

VELOCITY-BASED TRAINING VS. %1RM:

WHICH IS BETTER FOR DEVELOPING POWER?

BUAN

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10-minute Read

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Introduction

In recent years, new load-management methods for resistance training (RT) have been gaining popularity as a way of improving strength and power output as well as monitoring fatigue; such as velocity-based training (VBT) (Montalvo-Pérez et al., 2021). Where traditional resistance training (TRT) uses a percentage of an athlete's one-repetition max (%1RM) to prescribe load, VBT uses velocity to inform or enhance training practice and can monitor and adjust training load in any given lift. (Weakley et al., 2021; Orange et al., 2019).

Because of this, VBT may reduce unnecessary mechanical stress that may be caused by TRT and allow athletes to perform more repetitions (Montalvo-Pérez et al., 2021). In contrast, training based on %1RM does not account for the athlete's strength and energy levels on a given training day which can fluctuate due to fatigue, sleep, stress, nutrition or potential injury, making the training load harder than it should be (Liao et al., 2021). Though there are already ways of adjusting the volume of a lift according to an athlete's energy levels such as rating of perceived exertion or repetitions-in-reserve (Balsalobre-Fernández et al., 2021), they rely on the athlete's own judgement which can make it unreliable (Orange et al., 2022).



Figure 1: Linear position transducer (left) & accelerometer (right); devices used for VBT

Mechanics Behind Power Output and Training

Before we understand how VBT is utilised, we should first understand the mechanics behind power training as well as improving power and force.

Motor unit recruitment provides the physiological foundation for force production. Motor units consist of either type I or type II muscle fibres and its subclasses (Type IIa and IIx). Type II muscle fibre subclasses are characterized by having superior power output but are more susceptible to fatigue. Type IIx fibres exhibit the highest contractile velocity and peak power per unit area but fatigue rapidly (Schiaffino & Reggiani, 2011).

Henneman's size Principle

Motor unit recruitment follows Henneman's size principle, in which motor units are recruited in order of motor neuron size — smaller motor units (typically innervating type I fibres) are recruited first, and progressively larger motor units (innervating type II fibres) are recruited as force demands increase (Henneman et al., 1965) (Figure 2). The current literature surrounding muscle fibres suggests that RT performed at slower speeds due to loads >70% of 1RM produces a shift from type IIx and IIx/IIa hybrids to a purer IIa. In contrast, RT when carried out at faster velocities typically shows somewhat less of a loss in IIx and IIx/IIa fibres and a decrease in type I fibres (Plotkin et al. (2021).

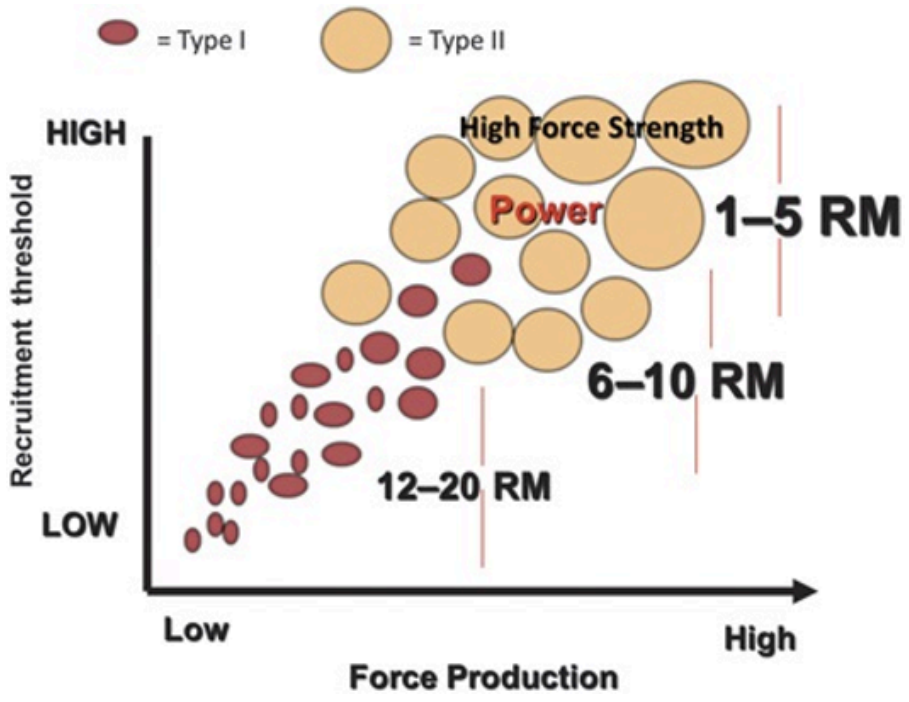


Figure 2: How Henneman's size principle translates into TRT. Printed with permission from Kraemer & Looney (2012)

How VBT is Implemented

Now that we understand the mechanics behind power training, let's look at how VBT is implemented by practitioners.

Table 1: Exercise velocities (m/s) at different %1RM (Balsalobre-Fernández & Torres-Ronda, 2021)

Load (% 1RM)			
40%	1.03	1.21	1
45%	0.96	1.14	0.94
50%	0.89	1.06	0.87
55%	0.82	0.99	0.81
60%	0.75	0.91	0.75
65 %	0.66	0.84	0.69
70%	0.60	0.77	0.62
75%	0.53	0.69	0.56
80%	0.46	0.62	0.5
85%	0.38	0.54	0.44
90%	0.31	0.47	0.37
95%	0.24	0.39	0.31
100%	**0.17**	**0.32**	**0.25**

Weakley et al. (2021) described VBT as an umbrella term that covers a wide variety or training approaches. Two key terms that are regularly associated with VBT is mean concentric velocity (MCV) and mean propulsive velocity (MPV).

- **MCV** is the average velocity produced over the entire concentric phase of a movement, including both the propulsive and braking phases (García-Ramos et al., 2018).
- **MPV** is the average velocity from the start of the concentric phase up to the point where the acceleration of the bar is lower than gravity (-9.81 $m \cdot s^{-2}$) and does not consider the braking phase (García-Ramos et al., 2018).

When to use MCV & MPV

At high relative loads (typically >80–90% 1RM), MCV and MPV converge because there is little or no braking phase; MPV is most useful at lighter loads where the braking phase is non-trivial. Within the VBT literature, the majority of the exercises that are analysed are barbell-based, with research reporting a near perfect relationship between the MCV and %1RM in exercises such as bench-press, back squat, deadlift and hip-thrust (Balsalobre-Fernández & Torres-Ronda, 2021). It is however important to note that the load-velocity relationship is exercise dependent, meaning different exercises may elicit different velocities albeit at the same %1RM (Table 1).

Load-Velocity Profile (LVP)

A tool used in VBT; describes the relationship between the load lifted and the velocity at which it is moved. A LVP is unique to each individual lifter and each specific exercise.

A LVP for an athlete can be created using data gathered from previous loads lifted, from which a regression can be calculated that fits the velocity of the different loads previously recorded. The more loads recorded, the more accurate the LVP (Balsalobre-Fernández & Torres-Ronda, 2021). When the LVP is established, two main approaches for VBT can be used; velocity zones (VZ) or velocity loss thresholds (VL) (Weakley et al., 2021).

- **VZ** involves performing repetitions within a pre-determined MPV band, based off an athlete's LVP.
- **VL thresholds** involve performing repetitions in a set until the repetition velocity falls below a pre-determined cut-off point (Orange et al., 2019).

To give a practical example, if prescribing an athlete, a bout of VBT with a VL of 15% (typically seen as a low VL), they would perform repetitions of their given exercise until the speed of their reps are 15% slower than the fastest rep, or until the reps are 15% slower than the pre-determined speed (this would vary from coach-to-coach). When comparing VBT with one-another, many studies would vary in the velocity zones/loss thresholds depending on the training goal (Weakley et al. 2021). What is repeatedly reported is the use of low VL thresholds may be favourable in peak power enhancement in comparison to high VL (Figure 2).

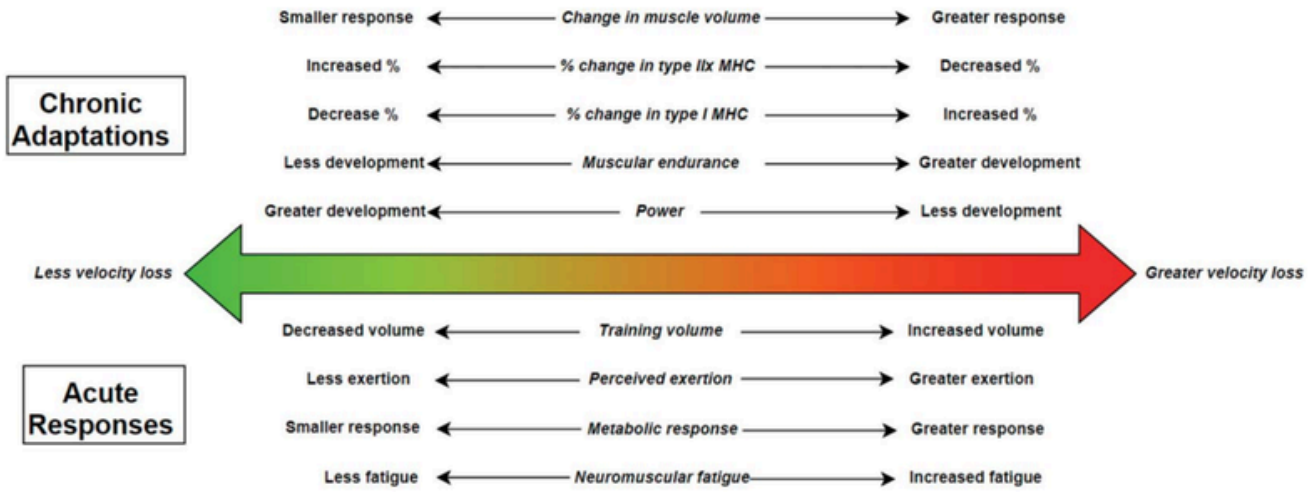


Figure 2: Acute and chronic training responses to training with greater or smaller VL thresholds (MHC = myosin heavy chain), printed with permission from Weakley et al. (2021)

Does VBT Work?

Does it work, how it compares to %1RM and practical applications.

In short; yes. VBT is a proven, effective training method to improve an athlete's power output, however the current literature does not suggest it is more effective than %1RM. VBT has been shown be a very effective method of fatigue management and muscle damage reduction. Vasiljevic et al. (2024) investigated the effects VBT and TRT had on muscle damage, evaluating creatine kinase (CK) and creatine kinase isoenzyme (CK-MB) as markers for muscle damage. CK and CK-MB activity was substantially lower in the VBT group across three separate assessments. Despite this, Vasiljevic et al. (2024) notes that CK and other fatigue markers may not provide a comprehensive picture on athlete readiness, with subjective measures of fatigue needing to be considered. With this in mind, it is not unreasonable to suggest %1RM can produce similar results if programmed with appropriate rest, volume and considering lifting intent and athlete readiness.

Practical Applications

In-season power-focused team sport athletes can implement VL10–20% on primary lower-body lifts as a fatigue-management strategy without sacrificing power adaptations; the velocity-zone approach requires individualised LVP testing and is therefore more practical in higher-resourced environments; load-matched VBT (matched intensity, velocity-guided autoregulation rather than effort termination) is the better choice when training volume must be preserved.

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