

Low-Velocity Loss Induces Similar Strength Gains to Moderate-Velocity Loss During Resistance Training

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Abstract

Galiano, C, Pareja-Blanco, F, Hidalgo de Mora, J, and Sáez de Villarreal, E. Low-velocity loss induces similar strength gains to moderate-velocity loss during resistance training. *J Strength Cond Res* XX(X): 000–000, 2019—This study aimed to analyze the effects of 2 velocity-based resistance training (VBT) programs that used the same relative loading but differed in the velocity loss (VL) throughout the set: 5% (VL5) vs. 20% (VL20). Twenty-eight physically active men (age: 23.0 ± 3.2 years; height: 175.8 ± 4.7 cm; body mass: 73.8 ± 10.8 kg) were randomly assigned to 2 groups: VL5 ($n = 15$) or VL20 ($n = 13$). Subjects followed a 7-week (14 sessions) VBT program using the squat exercise while repetition velocity was monitored. The following variables were assessed at pretest and posttest: estimated 1-repetition maximum (1RM); average velocity attained for all absolute loads common to pretest and posttest (AV); average velocity for those loads that were moved faster than $1 \text{ m} \cdot \text{s}^{-1}$ ($AV > 1$); average velocity for those loads that were moved slower than $1 \text{ m} \cdot \text{s}^{-1}$ ($AV < 1$); countermovement jump (CMJ); and 20-m running sprint time (T20). T20 and CMJ height were assessed before each training session to analyze their evolution during the training program. The VL5 group executed only 32.6% of the total repetitions performed by the VL20 group (156.9 ± 25.0 vs. 480.5 ± 162.0 rep). Both groups improved significantly ($p < 0.01$) in all variables analyzed (1RM, AV, $AV > 1$, $AV < 1$, CMJ, and T20) from pretest to posttest, with no significant differences between them. Therefore, a low VL (5%) induced similar gains in strength, jump, and sprint performance to a moderate VL of 20%, despite VL5 performing only 32.6% of the repetitions achieved by the VL20 group.

Key Words: velocity-based training, strength training, athletic performance, squat, sprint, jump

Introduction

Resistance training (RT) is recognized as an effective method for improving muscle strength and hypertrophy, power output, speed, and muscular endurance (17). The configuration of exercise stimuli in RT will differ according to the muscle action, intensity, exercise selected, volume, rest interval, and repetition velocity (17). Aside from these factors, a “level of effort” variable arises from the interaction between intensity and volume. The level of effort must be understood in terms of the number of repetitions actually performed in each set with respect to the maximum possible number of repetitions (nRM) that can be completed against a given load (9). Traditionally, the 1-repetition maximum (1RM) has been the primary reference to prescribe training aimed to develop strength and power adaptations. However, actual daily 1RM values may fluctuate depending on the neuromuscular performance variations experienced by athletes in each training session. Therefore, it cannot be guaranteed that the actual load truly represents the intended load (%RM) (24). The nRM is another method typically used to prescribe the training load. The nRM method implies that the set must be continued to failure, which may not be optimal for some athletes (5). Moreover, the nRM that can be performed with a given %1RM displays huge

interindividual variability (12,26). Therefore, a fixed number of repetitions per set with a given %1RM may mean that the number of repetitions left in reserve varies considerably between athletes. Recently, a velocity-based RT concept has been introduced, in which each %1RM corresponds to a determined mean concentric velocity (11,19,27,31,32). A very close relationship ($R^2 = 0.98$) between each %1RM and lifting velocity for the bench press exercise has been reported (11). This close relationship makes it possible to determine with high precision which %1RM has been lifted as soon as the first repetition of a set is performed with maximal voluntary velocity.

Recent research has also showed the load-velocity relationship in other exercises, including bench pull, full-squat, half-squat, and pull-ups (4,20,29,30,33). Because fatigue is proposed as a continuous rather than a failure-point phenomenon, the gradual decrease in lifting velocity during a training set can be interpreted as evidence of impaired neuromuscular function, and its assessment may provide a simple and objective means of quantifying levels of fatigue (16,28). A close relationship between the percentage of velocity loss (VL) incurred in a set and the percentage of completed repetitions with respect to the nRM ($R^2 = 0.96$) has also been observed (12). It is thus possible to determine the %1RM that has been completed from the VL achieved in the set with considerable accuracy (12). Consequently, the level of effort in terms of velocity-based RT must be prescribed in terms of 2 variables:

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(a) the first repetition's mean velocity, which is intrinsically related to loading intensity (11), and (b) a maximum VL to be allowed in each set, which is calculated as the percent loss in lifting velocity from the fastest (usually first) to the slowest (last) repetition in each set (28).

To find the optimal volume with different loads during RT to maximize strength gains, some studies have investigated how the stimulus changes in relation to the VL allowed within the set (23,24). These researchers compared 2 different RT protocols (20% velocity loss "VL20" vs. 40% velocity loss "VL40") using the same relative load over an 8-week period (23). The VL40 group maximized the hypertrophic response along with a fast-to-slow shift in muscle phenotype. However, the VL20 group did not display reductions in the fastest IIX fiber-type pool and achieved similar or even superior strength gains (23). In addition, the effects of training with other magnitudes of VL were compared (24). A soccer team was divided into 2 groups of 8 players: VL15 vs. VL30, using only the full-squat exercise. Training with a low magnitude of loss of velocity (VL15) induced greater strength and jump gains than training with a higher VL (VL30) (24). These studies thus show a tendency to achieve similar or better strength gains when the volume accumulated within the set is lower. However, it is unknown whether a lower level of fatigue than those previously analyzed would induce similar adaptations in physical performance. Therefore, the purpose of this study was to analyze the effects of 2 full-squat RT programs with the same relative load but different VL during the set (VL5 vs. VL20). Our hypothesis was that a small degree of fatigue within the set (VL5) would be enough to induce strength adaptations.

Methods

Experimental Approach to the Problem

The subjects trained twice a week over a 7-week period for a total of 14 sessions. Both groups used the same relative load (50% 1RM) during the entire training program, which was controlled by the lifting velocity of the first repetition ($\sim 1.14 \text{ m}\cdot\text{s}^{-1}$) but differed in the loss of velocity reached in each exercise set (VL5 vs. VL20). The subjects' 20-m sprint time (T20) and countermovement jump (CMJ) height were tested during the first training session each week. Sessions were performed in a research laboratory under the direct supervision of the investigators. Subjects were required not to engage in any other type of RT for the duration of the investigation. Both groups were assessed 5 days before (pretest) and 5 days after (posttest) the 7-week training intervention.

Subjects

Thirty healthy men volunteered to participate in this study. All subjects were physically active and had a minimum experience in RT training of 1.5 years. The initial 1RM strength for the full-squat exercise was $97.4 \pm 13.6 \text{ kg}$. Subjects were randomly assigned to each group, which only differed in the magnitude of VL allowed during the set: 20% (VL20) or 5% (VL5).

Values are reported as mean $\pm$ SD. Only those subjects who attended 100% of the training sessions were included in the statistical analysis. During the training process, 2 subjects in the VL20 group withdrew from the study for reasons not related to the study, so the final sample number was 28 (VL5;

$n = 15$; age: 22.1 ± 2.9 years; height: $175.1 \pm 5.3 \text{ cm}$; body mass: $72.5 \pm 11.3 \text{ kg}$ and VL20; $n = 13$; age: 23.9 ± 3.0 years; height: $176.6 \pm 3.5 \text{ cm}$; body mass: $75.7 \pm 9.4 \text{ kg}$). All subjects were informed about the experimental procedures and risks before they signed an informed consent. The study was approved by the Institutional Review Committee of the Pablo de Olavide University and was performed in accordance with the Declaration of Helsinki. No physical limitations or health problems were found during the training procedure. No subjects reported taking drugs, medications, or dietary supplements.

Procedures

Squat Loading Test. A Smith machine (Multipower Fitness Line; Peroga, Murcia, Spain) was used to perform the progressive loading test. The subjects performed the full-squat exercise from an upright position, descending at a self-controlled mean velocity (~ 0.50 – $0.70 \text{ m}\cdot\text{s}^{-1}$) until the tops of the thighs were below the horizontal plane, then immediately reversed motion and ascended back to the upright position at maximal intended velocity. One set of 8 repetitions with 20 kg was performed before testing as a warm-up protocol. The initial load was 30 kg and was progressively increased in 10-kg increments until the attained repetition velocity was lower than $0.68 \text{ m}\cdot\text{s}^{-1}$. This resulted in total 6.1 ± 0.9 increasing loads performed by each subject. One set of 3 repetitions was performed for light loads ($\geq 1.14 \text{ m}\cdot\text{s}^{-1}$), and only 2 repetitions were performed for moderate loads ($< 1.14 \text{ m}\cdot\text{s}^{-1}$) (30), with recovery times of 3 and 4 minutes, respectively. Strong verbal encouragement was provided to motivate subjects to give a maximal effort. Only the fastest repetition attained for every absolute load was saved for later analysis. The same protocol was used for pretest and posttest. All velocities showed in this study refer to mean propulsive velocity (MPV), which is defined as that fraction of the concentric phase during which barbell acceleration was greater than the acceleration because of gravity (32).

With this progressive loading test, we analyzed 4 variables: (a) estimated 1RM value, which was calculated from the MPV attained against the heaviest load of the test ($\text{Load} [\% 1\text{RM}] = -5.961 \text{ MPV}^2 - 50.71 \text{ MPV} + 117.0$; $R^2 = 0.954$; $\text{SEE} = 4.02\%$) (30); (b) the average MPV attained against all absolute loads common to pretest and posttest (AV); (c) the average MPV attained for absolute loads moved at velocities equal to or faster than $1 \text{ m}\cdot\text{s}^{-1}$ ($\text{AV} \geq 1$); and (d) average MPV attained for absolute loads moved slower than $1 \text{ m}\cdot\text{s}^{-1}$ ($\text{AV} < 1$). A linear velocity transducer (T-Force System; Ergotech, Murcia, Spain) was used to measure the velocity of the bar.

Sprint and Vertical Jump Tests. Before the first training session every week, CMJ and T20 performances were measured, so the changes in these variables were analyzed throughout the training program. First, a 5-minute warm-up consisting of joint mobilization was completed. After this, 5 sets of progressively faster 20-m running accelerations, separated by 1 minute, were executed. A standing start, with the self-selected lead-off foot placed 1 m behind the first timing gate, was used. Two maximal 20-m sprints with a 2-minute rest between each were performed on an indoor running track. The shortest T20 time was saved for further analysis. Sprint times were measured using photocells (Witty; Microgate, Bolzano, Italy). After measuring T20, a specific warm-up for jumping was performed. This warm-up consisted of 10 body-weight full

squats, 5 progressive-intensity (i.e., increasing jump height) CMJ, and 3 maximal CMJ with a 1-minute rest between each set. Then, 5 maximal CMJs were performed, with 5 seconds of rest between each jump. Height of CMJ was determined using an infrared timing system (OptojumpNext; Microgate), which calculated jump height (h) using flight time (t) and the acceleration because of gravity (g) as follows: $h = t^2 \cdot g / 8$. The highest and lowest values were discarded, and the resulting average was kept for analysis.

The same warm-up protocol was used at the beginning of every session, but the CMJ and T20 testing were done during every odd training session (i.e., RT session 1, 3, 5...). Test-retest reliability values as measured by the coefficient of variation (CV) were 2.3 and 1.0% for CMJ and T20, respectively. The intraclass correlation coefficients were 0.99 (95% confidence interval [CI]: 0.98–0.99) for CMJ and 0.98 (95% CI: 0.97–0.99) for T20.

Resistance Training Program. Once the warm-up was completed, subjects performed the full-squat RT. Velocity-based training was performed, instead of a traditional loading-based RT program (10,22). The training program consisted of 3 sets with 3-minute rest between each, using the same relative load (50% 1RM) in every training session. Before the squat training, the subjects carried out a warm-up of 5 repetitions with loads 10 and 20 kg lighter than the absolute load expected for the training session. The absolute load used for every training session was individually adjusted using the velocity of the first repetition of the first set, which was established at $1.14 \text{ m} \cdot \text{s}^{-1}$ ($\sim 50\%$ 1RM) (30) with a margin of $\pm 0.03 \text{ m} \cdot \text{s}^{-1}$. Therefore, absolute loads lifted at between 1.17 and $1.11 \text{ m} \cdot \text{s}^{-1}$ for the first repetition were considered valid. The 2 RT protocols differed in the degree of fatigue experienced during the exercise sets, which was objectively quantified by the magnitude of VL attained in each set and, consequently, differed in the number of repetitions performed per set. The VL20 group performed repetitions until a VL of 20% was attained. However, the VL5 group stopped performing repetitions when the velocity attained was $0.04 \text{ m} \cdot \text{s}^{-1}$ lower than the fastest of the set. As a margin of $\pm 0.03 \text{ m} \cdot \text{s}^{-1}$ was established, a VL decrease of $0.04 \text{ m} \cdot \text{s}^{-1}$ meant that the athlete was fatigued, and the set was concluded. At the end of the study, the VL average was 20.1 ± 0.4 and $5.6 \pm 0.6\%$ for VL20 and VL5, respectively. During training, subjects received immediate velocity feedback from the measurement system while being encouraged to perform each repetition at maximal intended velocity.

Statistical Analyses

Values are reported as mean $\pm$ SD. Test-retest absolute reliability was assessed using the CV, whereas relative reliability was calculated using the intraclass correlation coefficient with a 95% CI calculated with the one-way random effects model. The normality of distribution of the variables and the homogeneity of variance were verified using the Shapiro-Wilk test and Levene test, respectively. Data were analyzed using a 2×2 factorial analysis of variance using one -factor (VL5 vs. VL20) and one within-factor (pretest vs. posttest) analyses. Statistical significance was established at the $p \leq 0.05$ level. In addition, data were assessed for clinical significance using an approach based on the magnitudes of change (1,15). The standard differences and effect sizes (ES) for variable changes between

groups (VL5 vs. VL20) were calculated using the SD value of the pretest (3). Probabilities were also calculated to establish whether the true (unknown) differences were lower, similar to or higher than the smallest worthwhile difference or change ($0.2 \times$ between-subject SD) (3). Quantitative chances of better or worse effects were assessed qualitatively as follows: $<1\%$, almost certainly not; 1–5%, very unlikely; 5–25%, unlikely; 25–75%, possible; 75–95%, likely; 95–99%, very likely; and $>99\%$, almost certain. If the chances of obtaining beneficial/better or detrimental/worse were both $>5\%$, the true difference was assessed as unclear (1,15). Inferential statistics based on interpretation of the magnitude of effects were calculated using a purpose-built spreadsheet for the analysis of controlled trials (14). The rest of the statistical analyses were performed using SPSS software version 18.0 (SPSS, Inc., Chicago, IL).

Results

No significant differences between groups were found at pretest for any of the variables analyzed. Once the RT program was concluded, the VL5 group had executed only 32.6% of the total repetitions performed by the VL20 group (156.9 ± 25.0 vs. 480.5 ± 162.0 rep, for VL5 vs. VL20). The average VL was $5.6 \pm 0.6\%$ for VL5 and $20.1 \pm 0.4\%$ for VL20.

Squat Loading Test

Both groups attained significant improvements in all the variables analyzed, with no significant differences between them: 1RM (ES = 0.71 vs. 0.75; $p = 0.404$), AV (ES = 1.07 vs. 1.09; $p = 0.514$), $AV > 1$ (ES = 1.20 vs. 0.96; $p = 0.677$), and $AV < 1$ (ES = 1.35 vs. 1.64; $p = 0.541$) for VL5 and VL20, respectively (Table 1). The approach based on the magnitudes of change showed a *possible* better effect on 1RM for VL20, whereas *unclear* differences were observed for the rest of the variables (Figure 1). Figure 2A shows the evolution of the absolute load lifted at $1.14 \text{ m} \cdot \text{s}^{-1}$, corresponding approximately to 50% 1RM, in every training session.

Sprint and Vertical Jump Test

Significant improvements ($p = 0.001$) were observed for CMJ and T20 performance in posttest for both training groups (Table 1). The CMJ height increased in a similar way for both groups, showing an *almost certain* positive effect with no significant differences between them (VL5; ES = 0.44 vs. VL20; ES = 0.60; $p = 0.826$). The effects on T20 performance also showed an *almost certain* positive effect for both groups. Again, no between-group difference was found (VL5; ES = 0.88 vs. VL20; ES = 0.63; $p = 0.210$). In addition, VL5 induced a *possible* better effect on T20 than VL20, whereas *unclear* differences between groups were observed for CMJ height (Figure 1). Figures 2B, C show the evolution of CMJ and T20 performances throughout the RT program for each group.

Discussion

The main finding of this study was that the VL5 group, which performed fewer repetitions within the set, showed similar strength gains in full-squat exercise, CMJ, and T20 as the VL20 group (Table 1). In fact, VL5 only performed 32.6% of the repetitions that VL20 did (156.9 ± 25.0 vs. 480.5 ± 162.0 rep), with

Table 1**Changes in selected athletic performance variables from pre- to posttraining for each group.*†**

	Pre	Post	p-value	ES (90% CI)	Percent changes of better/trivial/worse effect
1RM-VL5 (kg)	97.7 ± 13.7	108.2 ± 14.5	0.001	0.71 (0.50–0.91)	100/0/0 almost certain
1RM-VL20 (kg)	97.0 ± 13.9	110.2 ± 18.4	0.001	0.75 (0.48–1.03)	100/0/0 almost certain
AV-VL5 (m·s ⁻¹)	1.01 ± 0.07	1.10 ± 0.08	0.001	1.07 (0.73–1.40)	100/0/0 almost certain
AV-VL20 (m·s ⁻¹)	0.97 ± 0.07	1.08 ± 0.10	0.001	1.09 (0.60–1.58)	100/0/0 almost certain
AV > 1-VL5 (m·s ⁻¹)	1.22 ± 0.05	1.30 ± 0.06	0.002	1.20 (0.70–1.69)	100/0/0 almost certain
AV > 1-VL20 (m·s ⁻¹)	1.18 ± 0.07	1.27 ± 0.10	0.001	0.96 (0.41–1.52)	99/1/0 very likely
AV < 1-VL5 (m·s ⁻¹)	0.77 ± 0.05	0.88 ± 0.08	0.001	1.35 (0.89–1.81)	100/0/0 almost certain
AV < 1-VL20 (m·s ⁻¹)	0.77 ± 0.02	0.90 ± 0.09	0.001	1.64 (0.97–2.32)	100/0/0 almost certain
CMJ-VL5 (cm)	34.3 ± 6.7	37.5 ± 6.9	0.001	0.44 (0.34–0.55)	100/0/0 almost certain
CMJ-VL20 (cm)	33.9 ± 4.9	36.9 ± 4.6	0.001	0.60 (0.43–0.76)	100/0/0 almost certain
T20-VL5 (s)	3.09 ± 0.15	2.94 ± 0.13	0.001	0.94 (0.75–1.13)	100/0/0 almost certain
T20-VL20 (s)	3.07 ± 0.16	2.96 ± 0.12	0.001	0.70 (0.46–0.94)	100/0/0 almost certain

*ES = effect size within group; CI = confidence interval; VL5, group that trained with a mean velocity loss of 5% in each set ($n = 15$); VL20, group that trained with a mean velocity loss of 20% in each set ($n = 13$); 1RM, estimated 1-repetition maximum squat strength; AV, average mean propulsive velocity attained against absolute loads common to pretest and posttest in the squat progressive loading test; AV > 1, average velocity developed against "light" loads, that is, those lifted faster than 1.00 m·s⁻¹; AV < 1, average velocity developed against "heavy" loads, that is, those lifted slower than 1.00 m·s⁻¹; CMJ, countermovement jump height; T20, 20-m sprint time.

†Data are mean ± SD. p value indicates significant intragroup differences.

an average of 11.0 ± 1.8 reps per session for VL5 vs. 34.3 ± 11.6 reps per session for VL20, respectively. These findings may indicate that a stimulus characterized by a low degree of fatigue achieved (VL5) and high velocity of the repetitions within the set may be enough to induce strength adaptations for this population. Therefore, it would not be necessary to exert more effort, which would result in greater fatigue and slower rates of recovery (25). Previous studies (23,24) have analyzed the effects of the magnitude of VL in the set. However, none of them analyzed the effects of such low levels of fatigue during the set. Our results highlight that to develop strength adaptations, a high volume of

repetitions within the set may not be necessary. In fact, both groups improved significantly in terms of 1RM, with no significant differences between groups. Pareja-Blanco et al. (23,24) showed similar and better results in 1RM strength in groups that achieved a lower VL in full-squat exercise while lifting the same relative load. However, in those studies, the groups classified as having a lower VL were experiencing losses of 15–20%, which correspond to the higher VL in the present study. Using the magnitude of change approach showed a *possible* better effect for VL20 than VL5 in this variable (Figure 1). Thus, a 5% of loss of velocity in the set may not be enough to maximize the 1RM

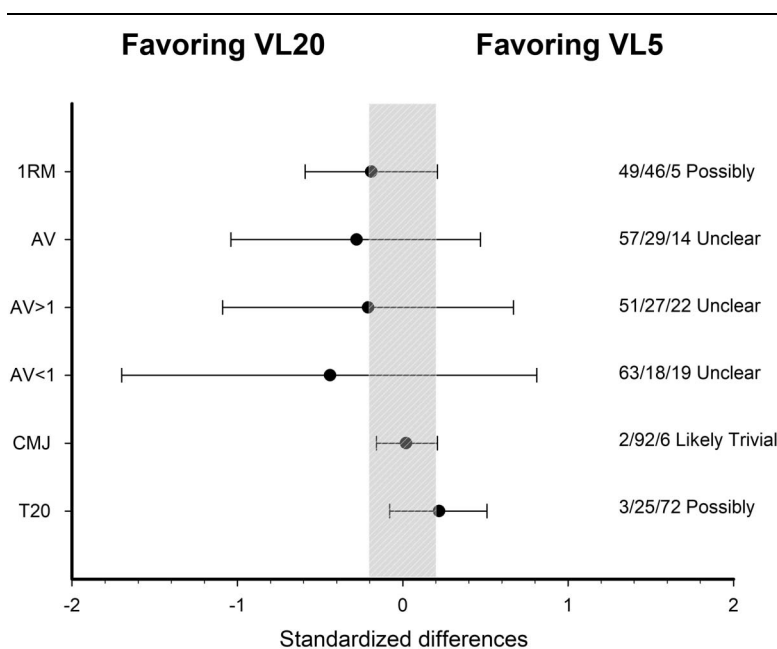


Figure 1. Difference scores (90% confidence intervals) for changes from pretest to posttest in 1-repetition maximum (1RM), average velocity for all absolute loads common to pretest and posttest (AV), average velocity for those loads that were moved faster than 1 m·s⁻¹ (AV > 1), average velocity for those loads that were moved slower than 1 m·s⁻¹ (AV < 1), countermovement jump (CMJ), and 20-m running sprint time (T20). VL5: group that trained with a mean velocity loss (VL) of 5% in each set ($n = 15$); VL20: group that trained with a mean VL of 20% in each set ($n = 13$). Gray areas represent trivial differences. The probability of the effect being practically relevant in favor of VL20 compared with VL5 is given in the boxes.

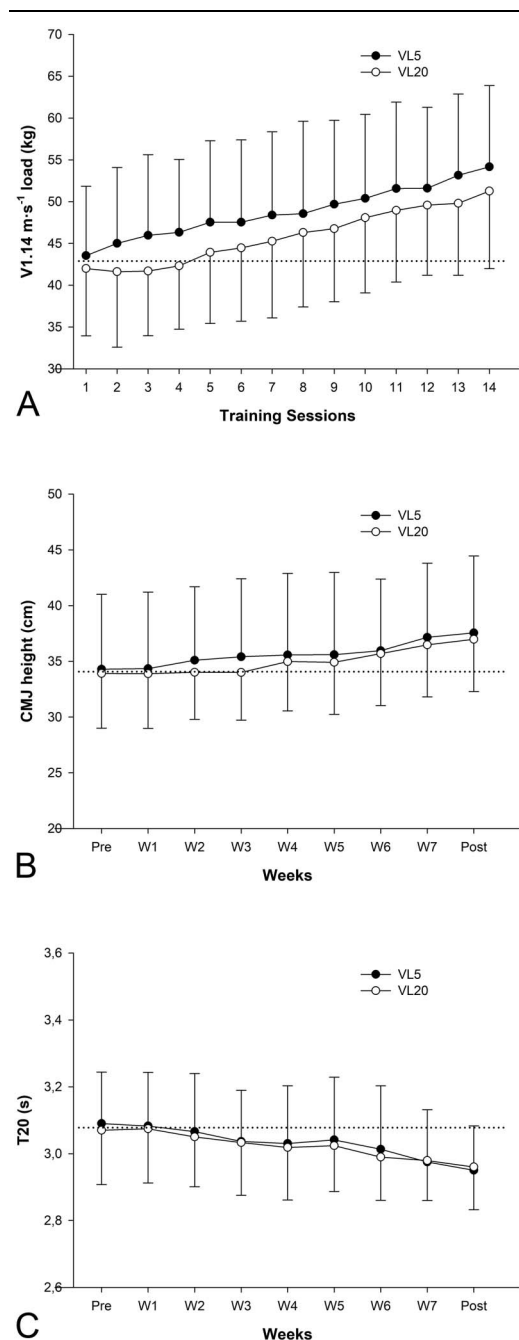


Figure 2. Evolution of physical performance throughout the season expressed as follows: (A) absolute Load lifted at $1.14 \text{ m} \cdot \text{s}^{-1}$ in each training session, which corresponds to approximately 50% 1RM in the squat exercise; (B) counter-movement jump height; and (C) 20-m running Sprint time. Data are mean $\pm$ SD. VL5: group that trained with a mean velocity loss (VL) of 5% in each set ($n = 15$); VL20: group that trained with a mean VL of 20% in each set ($n = 13$).

strength gains, at least with this intensity (50% 1RM). These findings seem to be in line with other authors who suggest the existence of an inverted U-shaped relationship between training volume and performance increase (7,8,18). Therefore, a certain minimal training volume seems to be necessary to elicit strength gains. We also analyzed how these training protocols affected the load-velocity curve by measuring the average MPV attained with lighter ($AV > 1$), heavier ($AV < 1$), and all absolute loads (AV)

and found similar improvements in both groups (Table 1). The effects observed in the load-velocity relationship in the VL20 group (11.3, 16.8, and 7.3% for AV, $AV < 1$, and $AV > 1$, respectively) were very similar to those observed in one of the previously cited studies (23), which also used a VL20 group (12.5, 21.7, and 6.2%), showing better results than the group that performed a higher number of repetitions for the same relative load (VL40).

Head coaches and strength and conditioning professionals are also interested in the effects of RT on athletic performance, rather than solely on muscle development and hypertrophic adaptations. In the present study, both training programs (VL5 and VL20) induced similar enhancements in CMJ and T20 performance. However, the training efficiency was higher for VL5 compared with VL20 because they obtained similar improvements by only performing the 32.6% of the reps performed by VL20. These findings are consistent with previous observations of training-induced specificity caused by training programs in which high-velocity contractions with low levels of fatigue were used (maximal VL was 20%) (23,24). In this regard, high values of VL in the squat exercise (30–40%) did not induce improvements in CMJ height, despite the high levels of discomfort and fatigue experienced in those training routines (23,24). Our study also showed enhancements in T20 performance, with no significant differences between groups but with an ES favorable to VL5 compared with VL20 (Figure 2). Thus, a very low VL in the set (5%) may induce a *possibly* better effect on sprint performance than moderate magnitudes of VL (20%). These improvements are similar to those observed in other studies that also used the squat exercise (2,13). There are also studies that have not showed sprint improvements using squat RT programs (23,24). However, some limitations need to be addressed. The main limitation is that in the present study and in the study by Hammami et al. (13), several sprints were performed before the RT session. This may have influenced the T20 improvements. Thus, whether the magnitude of sprint improvements was the result of the previous sprints or the RT program performed, or a combination of both, needs cautious interpretation.

To monitor the strength adaptations that occur during RT programs, some authors have assessed estimated 1RM changes during the squat RT program (23). In this regard, we assessed the changes in squat strength, CMJ, and T20 performance throughout the training program (Figure 2). Our results show that the performance of both groups improved for these variables during the RT program. This finding is very relevant in athletes who need to maintain a high level of strength throughout the season, with competitions every weekend or even every 3–4 days. It has been suggested that protocols that perform repetitions until or close to muscular failure result in failure to return to baseline performance until 48 hours post-exercise (21), and this fact could interfere with the development of other training components (6). Our findings suggest that low levels of VL (5 and 20%), which would allow a quick performance recovery, induce enhancements in squat strength, jump, and sprint performance.

Velocity-based RT with a VL of 5% resulted in similar strength gains in full-squat exercise, CMJ, and T20 performance as an RT program with a higher level of fatigue (20%), despite the VL5 group performing only 32.6% of the reps that the VL20 group did against the same relative load (50% 1RM). These findings challenge the “no pain no gain” concept. In fact, performing a VL of

20% was a less efficient way to improve performance for physically active subjects than a VL of 5%.

Practical Applications

Full-squat exercise is recommended as an effective form of RT for improving athletic performance; however, the effects of RT can vary because of a large number of factors, including VL during the set. The VL attained during the set may provide valid information about the optimal degree of fatigue necessary for maximizing performance. The current study's conclusions should be taken into account by strength and conditioning professionals, who must consider the most appropriate level of fatigue during a set and its orientation to velocity-based training programs.

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