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The Effects of Slow and Fast Velocity Training on Vertical Jump Using the DYNAMIC FORCE MONITOR

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ABSTRACT

This study proposed that there is a correlation between slow and fast velocity training and vertical jump in college students. Three female and three male students were pretested on height, weight, and vertical jump and were then put into one of two groups, one training at a fast velocity and the other training at a slower velocity. The subjects used the DYNAMIC FORCE MONITOR, a dynamic impingement exercise machine, to do squat exercises three times a week for seven weeks. Each training session consisted of three sets of 10 repetitions for the slow group and three sets of 15 repetitions for the fast group. This was to ensure that the two groups spent a relatively equal amount of time training. After seven weeks of training, the subjects were retested on weight and vertical jump. There was no correlation found between training group and vertical jump. Only one male subject increased his vertical jump by 6.0 cm, while another male subject showed no change. The remaining four subjects decreased their vertical jump by an average of 1.38 cm. There was also no correlation found between sex and performance. There was, however, evidence that subjects did increase maximum force output during the course of the study.

Keywords: *DYNAMIC FORCE MONITOR, Vertical Jump, Variable Velocity Training, Force Output*

INTRODUCTION

Athletic performance is advancing every day. Athletes are continuously searching for new training methods that will enhance their performance and give them an edge on the competition. Many of these training methods have focused on weight training. A number of studies have shown that weight training has increased strength and endurance (Grimby, et al, 1992), as well as muscle hypertrophy (Frontera, et al, 1988 and McCall, et al, 1996).

Within this realm of weight training, there have been other studies showing the best way in which to train. Higbie (1996) and colleagues studied the effects of concentric versus eccentric training. They found that concentric exercise increased strength in concentric muscle actions, and eccentric exercise increased strength in eccentric muscle action. McKethan and Mayhew (1974) found that, in general, isotonic exercises enhanced jumping performance more than isometric exercises.

Finally, there have been studies on variable velocity training. Van Oteghen (1975) conducted a study on the vertical jump of collegiate volleyball players using two different velocities. She found strength differences between the two groups, but there was no significant difference in vertical jump. Morrissey, et al (1998) also conducted a study that examined the effects of slow and fast velocity barbell squats on the vertical jump, long jump, and maximum squat of females. The researchers found that both the fast and the slow groups improved performance, however the fast group showed advantages that suggest it may be more effective than training at the slower velocity.

The present study also addresses the effectiveness of fast versus slow velocity training. The purpose was to use the DYNAMIC FORCE MONITOR to compare the vertical jump performance of college-aged students training at two different velocities. This machine is a prototype of a system that has been in development for 20 years. This study produced data from the DYNAMIC FORCE MONITOR, a breakthrough training system that has not yet been tested in this way.

MATERIALS AND METHODS

Subjects

Eight college-aged students, four females and four males not involved in other lower extremity training, volunteered to participate in this study. Each subject signed two consent forms before training began. The subjects were instructed to maintain their normal activity level, as well as eating and sleeping habits, during the study. Four of the subjects, two males and two females, were assigned to a fast training group and the other four were assigned to a slow training group. Of the eight original subjects, six successfully completed the study, three males and three females. Preliminary information on the subjects is listed in Table 1.

Table 1 Initial Physical Characteristics of Subjects

Variable	Men (n=3)	Women (n=3)
Age (yr)	20.3 ± 1.09	20.0 ± 0.82
Height (cm)	173.0 ± 0.94	172.0 ± 2.27
Weight (kg)	78.5 ± 5.35	75.0 ± 9.58
Vertical jump (cm)	57.0 ± 8.04	35.5 ± 0.85

Experimental Groups
The two test groups trained for 7 weeks using a squat exercise on the DYNAMIC FORCE MONITOR. The slow group trained at a cycle rate of 20.8 cm/s to 25.8 cm/s and the fast group trained at a cycle rate of 41.1 cm/s to 43.7 cm/s. Subjects also underwent testing before and after training to determine the effectiveness of training at the two different cycle rates.

Equipment
The DYNAMIC FORCE MONITOR (DYFORMON) was used to perform the squat exercises. Dr. Kent Noffsinger of McPherson College and Dr. William Kraemer of Ball State University created this machine in 1980 while attending graduate school at the University of Wyoming. McPherson College obtained the DYFORMON prototype in 1997. The DYFORMON consists of a five horsepower motor that powers an Olympic style weight lifting bar in a vertical motion over a complete cycle of 80.3 cm. There is a capacity for producing up to 22,000 N (5000 lbs.) of force (see Fig. 1).

Because this machine is gravity independent, the possibility of injury is less than that of free weights. Exercises done on the DYFORMON can be considered dynamic isometrics, which is an oxymoron. The machine provides the movement of the exercise while the participant resists the motion. This is referred to as impingement exercise. The settings can be adjusted so that the bar will move at various cycle rates, and sensors are attached to each side of the bar that can measure the force exerted on the bar in the up or down direction. In this study, subjects stood under the bar and did squat exercises.

Training Procedures
After preliminary testing, all subjects trained three days per week for seven weeks using the buddy system. No one used the DYFORMON unless under supervision of the author and instructor. The instructor operated the machine and made sure it was set at the appropriate cycle rate for each subject. Warm-up consisted of stretching and one or two warm-up squats at sub-maximal effort on the machine before each set. In each training session, subjects performed three sets of squats while the slow group did 10 repetitions and the fast group did 15 repetitions. This was to ensure that the two groups were training for relatively equal amounts of time. The first training session was to familiarize the subjects to the DYFORMON and to sign consent forms. Subjects completed three sets of squats at maximum power in each subsequent training session.

After seven weeks of training, subjects underwent testing identical to the pre-testing. This testing was done at least three days after the last training session to allow adequate recovery from muscle soreness and fatigue.

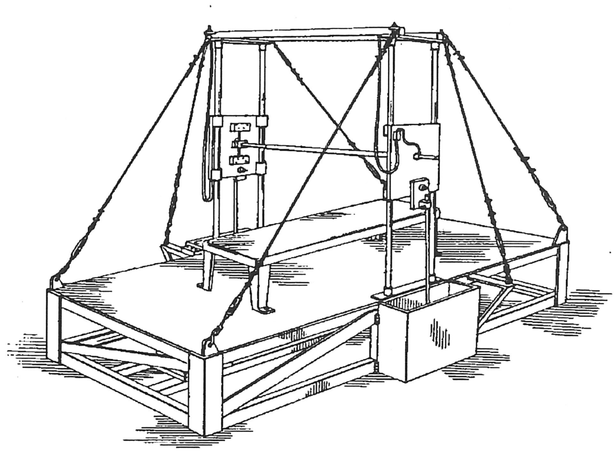

Fig. 1. Artist's rendition of the DYNAMIC FORCE MONITOR

Testing
Each subject underwent a series of tests before training began. Subject body weight was measured to the nearest half kilogram, and height was measured to the nearest half centimeter using standard scales.

The vertical jump was measured manually by the author. Each subject did a standing reach against a scale on the wall that was measured to the nearest half centimeter, and then did a series of three vertical jumps. To perform these jumps, subjects were instructed to bend their knees and swing their arms if they chose, but no steps could be taken into the jump. Each of the three jumps was measured to the nearest half centimeter. The standing reach was subtracted from the average of these jumps to calculate the final vertical jump.

Calibration
Preliminary force output was measured on the DYFORMON. To obtain actual force output, a calibration was done. Readings from the DYFORMON were taken as a subject stood on a standard scale and resisted the motion of the machine. The weight readings of the scale were used along with the readings from the DYFORMON to calculate a conversion factor. This was used to figure actual force output.

RESULTS

The purpose of this study was to determine if fast and slow training velocities have different effects on vertical jump. There were no significant results. Only one participant showed any increase in vertical jump performance, one showed no improvement, and four showed an average decrease in performance of 1.38 cm. The sex of the subjects did not seem to make a difference, either. Results from the final testing session are listed in Table 2.

Table 2 Final Physical Characterists of Subjects		
Variable	Men (n=3)	Women (n=3)
Weight (kg)	80.5 ± 7.71	76.5 ± 9.3
Percent Difference	2.5%	2.0%
Vertical Jump (cm)	58.5 ± 10.96	34.0 ± 1.18
Percent Difference	2.6%	-4.3%

Although not originally part of this study, force output was monitored throughout the final five weeks of training. It was found that maximum force output increased during the course of the study (see Fig. 2).

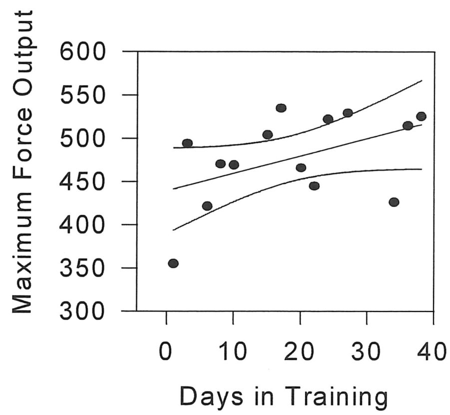

Figure 2. Average maximum force output of subjects during last five weeks of the study. Straight line represents regression with $r^2 = 0.22556$. The curved lines are 95% confidence levels.

DISCUSSION

Neither exercise group increased their vertical jump as a group. Only one subject out of six showed any increase at all. While the reasons for this are not known exactly, there are several factors that contributed to this trend. This subject has a long history as a weight lifter and was very familiar with the lifting routine, as well as the DYFORMON. He was more experienced than other subjects, and was possibly more focused while performing the squat exercises.

Other factors that contributed to the lack of positive results in this study are as follows. First, the method of measurement of the vertical jump was not completely accurate. There was no machine available to get a completely accurate reading. Secondly, many of the subjects were sick at various times during the study and did not participate in every work out session. There were also injuries that kept subjects from participating in every session or participating at maximal effort.

According to a study done by Bobbert and van Soest (1994), vertical jump decreases if muscle control remains the same as muscle strength increases. Control can be fine-tuned by practicing a movement as the muscle is strengthened. Subjects in this study were instructed not to practice their vertical jump to ensure that gains were due to training on the DYFORMON. This could be the primary reason for few positive results.

Weight differences were also noted. The one subject who increased his vertical jump gained five and a half kilograms. Two subjects gained between one and a half and two kilograms with decreased vertical jumps. The weight of two other subjects did not change while their vertical jumps decreased, and the final subject lost one kilogram and had no change in vertical jump.

It was observed that spacing between feet while doing the squat exercises affected maximum force output. Generally a narrower stance resulted in greater force. Training speed also affected force. The subjects training at the faster cycle rate could reach a higher force output at a slower cycle rate of about 25.8 cm/s. It was not determined whether the slow group did better at a slower cycle rate, but most seemed to do better at the 25.8 cm/s mark as well.

Two weeks before the final testing, the subjects had a holiday break and missed two training sessions. After returning for the final week of training and final testing, force readings were generally lower than before the break. However, it was noticed that by the end of the week, subjects were almost back to where they were before the break. The recovery time was much quicker at this point than at the beginning of the study.

As with any study using human subjects, this one was difficult to control. There was no way of completely controlling every possible variable such as diet, sleep and other activity. This lack of complete control may also have contributed to the lack of positive results from this study.

This study was just the beginning of testing on the DYFORMON training system. There needs to be continued testing to determine more efficient training methods using this system. There also needs to be more testing on the issue of variable velocity training. While the results of this study were inconclusive, other studies are needed to determine if this is a general trend, or simply the result of only one study.

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