2020

The Relationship between Velocity of Movement to Percentage of One Repetition Maximum in the Barbell Bench and Barbell Squat

Aaron Letinski
apbasketball44@gmail.com

THE RELATIONSHIP BETWEEN VELOCITY OF MOVEMENT TO PERCENTAGE OF ONE REPETITION MAXIMUM IN THE BARBELL BENCH AND BARBELL SQUAT

by

Aaron Letinski

B.S., Bluffton University, 2017

A Research Paper
Submitted in Partial Fulfillment of the Requirements for the
Master of Science in Education

School of Human Sciences
In the Graduate School
Southern Illinois University Carbondale
December, 2020

THE RELATIONSHIP BETWEEN VELOCITY OF MOVEMENT TO PERCENTAGE OF ONE REPETITION MAXIMUM IN THE BARBELL BENCH AND BARBELL SQUAT

by

Aaron Letinski

A Research Paper Submitted in Partial

Fulfillment of the Requirements

for the Degree of

Master of Science in Education

in the field of Kinesiology

Approved by:

Dr. M. Daniel Becque

Graduate School
Southern Illinois University Carbondale
August 3, 2020

AN ABSTRACT OF THE RESEARCH PAPER OF

Aaron Letinski, for the Master of Science in Education degree in Kinesiology presented on August 3, 2020, at Southern Illinois University Carbondale.

TITLE: THE RELATIONSHIP BETWEEN VELOCITY OF MOVEMENT TO PERCENTAGE OF ONE REPETITION MAXIMUM IN THE BARBELL BENCH AND BARBELL SQUAT

MAJOR PROFESSOR: Dr. M. Daniel Becque

The purpose of strength and conditioning for athletes is to enhance each individual athlete's athletic ability through a year-round program of strength, speed, and injury prevention. For many years, strength and conditioning professionals have based their athletes weights on a various percentages of their one repetition maximum (1RM). **Purpose:** The purpose of this study was to compare the velocity of a 10-repetition max (10RM), 5-repetition max (5RM), and 1RM bench press and barbell squat to standard percentages of a 10RM, 5RM, and 1RM in the bench press and barbell squat. **Methodology:** For each subject, testing was conducted over four sessions separated by 24 hours. The first session determined the five-rep bench max (5RM) and one rep bench max (1RM). Second session determined the 5RM and 1RM squat max. The third session determined the 10-repetition max (10RM) bench press. The fourth session determined 10RM squat. **Results:** In this study, the 10RM load for the bench press was 80% of 1RM. The 10RM load for the squat was 78% of the 1RM. The 5RM load for the bench press was 88% of 1RM. The 5RM load for the squat was 89% of the 1RM. **Conclusion:** Velocity of movement can be used instead of percentages of 1RM to select the proper training loads.

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

HEADING 1

INTRODUCTION

The purpose of Strength and Conditioning for athletes is to enhance each individual athlete's athletic ability through a year-round program of strength, speed, and injury prevention. For many years, strength and conditioning professionals have based their prescribed weight lifting loads on percentages of one repetition maximum (1RM). The purpose of this research was to compare the velocities of movement for a 10-repetition maximum effort (10RM), a 5-repetition maximum effort (5RM), and a 1RM maximum effort for the bench press and barbell squat.

Why Velocity-Based Training

Velocity-based training (VBT) is a training method used by coaches and practitioners to determine the optimal loading for strength training using the velocity at which an athlete can move a load independent of 1RM (Mann et al.,2015). First, with velocity-based training no matter what the training program calls for, a heavy, moderate, or light day, the athlete can use auto regulation to adjust the load. The velocity-based tool will track every repetition and will show each repetitions speed in meters per second (m/s). With the real time feedback, the athlete will know to increase or decrease in weight and not wait to ask a coach to watch their repetitions. Second, VBT allows you to give real time feedback to the athletes as they are performing the repetition. If a target speed is the goal then it has been suggested that specific goals can provide motivation for people to attain higher levels of performance. Velocity feedback alone can reduce the between-rep variability in movement velocity during exercise, while also potentially increasing movement velocity (Randell et al., 2011).

HEADING 2

METHODOLOGY

Four healthy men volunteered to take part in this study. Average age was 22.5 SD 1.8 years. Average height was 70.75 SD 2.4 inches. Average weight was 213.25 SD 30.2 pounds. Average number of years training was 5.5 SD 2.9 years. Participant's weight training experience ranged from 1 year to 6 years (2-3 sessions a week). There were no physical limitations reported by the participants that could have affected the testing. The Southern Illinois University Carbondale Human Subjects Committee approved this study. The velocity was recorded using Eliteform Velocity Tracker. The participants were required to avoid any 1RM or RM tests one week before the start of their first testing session. Each session involved a general warm up and specific warm up for their 1RM or repetitions test. In all testing sessions, the participants were given velocity feedback for every repetition from the EliteForm Velocity Tracker.

For each subject, testing was conducted over four sessions separated by 24 hours. The first session determined the five-repetition bench press maximum (5RM) and one repetition bench press maximum (1RM). The testing protocol for bench press started with the barbell (45 pounds) for five repetitions (reps). The participant rested for 90 seconds and 50 pounds was added to the bar and five reps were repeated again. The participant rested for 90 seconds. This process of adding 50 pounds for five reps was repeated until the movement velocity was 0.5 meters per second (m/s). Once the subject achieved a movement velocity of 0.5 m/s, only 20 pounds was added to the bar for five reps. The subject was given two attempts to add weight to achieve a 5RM. Once the 5RM was determined the athlete rested for 10 minutes and then started the 1RM test. The 1RM test began at the same weight as the 5RM. The subjects were given three

attempts to find their 1RM. Between five and 20 pounds was added to the bar after each attempt. Ninety seconds was allowed between each attempt.

The second session was used to determine the five-rep squat max (5RM) and one rep squat max (1RM). The testing protocol for squat started with the barbell (45 pounds) for five repetitions (reps). The participant then rested for 90 seconds and 50 pounds was added to the bar. Five reps was repeated again and then the participant rested for 90 seconds. This process of adding 50 pounds for five reps was continued until the velocity was 0.5 meters per second (m/s). Once the subject achieved a movement velocity of 0.5 m/s, only 20 pounds was added to the bar for 5 reps. The subjects were given two attempts to add weight to achieve a 5RM. Once a 5RM was determined the athlete rested for 10 minutes. The subject then proceeded to start the 1RM test. The 1RM test began at the 5RM weight for one rep. The subject then rested for 90 seconds. Between 5-20 pounds was added to the bar and three attempts were given to the subject to find their 1RM.

The third session determined the ten-repetition bench press maximum (10RM). The testing protocol for bench press started with the barbell (45 pounds) for ten repetitions (reps). The participant rested for 90 seconds and 50 pounds was added to the bar and ten reps were repeated again. The participant rested for 90 seconds. This process of adding 50 pounds for 10 reps was repeated until the movement velocity was 0.65 meters per second (m/s). Once the subject achieved a movement velocity of 0.65 m/s, only 20 pounds was added to the bar for ten reps. The subject was given two attempts to add weight to achieve a 10RM.

The fourth session determined the ten-repetition squat maximum (10RM). The testing protocol for squat started with the barbell (45 pounds) for 10 repetitions (reps). The participant

rested for 90 seconds and 50 pounds was added to the bar and ten reps were repeated again. The participant rested for 90 seconds. This process of adding 50 pounds for ten reps was repeated until the movement velocity was 0.65 meters per second (m/s). Once the subject achieved a movement velocity of 0.65 m/s, only 20 pounds was added to the bar for ten reps. The subject was given two attempts to add weight to achieve a 10RM.

HEADING 3

RESULTS

The strength and conditioning field uses a percentage chart to set the intensity of training for the athletes. One of the most popular charts to track intensity is the Relative Intensity Chart. According to the Relative Intensity Chart a 10 RM load is 72.5% of an individual's training 1RM. In this study, the 10RM load for the bench press was 80% of 1RM. The 10RM load for the squat was 78% of the 1RM. The Relative Intensity Chart for a 5RM load is 87.5% of an individual's training 1RM. In this study, the 5RM load for the bench press was 88% of 1RM. The 5RM load for the squat was 89% of the 1RM.

The data showed that the average velocity for a 10RM squat was 0.40 ± 0.01 and bench was 0.32 ± 0.02 meters per second. The average velocity of a 5RM squat was 0.32 ± 0.02 and bench was 0.25 ± 0.01 meters per second. The average velocity for a 1RM squat was 0.22 ± 0.03 and bench was 0.2 ± 0.01 meters per second.

The average velocity of barbell squat for subject 1 for each of his tests were 10 RM at 0.40±0.03 m/s at 76.5% intensity, 5RM at 0.35±0.03 m/s at 90.5% intensity, and 1RM at 0.18 m/s at 100% intensity. The average velocity of barbell squat for subject 2 for each of his tests were 10 RM at 0.43±0.02 m/s at 61.5% of intensity, 5RM at 0.35±0.05 m/s at 81% intensity, and 1RM at 0.27 m/s at 100% intensity. The average velocity of barbell squat for subject 3 for each of his tests were 10 RM at 0.38±0.04 m/s at 78% of intensity, 5RM at 0.28±0.02 m/s at 87.5% intensity, and 1RM at 0.24 m/s at 100% intensity. The average velocity of barbell squat for subject 4 for each of his tests were 10 RM at 0.39±0.04 m/s at 75.5% of intensity, 5RM at 0.31±0.03 m/s at 89% intensity, and 1RM at 0.20 m/s at 100% intensity.

The average velocity of barbell bench for subject 1 for each of his tests were 10 RM at 0.35±0.05 m/s at 80% intensity, 5RM at 0.26±0.04 m/s at 90.5% intensity, and 1RM at 0.21 m/s at 100% intensity. The average velocity of barbell bench for subject 2 for each of his tests were 10 RM at 0.33±0.04 m/s at 66% intensity, 5RM at 0.26±0.03 m/s at 90.5% intensity, and 1RM at 0.18 m/s at 100% intensity. The average velocity of barbell bench for subject 3 for each of his tests were 10 RM at 0.33±0.03 m/s at 76.5% intensity, 5RM at 0.24±0.04 m/s at 87.5% intensity, and 1RM at 0.22 m/s at 100% intensity. The average velocity of barbell bench for subject 4 for each of his tests were 10 RM at 0.29±0.05 m/s at 70.5% intensity, 5RM at 0.24±0.04 m/s at 86% intensity, and 1RM at 0.19 m/s at 100% intensity.

Table 1

Average Velocity for 10RM Barbell Squat	Subject 1	Subject 2	Subject 3	Subject 4
Repetition 1	0.45	0.47	0.45	0.43
Repetition 2	0.42	0.48	0.44	0.42
Repetition 3	0.42	0.45	0.42	0.41
Repetition 4	0.41	0.45	0.41	0.38
Repetition 5	0.42	0.46	0.40	0.36
Repetition 6	0.42	0.44	0.31	0.35
Repetition 7	0.37	0.42	0.36	0.35
Repetition 8	0.36	0.40	0.38	0.30
Repetition 9	0.37	0.42	0.34	0.31
Repetition 10	0.36	0.39	0.30	0.28

Table 2

Average Velocity for 10RM Barbell Bench	Subject 1	Subject 2	Subject 3	Subject 4
Repetition 1	0.41	0.38	0.38	0.35
Repetition 2	0.40	0.37	0.38	0.36
Repetition 3	0.40	0.4	0.37	0.34

Repetition 4	0.38	0.37	0.35	0.32
Repetition 5	0.38	0.35	0.35	0.32
Repetition 6	0.36	0.33	0.33	0.29
Repetition 7	0.37	0.31	0.34	0.29
Repetition 8	0.33	0.30	0.30	0.26
Repetition 9	0.33	0.30	0.29	0.23
Repetition 10	0.20	0.26	0.27	0.18

Table 3

Average Velocity for 5RM Barbell Squat	Subject 1	Subject 2	Subject 3	Subject 4
Repetition 1	0.38	0.42	0.38	0.36
Repetition 2	0.38	0.40	0.36	0.36
Repetition 3	0.37	0.38	0.33	0.33
Repetition 4	0.32	0.30	0.33	0.30
Repetition 5	0.31	0.27	0.30	0.28

Table 4

Average Velocity for 5RM Barbell Bench	Subject 1	Subject 2	Subject 3	Subject 4
Repetition 1	0.33	0.30	0.32	0.29
Repetition 2	0.31	0.30	0.28	0.29
Repetition 3	0.27	0.24	0.26	0.25
Repetition 4	0.24	0.25	0.21	0.22
Repetition 5	0.19	0.21	0.15	0.17

Table 5

Average Velocity for 1RM Barbell Squat	Subject 1	Subject 2	Subject 3	Subject 4
Repetition 1	0.18	0.27	0.24	0.20

Table 6

Average Velocity for 1RM Barbell Bench	Subject 1	Subject 2	Subject 3	Subject 4
Repetition 1	0.21	0.18	0.22	0.19

HEADING 4

DISCUSSION

The main finding of the study was that velocity-based strength training will allow the strength and conditioning coach to be able to look at the velocity of movement and relate it to an intensity of effort percentage. Strength coaches will see a velocity and understand the percentage range of the athlete.

Creating a velocity profile and keeping track of bar speed. Velocity based training can allow an athlete another way to express strength. Everyone wants to get stronger but at some point, athletes will plateau. Their training will never be linear. Showing an athlete that they were able to move the same weight but faster in meters per second will allow the athlete to see that they are getting stronger even if the weight on the bar does not show it. Two high-level football athletes who play the same position may have the same bench press of 300 pounds. One player has higher velocities at the same sub-maximal loads. This suggests that he has a greater movement velocities which will result in greater power and increased athletic performance (Jovanović et al,. 2014).

Estimating sub-maximal loads for training athletes is always a problem for training athletes. The percentage of the 1RM is problematic in training sessions because the percentage varies. In our study the 10RM was supposed to be 72.5% of 1RM. Actually, the 10RM was 80% of the bench press 1RM and 78% of the squat 1RM. The relationship between the repetition maximum and the percentage varies from person to person and with training. At the same time, estimating 1RM for a lift is a challenge. Some may rise to the challenge of testing and produce a personal record. Another athlete may be too nervous or too excited and underperform. If the

athlete underperforms, their true strength will be underestimated and their loads at a given percentage of 1RM will not be correct. An example to consider is 3 sets of 6 reps at 55%. This should be moderately hard but if the 1RM as not be accurately estimated it can feel like a maximal effort. Velocity-based training can give the athlete another cue to know their training load. A 3x6 at 55% should be near the 0.75 m/s.

Lastly, velocity-based training can be used to set training loads rather than using percentage-based training. For example, a training session can be structured to perform 5 sets of 3 reps of barbell bench press starting at .5 m/s until rep velocity falls under .3 meters per second. At this point it is possible to either reduce the load and maintain the velocity or maintain the load and complete the session at a slower velocity. Knowledge of the velocity and changing the load may result in superior gains in power, the critical variable in performance. A velocity-based approach has numerous other advantages. It is sensitive to day-to-day readiness fluctuations and changes in 1RM the occur during longer training blocks. Velocity-based approaches also allow for autoregulation of load and individualization of training volume and load using velocity bands and velocity stops for both reps (within-set) and sets (between sets using “average set velocity stops”) (Jovanović et al., 2014). Finally, velocity bases training provides immediate real-time feedback to the athlete motivating athletes to apply consistent maximal lifting effort which will result in positive training effects (Randell et al., 2011b).

HEADING 5

CONCLUSION

Based on the results from this study, it is possible to use velocity-based training to have a percentage of intensity on an athlete. The strength and conditioning field can utilize a day-to-day setting for the real time feedback knowing the percentage of the athlete's intensity every repetition. With this information, specialists can estimate an athletes percentage of intensity from velocity-based training. The strength and conditioning coach can build a more injury resilient, stronger and faster athlete with the knowledge of when deload is needed or when an athlete is adapting correctly to the program.

REFERENCES

Hirsch, S. M., & Frost, D. M. (2019). Considerations for Velocity-Based Training: The Instruction to Move "As Fast As Possible" Is Less Effective Than a Target Velocity. *The Journal of Strength & Conditioning Research*.

Jovanović, M., & Flanagan, E. P. (2014). Researched applications of velocity based strength training. *J Aust Strength Cond, 22*(2), 58-69

Kenn J., The coach's strength training playbook. Coaches Choice, Monterey 2003.

Mann, J. B., Ivey, P. A., & Sayers, S. P. (2015). Velocity-based training in football. *Strength & Conditioning Journal*, *37*(6), 52-57.

Locke EA, Latham GP. New directions in goal-setting theory. Curr Dir Psychol Sci 15: 265–268, 2006

Randell, A.D., Cronin, J.B., Keogh, J.W., Gill, N.D., Pedersen, M.C.(2011a) Effect of instantaneous performance feedback during 6 weeks of velocity-based resistance training on sport-specific performance tests. Journal of Strength and Conditioning Research. 25: 87 – 93.

Randell A.D., Cronin J.B., Keogh J.W., Gill N.D., Pedersen M.C.(2011b) Reliability of performance velocity for jump squats under feedback and nonfeedback conditions. Journal of Strength and Conditioning Research. 25: 3514 - 3518.

Romness, C. (2019, October 12). CLUSTER TRAINING - BEHIND THE BLOCK. Retrieved from https://www.allegiategym.com/blog/cluster-training-behind-the-block

Siff M.C., Supertraining. Supertraining Institute, Denver, Colorado 2003

VITA

Graduate School
Southern Illinois University

Aaron Letinski

Apbasketball44@gmail.com

Bluffton University

Bachelor of Science, Exercise Science, May 2017

Research Paper Title:

The Relationship between Velocity of Movement to Percentage of One Repetition Maximum in the Barbell Bench and Barbell Squat

Major Professor: M. Daniel Becque