acceleration efforts. Timing lights (Swift Speedlight Timing Systems; Swift Performance, Brisbane, Queensland, Australia) were used to measure each sprint, with gates placed 1.5-m wide at the start line, 5-, 10-, and 20-m distances.[20] The participants were given a 2-minute rest between trials and commenced the 20-m sprints when they were ready, in a crouched starting position with the lead foot at the back edge of the start line, which was at 0 m. The participants were not given feedback regarding their time following each trial. The fastest of the 3 trials was used for further analysis.

***505 COD Test.*** The participants assumed a crouched starting position and sprinted for 15 m before changing direction off a designated turning point and sprinting back toward the start line for another 5 m.[21] The timing gates were positioned 5 m from the designated turning point. The participants completed the COD test 6 times, with a 2-minute rest between trials: 3 with the dominant leg turning off the designated line and 3 with the nondominant leg. The participants were not given feedback regarding their time after each trial. The quickest trial on each leg was used for further data analysis.

## VBT and PBT Training Protocols

The participants performed the same warm-up protocols as the 1RM assessment. Every repetition in every set (warm-up and training sets) was performed with maximal concentric velocity for all participants in both groups. All participants performed 4 sets of warm-up squats using 20%1RM (3 repetitions), 40%1RM (3 repetitions), 60%1RM (3 repetitions), followed by 1 repetition at the assigned sessional training load. A 2-minute passive rest was enforced between warm-up repetitions, and following this, a 2-minute rest was given prior to the training sets.

The PBT group lifted with fixed relative loads from 59%1RM to 85%1RM, based on their pretest 1RM (Table 1). However, the VBT group lifted with loads that could be adjusted (higher or lower) from set to set to reach the prescribed sessional target velocity that was established from the participant's individualized LVP and subsequent MV table (Figure 2). For the VBT group, the sessional target velocity corresponded to the same relative load as the PBT session. For example, in session 1, the PBT group trained with a fixed 68%1RM load, whereas an example participant from the VBT group trained with adjustable loads to achieve a sessional average repetition velocity of 0.73 m·s$^{-1}$, which corresponded to 68%1RM in their MV table.

To determine the first set's training load for each VBT session, the MV of the last set of the warm-up (1 repetition performed at the assigned sessional training load) was compared with the target velocity in the MV table (Figure 2). If the MV was 0.06 m·s$^{-1}$ higher or lower than the target velocity, the load of the first set was adjusted by ±5%1RM. If the difference was 0.12 m·s$^{-1}$ higher or lower than the target velocity, then a ±10%1RM load adjustment was made, and so on. This was based on previous research that found the smallest detectable difference (normal variation in velocity) in MV between sessions for the full-depth free-weight back squat to be ±0.06 $m \cdot s^{-1}$, with relative loads ranging from 20%1RM to 90%1RM.[12] During the VBT sessions, once a set of 5 repetitions was completed, the load for the subsequent set could be adjusted by ±5%1RM if the average of the MV for the 5 repetitions of the previous set was 0.06 $m \cdot s^{-1}$ higher or lower than the target velocity for that session.

Thus, all participants from both groups performed 5 sets of 5 repetitions (completing 25 repetitions per session), but the training load for the VBT group could be adjusted according to the average MV of the preceding set's repetitions. During the 2-minute interset rest period, the principal researcher assessed the average set velocity (which was transmitted from the LPT to an iPad via Bluetooth) and made appropriate load adjustments for each participant within the VBT group. Verbal encouragement was provided for every participant in both groups for all training repetitions. This was done to ensure maximal effort was provided in the concentric phase of the squat repetitions throughout the training study.

The average repetition velocity deviation for each session was determined by calculating the average difference in MV of each repetition compared with the MV from the individualized LVP (Table 1). The average repetition velocity was determined as the average MV for each participant in each session (Table 1). Average repetition load was calculated as the average relative load lifted for each repetition in a session (Table 1).

### Session RPE Measures

During the pretraining 1RM assessment, the participants were familiarized with the 0 to 10 OMNI-Resistance Exercise scale, which is a specific RPE scale tailored to resistance training.[22] The participants were then shown the scale and asked how difficult the session was, 30 minutes following the last repetition. The participant would then verbally indicate a number from 0 to 10 on the scale after comparing it with the corresponding descriptor. The participants' scores were averaged over each session for each group and used for further analysis.

### Statistical Analyses

Intraday reliability during preintervention testing was measured using an intraclass correlation coefficient (ICC) and CV.[23] All testing data were assessed for homogeneity of variance using the Levene test ($P \geq .05$) and checked for normal distribution with the Shapiro–Wilk test ($P \geq .05$), and all assumptions were met (SPSS, version 22; IBM Corp, Armonk, NY). The effect size (ES; ±90% confidence intervals) differences within groups for the preintervention and postintervention measures of the 1RM, LVP ([pre = LVP 1, post = LVP 2]; MV at 20%1RM, 40%1RM, 60%1RM, 80%1RM, 90% 1RM, and 100%1RM), PV-CMJ, 20-m sprint times (inclusive of 5-, 10-, and 20-m sprint), and COD times (dominant leg and nondominant leg) were calculated using the following equation[24]:

$$\text{ES} = (\text{mean group premean group post})/\text{pooled SD}$$

This same ES equation was also used to detect differences in the training session data, including average repetition velocity deviation, average repetition velocity, average repetition load, and session RPE. However, the between-group ES was calculated as[24]

$$\text{ES} = ([\text{mean VBT group pre–post}] - [\text{mean PBT group pre–post}]) / \text{pooled SD of the mean difference}$$

The ES were interpreted as trivial (≤0.2), small (0.20–0.60), moderate (0.60–1.20), large (1.20–2.00), or very large (≥2.0).[25] In addition, all testing data were analyzed for practical significance using magnitude-based-decisions qualitative descriptors: <0.5%, almost certainly not; 0.5% to 5%, very unlikely; 5% to 25%, unlikely; 25% to 75%, possibly; 75% to 95%, likely; 95% to 99.5%, very likely; and >99.5%, almost certainly.[25,26] If the 90% confidence interval crossed both the upper and lower boundaries of a trivial effect, the magnitude of change was described as unclear.[25] The data are reported as mean (SD) unless stated otherwise.

## Results

### Reliability of Preintervention Tests

High trial-to-trial reliability was observed during preintervention testing for all participants in the squat MV at each relative load in LVP 1 (ICC = .85–.98, CV = 2.1%–7.9%), for PV-CMJ (ICC = .93, CV = 2.9%), 20-m sprint times (ICC = .92, CV = 2.5%), and COD times (ICC = .90, CV = 5.2%).

### Training Data

The training data, including average repetition load, average repetition velocity, average repetition velocity deviation per session, and sessional RPE scores, are presented in Table 1 for both groups. Every participant from both training groups completed 100% of all sessions. Over the entire intervention, there were small (ES = 0.24) but unclear differences in the average relative training load for the VBT group (69.2%1RM [7.0%1RM]) compared with the PBT group (70.9%1RM [7.4%1RM]; Table 1). Large differences (ES = 1.25) and *almost certainly* faster average training repetition velocities were found in favor of the VBT group compared with the PBT group (MV = 0.76 [0.08] $m \cdot s^{-1}$ vs 0.66 [0.08] $m \cdot s^{-1}$; Table 1). In addition, the average training repetition velocity deviation was very large (ES = 2.14) and *almost certainly* greater for the PBT group (−13.6% [6.8%]) compared with the VBT group (−0.2% [5.2%]). The session RPE scores were moderately (ES = 0.72) and *likely* higher across the 6-week intervention period in the PBT group (6.0 [1.3]) compared with the VBT group (5.1 [1.2]), with moderate to large (ES = 0.76 to 1.79) differences reported from sessions 10 to 15 (Table 1).

### Testing Results

Small to trivial (ES < 0.38) and *unclear* differences were observed between the VBT and PBT groups for all testing measures at preintervention time points. *Likely* to *very likely* beneficial improvements were made by the VBT group in the 1RM (11.3%; ES = 0.89), PV-CMJ (7.4%; ES = 0.79), 5-m sprint (6.5%; ES = 1.17), 10-m sprint (3.8%; ES = 0.93), and COD times (4.9%–5.4%; ES = 1.20–1.27) compared with the preintervention measurements (Table 2), whereas, for the PBT group, *possible* and *almost certain* improvements were made in the COD times (3.6%; ES = 0.86) and 1RM (12.5%; ES = 1.41), respectively (Table 2). When comparing the training effects between the VBT and PBT groups (Figure 3), VBT was *very likely* more beneficial for PV-CMJ (ES = 1.81), 5-m sprint (ES = 1.35), and 20-m sprint (ES = 1.27) and *likely* favorable for the 10-m sprint (ES = 1.24) and nondominant-leg COD (ES = 0.97), whereas the dominant-leg COD (ES = 0.67) was possibly favorable. There was a small (ES = −0.57) but *unclear* training effect for PBT in 1RM

**Table 2 Within-Group Comparisons for Preperformance and Postperformance Measures, Differences, Percentage Changes, and Statistical Analyses**

| | VBT | | | | | | PBT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pre | Post | Absolute Δ | % Δ | ES | MBD | Pre | Post | Absolute Δ | % Δ | ES | MBD |
| 1RM, kg | 136.7 (18.9) | 153.6 (19.4) | 17.0 (4.8) | 11.3 | 0.89 (0.08 –1.70) | Likely | 135.2 (11.0) | 152.1 (12.8) | 19.1 (4.3) | 12.5 | 1.41 (0.57 to 2.25) | Almost certainly |
| PV-CMJ, m·s$^{-1}$ | 2.50 (0.23) | 2.69 (0.25) | 0.19 (0.03) | 7.4 | 0.79 (0.07 –1.46) | Likely | 2.53 (0.19) | 2.63 (0.21) | 0.10 (0.02) | 4.0 | 0.50 (–0.20 to 1.16) | Unclear |
| LVP at 20%1RM, m·s$^{-1}$ | 1.29 (0.12) | 1.37 (0.13) | 0.08 (0.02) | 6.5 | 0.64 (–0.19 to 1.43) | Possibly | 1.25 (0.11) | 1.33 (0.12) | 0.08 (0.03) | 6.3 | 0.69 (–0.15 to 1.49) | Possibly |
| LVP at 40%1RM, m·s$^{-1}$ | 1.12 (0.07) | 1.20 (0.07) | 0.08 (0.03) | 7.4 | 1.14 (0.24 –1.96) | Very likely | 1.08 (0.06) | 1.14 (0.07) | 0.08 (0.02) | 6.4 | 0.92 (0.05 –1.73) | Likely |
| LVP at 60%1RM, m·s$^{-1}$ | 0.90 (0.06) | 0.97 (0.08) | 0.07 (0.02) | 7.9 | 0.99 (0.11 – 1.80) | Likely | 0.87 (0.06) | 0.93 (0.07) | 0.06 (0.02) | 6.9 | 0.92 (0.05 –1.73) | Likely |
| LVP at 80%1RM, m·s$^{-1}$ | 0.68 (0.07) | 0.76 (0.07) | 0.07 (0.04) | 11.6 | 1.14 (0.24 – 1.96) | Very likely | 0.65 (0.07) | 0.73 (0.07) | 0.08 (0.03) | 9.0 | 1.14 (0.24 –1.96) | Very likely |
| LVP at 90%1RM, m·s$^{-1}$ | 0.50 (0.06) | 0.58 (0.06) | 0.08 (0.06) | 18.3 | 1.33 (0.41 –2.17) | Very likely | 0.48 (0.07) | 0.55 (0.07) | 0.06 (0.03) | 13.8 | 1.00 (0.12 –1.81) | Likely |
| LVP at 100%1RM, m·s$^{-1}$ | 0.24 (0.05) | 0.48 (0.06) | 0.25 (0.07) | 100.2 | 4.00 (2.51 –5.22) | Almost certainly | 0.23 (0.04) | 0.44 (0.05) | 0.21 (0.10) | 89.7 | 3.50 (2.13 –4.63) | Almost certainly |
| 5-m sprint, s | 1.16 (0.06) | 1.09 (0.06) | 0.07 (0.02) | –6.5 | –1.17 (–1.99 to –0.27) | Very likely | 1.14 (0.06) | 1.10 (0.07) | 0.04 (0.01) | –3.3 | –0.61 (–1.41 to 0.23) | Unclear |
| 10-m sprint, s | 1.90 (0.08) | 1.83 (0.07) | 0.07 (0.03) | –3.8 | –0.93 (–1.74 to –0.06) | Likely | 1.90 (0.10) | 1.86 (0.10) | 0.04 (0.01) | –2.0 | –0.40 (–1.19 to 0.42) | Unclear |
| 20-m sprint, s | 3.20 (0.11) | 3.14 (0.12) | 0.06 (0.02) | –1.8 | –0.52 (–1.32 to 0.31) | Unclear | 3.21 (0.16) | 3.18 (0.16) | 0.03 (0.01) | –0.9 | –0.19 (–0.98 to 0.62) | Unclear |
| DL-COD, s | 2.32 (0.10) | 2.20 (0.10) | –0.13 (0.04) | –4.9 | –1.20 (–2.02 to –0.29) | Very likely | 2.30 (0.10) | 2.21 (0.11) | –0.09 (0.03) | –3.6 | –0.86 (–1.66 to 0.01) | Possibly |
| NDL-COD, s | 2.38 (0.12) | 2.24 (0.10) | –0.14 (0.07) | –5.4 | –1.27 (–2.10 to –0.35) | Very likely | 2.34 (0.10) | 2.25 (0.11) | –0.09 (0.07) | –3.5 | –0.86 (–1.66 to 0.01) | Possibly |

Abbreviations: 1RM, 1-repetition maximum; CMJ, countermovement jump; DL-COD, dominant leg 505 change-of-direction test; ES, effect size; LVP, load–velocity profile; LVP at 20%–100%1RM, mean velocity in the load–velocity profile from 20% to 100%1RM at pre (LVP 1) and post (LVP 2); MPD, magnitude-based decisions; NDL-COD, nondominant leg 505 change-of-direction test; PBT, percentage-based training group; PV, peak velocity; PV-CMJ, PV in the CMJ with 30%1RM; VBT, velocity-based training group.

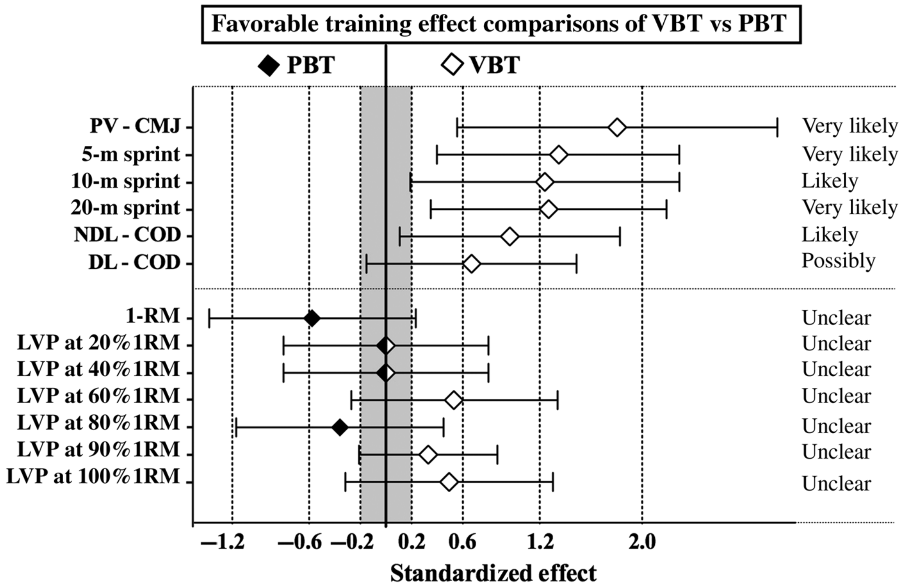



**Figure 3** — Between-groups effect-size comparisons for the changes in testing measures. %1RM indicates percentage of 1-repetition maximum; DL-COD, dominant-leg 505 change-of-direction test; NDL-COD, nondominant-leg 505 change-of-direction test; PBT, percentage-based training group; PV-CMJ, peak velocity in the countermovement jump with 30%1RM; VBT, velocity-based training group.

improvement (Figure 3). Furthermore, it was *unclear* whether either training method was more beneficial than the other for improvements in squat velocities from LVP 1 to LVP 2 (ES = −0.35 to 0.53; Figure 3). However, both the VBT and PBT groups *possibly* to *almost certainly* improved their MV against the same absolute load from LVP 1 to LVP 2 (Table 2). In addition, there were no differences between LVP 1 and LVP 3 for both groups across the relative load spectrum (20%1RM–90%1RM; Figure 4).

## Discussion

The main hypotheses of this study were that VBT would result in a greater magnitude of adaptation for maximal strength, loaded CMJ, sprint, and COD performance compared with PBT due to the individualized approach of VBT. However, our findings only partly supported our hypotheses. There were more favorable training effects for the VBT group in the PV-CMJ (ES = 1.81), sprint times (ES = 1.27 to 1.35), and COD times (ES = 0.67 to 0.97), while it was *unclear* whether either training method was more favorable for increasing maximal strength (ES = −0.57) or enhancing squat velocities in the LVP (ES = −0.35 to 0.53). Notably, the strategy of adjusting load to match daily readiness to train created the perception that the VBT sessions were easier than the PBT sessions (RPE = 5.1 vs 6.0; ES = 0.72) and allowed the VBT group to perform training repetitions with faster velocities (MV = 0.76 $m{\cdot}s^{-1}$ vs 0.66 $m{\cdot}s^{-1}$; ES = 1.25). The faster average training repetitions may explain the favorable VBT effects for the loaded jump, sprint, and COD assessments compared with the PBT group.

Both the VBT (~11%, ES = 0.89) and PBT (~12%, ES = 1.41) groups improved their 1RM after the 6 weeks of squat training (Table 2). Notably, the magnitude of maximal strength increases for both groups in the present study were slightly greater than the findings reported by Dorrell et al[14] (VBT: ~9%, ES = 0.59; PBT: ~8%, ES = 0.44), which may be due to the present study's greater training frequency in the same 6-week training period (18 sessions compared with 12) or differences in periodization strategies. In the present study, even though the relative (in percentage) improvement in 1RM was quite similar between groups, the PBT group lifted with slower average repetition velocities but slightly heavier average repetition loads compared with the VBT group (Table 1). This suggests that heavier loads and the intent to move an external load as fast as possible are critical factors for enhancing strength and, potentially, more important than targeting faster velocity outputs, so long as concentric muscular failure is not achieved. Previous VBT research by Padulo et al[27] showed that strength-trained males (1RM/body mass = ~1.3) increased their 1RM by ~10% after performing maximal concentric velocity bench-press training for 3 weeks (6 sessions), where training sets were ceased once the repetition velocity dropped below 20% of the fastest repetition from the first set. By comparison, another group (1RM/body mass = ~1.3) in the same study had no significant change in 1RM (0.17% increase) after training with the same exercise and training frequency but performed repetitions with self-selected concentric velocity and to concentric muscular failure. The greater increases in 1RM observed for the VBT group in the Padulo et al[27] study were attributed to a greater recruitment of motor units at a high-firing frequency, which can improve the rate of force development. Consequently, it could be speculated that the requirement for all participants to use maximal intent during the concentric phase increased muscle activation and firing frequency of the lower body muscles. This may have contributed to improvements in the rate of force development that led to the increases in 1RM for both the VBT and PBT groups.[28]

In the present study, even though there were only small (ES = 0.24) differences in relative load lifted between groups (Table 1), this subtle decrease in load for the VBT group (to achieve the intended sessional target velocity) resulted in maintaining session velocity and large (ES = 1.25) differences in MV of the training repetitions between groups (Table 1). As a consequence, even though the faster squat velocities performed by the VBT group during training did not lead to more favorable

| | VBT | | | PBT | | |
|---|---|---|---|---|---|---|
| | LVP 1 | LVP 2 | LVP 3 | LVP 1 | LVP 2 | LVP 3 |
| **20%1RM, m·s$^{-1}$** | 1.29 (0.12) | 1.37 (0.13) | 1.30 (0.13) | 1.25 (0.11) | 1.33 (0.12) | 1.26 (0.12) |
| **40%1RM, m·s$^{-1}$** | 1.12 (0.07) | 1.20 (0.07) | 1.11 (0.08) | 1.08 (0.06) | 1.14 (0.07) | 1.06 (0.08) |
| **60%1RM, m·s$^{-1}$** | 0.90 (0.06) | 0.97 (0.08) | 0.89 (0.08) | 0.87 (0.06) | 0.93 (0.07) | 0.88 (0.07) |
| **80%1RM, m·s$^{-1}$** | 0.68 (0.07) | 0.76 (0.07) | 0.67 (0.06) | 0.65 (0.07) | 0.73 (0.07) | 0.65 (0.07) |
| **90%1RM, m·s$^{-1}$** | 0.50 (0.06) | 0.58 (0.06) | 0.49 (0.05) | 0.48 (0.07) | 0.55 (0.07) | 0.46 (0.07) |
| **# *100%1RM*, m·s$^{-1}$** | # 0.24 (0.05) | # 0.48 (0.06) | # 0.25 (0.05) | # 0.23 (0.04) | # 0.44 (0.05) | # 0.22 (0.05) |

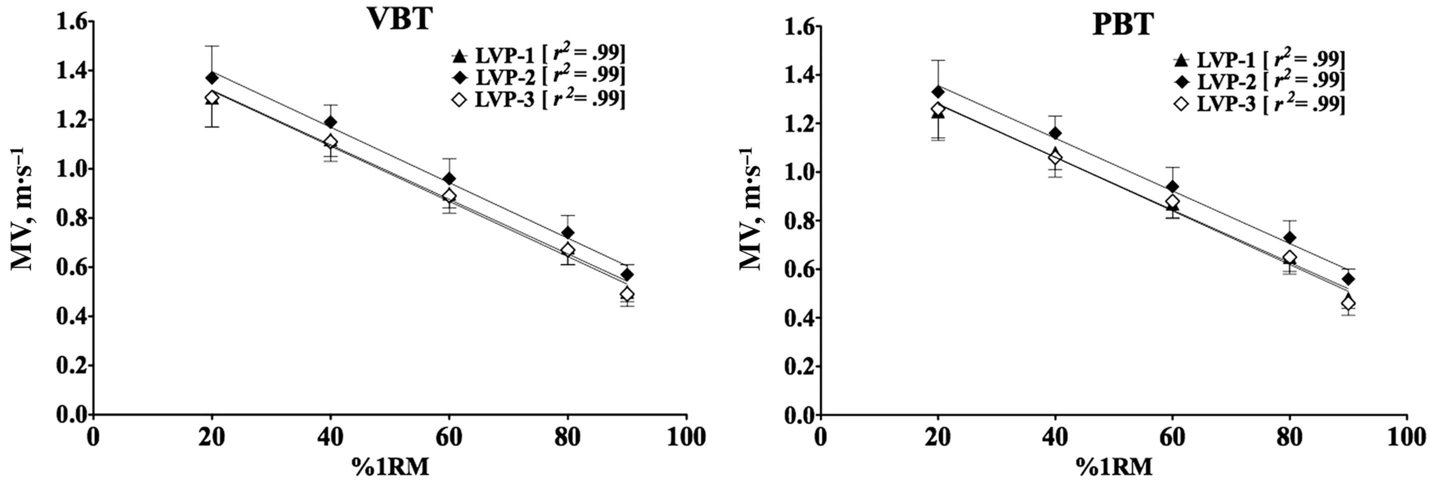



**Figure 4** — LVPs (using MV) at baseline (LVP 1), posttraining 1RM assessment (LVP 2), and posttraining LVP assessment (LVP 3). %1RM indicates percentage of 1-repetition maximum; MV mean velocity; LVP, load–velocity profile; PBT, percentage-based training group; VBT, velocity-based training group. #MV at 100%1RM was not included in the LVPs, as it is not reliable.

1RM gains than the PBT group, it may have assisted with favorable improvements in PV-CMJ (ES = 1.81), sprint times (ES = 1.27 to 1.35), and COD times (ES = 0.67 to 0.97) compared with the PBT group. These findings are in accordance with previous research demonstrating that greater consistency of training with higher velocity outputs can lead to superior improvements in jumping and sprinting.[29]

The VBT and PBT groups had *possibly* to *almost certainly* faster squat velocities against all of the same absolute loads in their LVP from LVP 1 to LVP 2, which was to be expected according to the load–velocity relationship.[13] As seen in Table 2, the absolute changes in the velocities across the relative load spectrum were very similar between groups (LVP 1 vs LVP 2), even though the VBT group trained with faster training repetition velocities compared with PBT. This suggests that the intent to move the bar as rapidly as possible is an important stimulus for enhancing velocity against a given load, regardless of the training method utilized. Furthermore, there were trivial differences in MV between LVP 1 and LVP 3 across the relative load spectrum (20%1RM–90%1RM), despite the increases in maximal strength for both groups (Figure 4). Similar findings were also reported by González-Badillo and Sánchez-Medina,[13] who found there was no significant change in velocities (ICC = .81–.91; CV = 0.0%–3.6%; $P > .05$) across the relative load spectrum (30%1RM–100%1RM) from a bench press LVP performed before and after 6 weeks of upper-body strength training, despite an increase in maximal strength of 9.3%. Thus, the present study's findings are in accordance with the findings of González-Badillo and Sánchez-Medina,[13] where velocity in the LVP across the relative load spectrum remained stable when maximal strength changed.

Compared with PBT, it was found that the participants in the VBT group perceived training to be easier (Table 1). This was particularly pertinent during resistance training sessions 10 to 15, where moderate to large differences in RPE scores (ES = 0.76 to 1.79) were reported between groups (pertaining to loads of 72% 1RM–85%1RM). During these sessions, the VBT group perceived these sessions to be easier when compared with the PBT group, despite there being only trivial to small differences (ES = 0.17 to 0.55) in the relative training load of sessions 10 (81%1RM), 11 (77%1RM), 12 (72%1RM), and 13 (85%1RM). These reductions in perceived effort (while completing similar external loading) may be beneficial for reducing subjective measures of training load.[30] Similarly, Orange et al[15] showed in their applied training study that the use of VBT in the back squat exercise helped to reduce perceived levels of training stress compared with a PBT group.

During the present study, the participants were in a relatively controlled training environment where they refrained from performing other external modes of training. Consequently, only small differences in load were reported between groups throughout the training study (Table 1). However, in a team sport environment, when multiple factors must be considered (technical skills, matches, conditioning, etc), other fatiguing elements could exacerbate the magnitude of velocity loss beyond that reported in the present study. This may be of additional benefit when using the LVP–VBT approach and assist in the mitigation of physical and psychological stressors that can negatively influence performance.[15] Alternatively, training load can be increased to accommodate for participants who perform repetitions with faster velocities compared with their baseline LVP. For example, in the present study, a participant in the VBT group lifted with heavier loads than the average PBT group member for 13 of 18 training sessions. For this participant, the slightly higher training loads over the entirety of the training program compared with the PBT group (74.3%1RM vs 70.9%1RM) also led to slightly higher increases in 1RM compared with PBT (14.5% vs 12.5%). Thus, a critical aspect to the LVP–VBT method is that it allows individuals to lift with appropriate loads on any given day to accommodate for individual rates of training adaptation.

We acknowledge that some limitations exist within this study. For example, during the heavier VBT sessions, some of the "stronger" participants (~2 > 1RM squat/body mass), who typically have less capacity for maximal strength improvement compared with "weaker" participants, were often unable to maintain the session's target velocity with the same load they lifted from the first set. Therefore, these participants had to lift with lighter loads (~5%1RM decrease) in the last couple of sets to achieve the session's target velocity, compared with the PBT group. Contrastingly, the "weaker" individuals (1RM squat/body mass from approximately 1.5–2) in the VBT group, who gained strength more rapidly, could lift with faster velocities than their sessional target velocity, and were typically able to lift heavier loads than the PBT group. All things considered, VBT was perceived with less difficulty and gave superior improvements in the loaded jump, sprints, and COD tasks, and PBT had only small but *unclear* differences in 1RM improvement. Therefore, we believe the VBT methodology used in the present study was appropriate for all well-trained participants to enhance their maximal strength, jump, sprint, and COD performance. That being said, since decreasing the load negatively affects maximal strength, some stronger individuals whose primary goal is to enhance maximal strength may prefer to modify the load only when the training velocity is superior to the prescribed velocity.

Another perceived limitation in this study was the lack of randomization when assigning participants to the training groups. Randomization is important to avoid bias; however, in the present study, it was critical that the VBT and PBT groups were matched based upon strength levels to prevent potential bias. Although all the participants were well-trained (1.5 > 1RM squat/body mass), there were some individuals who were considerably stronger (2 > 1RM squat/body mass) than others. Therefore, if either group was unevenly matched with "weaker" or "stronger" participants, then the magnitude of training adaptation may have been different between the groups, as "weaker" individuals typically have greater capacity for improvement, particularly in maximal strength. Importantly, once we assigned the groups based on their baseline strength levels, there were no differences in the pretesting data between groups for any of the tests. Therefore, we believe the lack of randomization was actually beneficial to differentiate the training methods and prevent potential bias. Finally, it should be noted that during the interset rest period, appropriate load adjustments were required for the VBT group. Although this was not difficult, in practice, this would add some additional complexity for an athlete compared with PBT.

Resistance training load and volume are critical to optimizing strength and power adaptations; therefore, future VBT studies could look to explore the combination of multiple VBT methods. For example, previous VBT studies have explored the use of velocity loss thresholds to terminate repetitions in a set to control resistance-training volume.[31,32] Therefore, a combination of the individualized LVPs to objectively prescribe relative training load based on the physiological condition of an individual on a given day and the implementation of velocity loss thresholds to account for the appropriate volume of repetitions could be of great use for individuals looking to train with accurate training load and volume.

## Practical Applications

By monitoring MV to modify resistance training load, the individualized LVP–VBT method described in this study can be utilized to enhance maximal strength, loaded CMJ, sprint, and COD performance. In addition, this VBT method may be beneficial for the management of perceived training loads, particularly in individuals who take part in numerous forms of training (eg, resistance training, conditioning, technical/tactical). Furthermore, some individuals could benefit from the individualized approach of this VBT method if maximal strength is likely to increase rapidly, such as "weaker" individuals (~2 < 1RM to body mass) or when an individual returns to regular training following sedentary training periods (ie, return from injury). That being said, if all repetitions are performed with maximal intent but not to concentric muscular failure, a stronger athlete (~2 > 1RM to body mass) may gain a slight advantage in maximal strength improvements using a periodized PBT resistance-training program with regular training frequency and progressive overload instead of this VBT method.

## Conclusions

Both VBT and PBT methods were effective for improving maximal strength and COD performance, but VBT was more beneficial than PBT for enhancing loaded CMJ, sprint, and COD assessments. All things considered, PBT may be slightly favorable for stronger individuals solely focused on increasing maximal strength, whereas VBT may be preferred by athletes seeking to enhance their loaded CMJ, sprint, and COD performance. In addition, athletes who may experience day-to-day fluctuations in performance may benefit from the decreased perceptual demands of VBT.

### Acknowledgments

The authors would like to thank all of the participants for providing their valuable time in volunteering for this study, and Edith Cowan University, who provided financial assistance and all testing equipment.

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