# An Examination of Training on the VertiMax Resisted Jumping Device for Improvements in Lower Body Power in Highly Trained College Athletes

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## Abstract

Training to develop superior muscular power has become a key component to most progressive sport conditioning programs. Conventional resistance training, plyometrics, and speed/agility modalities have all been employed in an effort to realize superlative combinations of training stimuli. New training devices such as the VertiMax resisted jump trainer are marketed as a means of improving lower body reactive power. The purpose of this study was to evaluate the effectiveness of the VertiMax, in combination with traditional training modalities, for improvements in lower body power among highly trained athletes. Forty men and women Division I collegiate athletes representing the sports of baseball, basketball, soccer, gymnastics, and track completed a 12-week mixed-methods training program. Two groups were constructed with both groups performing the same conventional resistance training and strength training exercises. The training control group performed traditional plyometric exercises while the experimental group performed similar loaded jump training on the VertiMax. Lower body power was measured before and after the training program by the TENDO FiTROdyne Powerlizer and statistically compared for differences between groups. Data analyses identified a significant ($p < 0.05$) and meaningful difference between power development among the 2 groups, with the VertiMax eliciting a greater treatment effect (effect size = 0.54) over conventional resistance and plyometric training alone (effect size = 0.09). These data convincingly demonstrate that the VertiMax represents an effective strategy for developing lower body power among trained college athletes, when combined with traditional strength and conditioning approaches.

**Key Words** VertiMax, plyometric exercise, power, speed, physical conditioning

## Introduction

For all athletes, the ability to transfer training-induced physiological adaptations to performance in skill-related activity is essential for optimal functioning, injury reduction, and competitive success. Just as inferior skill limits the extent of athletic succession, for today's aspiring athlete, inferior physical fitness will handicap even the most skilled individual. Clearly, the extent to which fitness influences performance is fundamentally distinctive. For some sports, physical conditioning and athletic practice are synonymous, as ability is dictated principally by fitness capacities (i.e., marathon running, sprint cycling, power lifting). In contrast, many other activities are characterized by a diverse multidimensional set of physiological competencies, underscoring the importance of specific, effectual training modalities. By combining the appropriate training stimuli with the appropriate quantity and quality of skilled movement, coaches and sport performance specialists may collaborate to optimize training efficiency and elicit the most transferable adaptations.

In combination with quality of movement, training to stimulate muscular adaptation for peak power output resides as a principal developmental objective. Collegiate athletes are traditionally introduced to explosive lifting early in the off-season as an adjunct to important functional and conventional power lifting exercises. Ultimately, the inclusion of explosive lifting as a primary training tenet is done to stimulate neuromuscular adaptation, supporting the development and enhancement of muscular rate of force development and peak power. This customary training agenda manifests as a shift in

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emphasis from training the basic force production capacities of muscle, to developing muscular contraction velocity and movement speed, and ultimately to preparing the musculoskeletal system for performance in powerful athletic events. However, despite proven efficacy to promote such specialized adaptations, many professionals have abandoned traditional explosive lifting techniques, citing safety concerns, and/or inefficient time expenditure.

In an effort to supplement/replace traditional approaches, various training technologies and prescription innovations have been devised to elicit similar muscular power adaptation. Lower load, high-speed training has gained considerable popularity among professionals, as well as the sport science community. Although the recommendation to train with high speed is not a novel approach, little is known about the optimal implementation strategy. One technique, in particular, loaded jump training, has received considerable interest, as of late (9). Conceivably, overloading a vertical jump may be a superior means for development of rate of force production and peak power output, as execution is not heavily contingent on technique, thus enabling athletes of various backgrounds to productively train. Many research investigations have supported the use of jump training modalities, demonstrating significant enhancements in peak power output, jumping ability, sprint acceleration, rate of force development, and general strength-power profiles (9).

Albeit popular for overloading high-velocity concentric muscle actions and reducing technique vulnerabilities, loaded jump training may be similarly valuable for development of muscle eccentric deceleration. Most often considered a protective barrier to injury, coordinated eccentric muscular recruitment is also a fundamental requisite for jumping ability (9). Case in point, during the countermovement phase of a jump (i.e., the transition phase from eccentric to concentric, otherwise known as the amortization phase of a plyometric movement), stored elastic energy from the prestretched muscle is transferred to optimize mechanical recoil of the musculotendinous unit. By deliberately accentuating the eccentric deceleration phase of a multijoint movement, specialized training interventions may be designed to induce neuromuscular adaptations in the stretch-shortening cycle (SSC), supporting both voluntary activation and inhibitory and/or facilitatory reflexes (2). Collectively, these neural adaptations may support enhanced mechanical efficiency of jumping (1,3,13–16), improved muscle-activation patterning and dynamic joint stability (4), and increased agonist muscle innervation through the stretch reflex (5,6,12,17), leading to increased joint moments, greater ground reaction force, and superior jumping ability (11).

Seemingly, the benefits of loaded jump training have far-reaching implications for preparing athletes to compete in similar dynamic activities. However, many dynamic movements rely on explosive contractions involving longer concentric actions than experienced during brief SSC movements, and may be limited by the ability of the muscle to produce force during fast contraction velocities (18). Evidence has suggested that combining heavy resistance training with high-speed exercises may be the optimal technique for eliciting neuromuscular adaptation to support both the stretch reflex and rate of force development, as well as for improvement in a variety of performance variables concerned with maximal strength and power (8). Independently, heavy-resistance–low-velocity training as well as low-resistance–high-velocity training may effectively generate improvements at the high force end of the force-velocity curve and toward the high-velocity end of the force-velocity curve, respectively. In combination, it is plausible that training for strength and speed may elicit a powerful synergistic effect, and maximize neuromuscular development for peak power output and explosive athletic performance.

Failure to optimize each of the basic force-producing characteristics of the neuromuscular and musculoskeletal systems may diminish the developmental potential of muscular power adaptation and expression across a continuum of high-force and high-speed movements. Specifically, the combination of various training methods to elicit a maximal transference in power output is critical for explosive athletes. Of particular importance to advanced trainees such as collegiate athletes, a progression in specialized stimuli to accompany increased training experience is essential to sustain continued adaptation (19,21,23). As athletes become more highly trained, the stimulus applied during conditioning must increase to continue to overload the neuromuscular system and elicit a training adaptation. The development of training aids to enable this progressive overload is an industrious pursuit. While many such aids are currently marketed, few have demonstrated effectiveness among athletic populations.

The purpose of this investigation was to examine the effects of a concurrent mixed-methods training protocol (i.e., traditional power lifting and explosive lifting) supplemented with loaded jump training using the VertiMax (VMax) resisted jump training device compared to a traditional resistance/plyometric training regimen on jumping ability and peak power output in collegiate athletes. The VMax (Figure 1) is a platform-based device with bungee attachments for the waist, hands, and thighs. Strategic placement and adjustment of bungee resistance allow for the performance of plyometric jumping exercises with resistance added.

## METHODS

### Experimental Approach to the Problem

Highly trained, NCAA Division I collegiate athletes from various sports were recruited and assigned to either a standard mixed-methods training program or a standard training program plus loaded jump training. Although the men and women athletes were from different sports and involved in specific conditioning programs, both treatments were equally represented for each involved sport subgroup. The assigned treatments consisted of a 12-week intervention during each

**Figure 1.** The VertiMax.

athlete's respective off-season, which ultimately coincided with the basic strength and strength/power phases of training, respectively. Before and after the training interventions, athletes were tested on vertical jumping ability and peak power output in order to assess the effectiveness of treatment strategy, as well as the differences between groups.

### Subjects

Forty Division I collegiate athletes ($n = 26$ men, $n = 14$ women) representing the sports of baseball, gymnastics, soccer, and basketball were recruited for this 12-week training intervention study. Before baseline testing, athletes were assigned to 1 of 2 groups: VMax group or training control (TCo) group. Because there were slight variations in training programs for each different sport, groups were composed equally of athletes from each particular sport to protect against a confounded experimental affect derived through differences in training. Athletes from each sport were randomly assigned to a respective group, ensuring that equal numbers of athletes from a given sport were placed in each group. Therefore, the only difference in training across the 2 groups was the inclusion of resisted jumping exercises on the VMax device. Both groups were composed of 13 men and 7 women, each of whom committed to adhering to the training protocol and refraining from performing alternative or supplemental workouts. Compliance with training was monitored by the researchers and strength and conditioning staff responsible for training sessions. While athletes in both groups missed training sessions, exclusion criteria for analyses was set at anything in excess of 2 missed workouts, over the entire 12-week training intervention; however, no athlete met such criteria.

### Power Measurements

Lower body peak power was identified through the use of the TENDO FiTROdyne Powerlizer (Fitro-Dyne; Fitronic, Bratislava, Slovakia) according to protocols suggested by Jennings et al. (10). Athletes weighed-in immediately prior to performing a maximal countermovement jump test. In order to effectively test power output during the counter movement vertical jump, the TENDO unit cord was attached to the back waistband of each subject's athletic shorts. This arrangement allowed for the base of the TENDO FiTRO-dyne unit to be positioned on the floor behind the athlete during the test, in such a way that valid readings could be obtained without impeding jump technique and/or performance. In order to calculate power output in watts, each athlete's body mass was imported into the Fitrodyne microcomputer. The TENDO unit proficiently computed PP according to the speed of movement in the concentric phase of the jump test, as well as each respective athlete's body mass. Certified strength and conditioning specialists and investigators oversaw all testing processes to ensure proper technique and safety (7).

### Training Protocol

Both groups performed similar training programs composed of free weight resistance training with lower body compound exercises (e.g., back squat, powercleans, standard deadlifts, dumbbell walking lunges, and Romanian deadlifts) (Table 1).

**Table 1.** Lower body exercises performed during intervention.

| |
|---|
| Resistance exercises (2–3 $d \cdot wk^{-1}$, 6–10 sets total, 80–90% 1RM) |
| Back squat |
| Powercleans |
| Deadlifts |
| Dumbbell walking lunges |
| Romanian deadlifts |
| Sprint and plyometric exercises (1–2 $d \cdot wk^{-1}$, 10–15 repetitions per exercise) |
| 20–40 yd sprints |
| Front/side hurdle jumps |
| Depth jumps |
| Split jumps |
| Bounding |
| Additional exercises performed by the VertiMax training group (1–2 $d \cdot wk^{-1}$) |
| Resisted quarter jumps: 2–4 sets, 8–10 jumps |
| Resisted half jumps: 2–4 sets, 5–10 jumps |
| Resisted split jumps: 2–4 sets, 5–10 jumps |

**Table 2.** Results.

| Group | Pre-test (W) | Post-test (W) | Improvement | ES |
|---|---|---|---|---|
| TCo | 986.45 ± 176.11 | 1002.70 ± 187.88 | +16.25 ± 42.67 | 0.09 |
| VMax | 1197.55 ± 202.47* | 1306.70 ± 188.67* | +109.15 ± 107.69* | 0.54* |

ES = pre/post effect size; TCo = control group; VMax = VertiMax group.
*Groups differ at $P < 0.01$.

In conjunction with traditional resistance training, the TCo group also performed running and plyometric drills, including variable-distance sprints, split-squat jumps, variable-height depth-jumps, and hurdle-jumps. Athletes from both treatments followed a periodized training program with resistance exercises performed 2–3 days per week, and sprint/plyometric (TCo group) or sprint/VMax (VMax group) training 1–2 days per week, for 12 total weeks. Volume of resistance training exercises averaged 8 sets per muscle group at a mean intensity of 80–90% of 1-repetition maximum (1RM) (19,25). These training values were selected because they have been shown to be the most operational combination of training stimuli for eliciting maximal strength among athletic populations (20). Sets and repetitions for each exercise were periodized in daily undulating (24) fashion.

In addition to the traditional compound lower body lifts and equated sprint work, the VMax group performed supplementary exercises on the VMax V-6 training apparatus (Genetic Potential; Tampa, Fla.). The VMax is a platform-based unit complete with adjustable bungee chords that can be attached to a waist belt worn by an athlete. To further overload each movement, hand straps connected to bungee chords were worn by all study athletes, allowing accentuated resistance on the arm swing phase and spinal extension during all jumping movements. Resistance on the bungee chords was adjusted to apply more or less resistance when needed.

The 3 supplementary exercises performed by all subjects in the VMax group were half squat jumps, quarter squat jumps, and split squat jumps. Half squat jumps involved performing 8–10 jumps with a slight pause between each rep, while quarter squat jumps were 5–10 jumps done repetitively with no pauses. Depth of the countermovement for each of the VMax-resisted squat jump exercises (i.e., half and quarter squat jumps) was left to the discretion of the individual athlete and depended on personal jumping technique; however, no dramatic differences were observed between participants.

Spilt squat jumps were performed by instructing each athlete to assume a deep lunge position with a flexed knee and hip of the lead leg and fully extended hip of the trail leg. At his or her discretion, each athlete then jumped as high as possible (i.e., vertically) and, while in the air, switched the position of each leg to decelerate in the oppositely situated lunge position. Multiple repetitions were performed as quickly as possible with no rest between each jump. For all loaded jump exercises on the VMax, resistance on the bungee chords was progressively increased over the duration of 12 weeks to provide appropriate progression in stress. Training sessions on the VMax apparatus took place in groups of 4 athletes. After performing the assigned number of repetitions, an athlete would be disconnected from the chords and directed to the end of the line, while the next athlete assumed his or her place on the platform. This sequence resulted in approximately 2 minutes of rest between each set of like exercises on the VMax and approximately 5 minutes between different loaded jump exercises. Two to 3 sets of each exercise were performed.

#### Statistical Analyses

Descriptive data (mean and *SD*) for the various tests were computed. At pre-test, the TCo group demonstrated significantly lower power (−211.10 W) than the VMax group ($p < 0.05$). Therefore, change in power from pre- to post-testing was calculated and analyzed by independent samples *t*-test. Level of statistical significance was set at $p \leq 0.05$, with meaningfulness of differences determined by the use of effect sizes (ESs). Effect sizes were calculated by determining the difference between pre- and posttest means, divided by the pretest *SDs* and interpreted according to a scale previously proposed by Rhea (22).

### Results

Descriptive statistics from pre- and post-testing are shown in Table 2. The average improvement in power observed in the TCo group (+16.25 ± 42.67 W) resulted in a very small ES of 0.09, which did not reach statistical significance ($p > 0.05$). The increase in power in the VMax group (+109.15 ± 107.69 W) represented a moderate ES of 0.54 and was found to be statistically different ($p < 0.05$) from pretest power. Improvement in power following training was found to differ between groups ($p < 0.05$) in favor of the VMax group (+92.9 ± 65.01 W).

### Discussion

These data clearly demonstrated an added benefit of performing loaded jump training exercises on the VMax apparatus in conjunction with traditional preparatory strength and conditioning modalities, when compared to strength/power training alone. The large difference in power improvement is quite substantial when considering that baseline power measures in the VMax group were significantly higher than those of the TCo group. Certainly, it was expected that significantly greater initial peak power capacities could result in an overall diminished comparative test-retest improvement for the VMax group; according to the principle of diminishing returns. However, such an expectation was not realized at the completion of the intervention and post-test, lending even further support to the effectiveness and practical application of this training device.

Comparing the improvements in power observed in the current study to a recent study by Hoffman et al. (9) involving resisted jump training on the Cormax Jump Squat Device (Cormax Strength Power Systems, Valley City, ND), the VMax group in the current study exceeded improvements in lower body power (ES = 0.54) compared to both intervention groups in the Hoffman et al. study (ES = 0.49 and 0.22, respectively). Therefore, it may be concluded that training on the VMax not only enhances lower body power improvements compared to conventional resistance training and plyometrics, it also exceeds the benefits observed with other resisted jump training devices on the market.

Due to the lack of biometric data acquired during this study, physiological explanations for the findings will remain strictly theoretical. Perhaps such speculation may lead to future research and improved knowledge in this area. Certainly, numerous physiological factors influence rate of force development and muscular power output, 2 of which include activation of muscle tissue and synchronization of fiber recruitment. Recruitment of larger numbers of motor units and synchronizing their activation would result in much greater force development in a rapid fashion. Thus, such adaptations would greatly enhance power output. It is possible that training on the VMax resulted in greater adaptations in such areas. Subsequent research is needed, however, using EMG measures to verify such a hypothesis.

While strength training and plyometric exercise have been shown to increase power among athletes, as an individual becomes more highly trained, the resultant adaptation to training diminishes. The athletes employed in this study were very accustomed to conventional sports conditioning methods as was used by the TCo group. Each athlete had performed plyometric-type exercises for at least 2 years. Basketball players and gymnasts in particular are quite accustomed to performing jumps with only their body weight as resistance. In such cases, conventional plyometric exercises are unlikely to provide significant amounts of overloading stimuli to the neuromuscular system. A unique quality of the VMax apparatus is in the ability to apply progressive resistance to plyometric jumps. The added resistance, along with the capacity to alter and progress the resistance over time, may certainly be used to enhance the stimulation of the neuromuscular system and to elicit adaptations in the areas of activation and synchronization.

## Practical Applications

Performance of resisted jump exercises on the VMax has been shown to have a positive effect on power development among well-trained collegiate athletes. In an arena where maximal power adaptations are considered necessary, inclusion of such training to supplement conventional strength and power training will result in significantly greater adaptations. Superior performance enhancement and injury reduction may be expected with the incorporation of the VMax apparatus over other alternatives of jump training. The functional mechanisms responsible for these benefits are as a result of the versatility of movement that the VMax permits and the unique capacity to exaggerate jump landing/movement deceleration as well as the unrestricted ability to progressively overload the training stimulus.

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