High Velocity Training

Interest in the science of strength training and its associated benefits is a growing phenomenon within the fitness movement. The fact that approximately eight weeks of heavy resistance training can produce significant gains in strength is well established. The consensus position supported by hundreds of experimental studies is that gains in strength are the primary result of increased muscle size, referred to as hypertrophy. What is less well known is the phenomenon that results in the manifestation of increased strength after only a few strength-training sessions. Speculation is that these short-term effects are the results of changes in neural factors. Studies have shown that short-term resistance training can increase strength production in the absence of hypertrophy. While neural factors are not well defined, these early strength gains are largely attributed to an increase in the maximal muscle activation level.

Training Protocols

The interaction of velocity and human force production has been known for some time and traditional training and research have focused on slow velocity, high resistance movements. On the other hand, the effect of high velocity, low resistance training adaptations related to an individual's ability to move quickly has not been thoroughly investigated. Furthermore, nearly all contemporary resistance-training prescriptions consist of detailed periodized programs lasting for a minimum of eight weeks in order to increase muscle hypertrophy and strength. Yet, a resistance-training program lasting only a few days may also result in significant performance gains if the exercise is new to the individual. Furthermore, movement speed can be increased if the exercise is performed very quickly with a light load.

TRAINING ADAPTATIONS

The initial changes in strength following training occur at a rate too fast to be accounted for by hypertrophy. Therefore, neural changes must play a role in acute strength gains. Previous investigations of neural and hypertrophic contributions to muscle strength gains have had trained and untrained subjects perform eight weeks of progressive resistance-training. At the end of training, all subjects exhibit increased maximal strength. Yet more importantly, electromyographic (EMG measures neural electrical activity) measurements indicate that changes in electrical activity of the elbow muscles are primarily responsible for early strength increases while hypertrophy gradually increases as a contributory factor over time. The short-term strength gains in untrained subjects appear to be due almost exclusively to neural adaptations.

Other experiments investigating short-term velocity specific training have had untrained volunteers participate in either slow or fast training groups. They find that strength does not change following slow training but fast training exhibits approximately 20% increases in strength. The conclusion is that the associated neural changes accompanying high velocity training are responsible for early changes in performance. Studies have also demonstrated short-term improvements in strength at moderate velocities when the thigh muscle mass is measured via MRI. At the conclusion of training, muscle fiber area reveals no changes, yet the neural activity of the thigh muscles increases significantly. These collective results point to neural facilitation as an outcome of novel training.

Possible explanations

Two broad categories that may explain velocity-specific training adaptations are alteration of the muscle's ability to produce force at high velocities and alteration of neural activity within the nervous system. The latter is generally referred to as learning in an exercise environment. It is known that during the early stages of training, muscular hypertrophy lags behind neural adaptation, which tends to support learning as a satisfactory explanation for any change in strength.

In other words, the skill required to perform repeated fast movements involves coordination within the neural system, which results in increased strength. Therefore, one possible explanation for early strength gains might be skill acquisition of the required task. It is clear that strength adaptations are greatest when exercises are performed in a velocity-specific training manner. However, perhaps the zeal to measure strength improvements has made it necessary to ignore any velocity adaptations associated with these same exercises. However, velocity-specific training can serve to increase limb velocity in the absence of any force changes. As such, trained subjects are able to produce force more rapidly even though their absolute peak strength remains unaffected. This ability to produce force rapidly has also been linked to neural facilitation.

Practical Applications

The biomechanics associated with falls report a strong relationship between the amount of force generated at ground contact and step velocity. That is, very fast step velocities are associated with low force generation while slow step velocities require greater force output. A biomechanical model calculates that slowing step velocity by 75% would require a force increase of approximately 82%. However, a 65% increase in step velocity would require 50% less force output. Since large force increases are unrealistic in an elderly population who are at the greatest risk of falling, short-term increases in limb velocity may reduce the need for greater strength. Therefore, a short-term training program consisting of fast movements with light loads as opposed to a long-term heavy resistance training regimen designed to induce muscle hypertrophy might better serve elderly persons. Training programs that result in an acute increase in velocity while maintaining force have wide ranging applications to exercise prescriptions designed to impact explosive work.

Summary

It is clear from the previous discussion that high-velocity low load training is related to an ability to produce force quickly and that this ability has implications for activities in everyday life as well as athletic endeavors. High velocity exercise results in specific high-velocity adaptations and should be employed when attempting to enhance high- speed movement. In addition, short duration training is effective for the acute adaptation of neural factors, which results in increased human performance in the absence of muscular hypertrophy.

Written for the American College of Sports Medicine by Lee E. Brown, EdD, CSCS,*D, FACSM

Current Comments are official statements by the American College of Sports Medicine concerning topics of interest to the public at large.

Street Address: 401 W. Michigan St. • Indianapolis, IN 46202-3233 USA
Mailing Address: P.O. Box 1440 • Indianapolis, IN 46206-1440 USA
Telephone: (317) 637-9200 • FAX: (317) 634-7817

AMERICAN COLLEGE of SPORTS MEDICINE
www.acsm.org