Examination of Bar Velocity in Barbell Back Squat

Kimitake Sato
East Tennessee State University, satok1@etsu.edu

Kevin M. Carroll

Michael H. Stone
East Tennessee State University, stonem@etsu.edu

Follow this and additional works at: https://dc.etsu.edu/etsu-works

Citation Information
Sato, Kimitake; Carroll, Kevin M.; and Stone, Michael H.. 2016. Examination of Bar Velocity in Barbell Back Squat. ISBS Meeting, Tsukuba, Japan. https://ojs.ub.uni-konstanz.de/cpa/article/view/6958
Examination of Bar Velocity in Barbell Back Squat

Copyright Statement
© The Author(s). This document was originally published in the Proceedings of the International Conference of Biomechanics in Sports.
EXAMINATION OF BAR VELOCITY IN BARBELL BACK SQUAT

Kimitake Sato, Kevin M. Carroll & Michael H. Stone
Center of Excellence for Sport Science & Coach Education
Department of Exercise & Sport Science
Designated Olympic Training Site
East Tennessee State University
Johnson City, TN USA

PURPOSE
The purpose of this study was to examine rep-to-rep bar velocity in the barbell back squat. The study mainly focused on changes in velocity over 10 repetitions at a relative intensity of 78-80% of 1RM. This study also examined changes in variations over the 10 repetitions.

INTRODUCTION
Bar velocity measurement is increasing its popularity in strength and conditioning to measure how fast lifters are moving external loads in training. Instruments such as TENDO-unit™ and gymAware™ have been used to measure bar velocity with a wired connection to the bar (Cronin, Jones, & Hagstrom, 2007; Gonzalez, Hoffman, Rogowski, Burgos, Manalo, Weise, Frangala, & Stout, 2013). This type of measurements have focused on back squat, bench press along with some explosive lifts. In recent years, wireless instruments (via Bluetooth™ connection) such as PUSH™ and BarSense™ are used for a similar purpose, but provide a user-friendly approach with “no wires” in the testing environment. The PUSH™ unit provides versatility to accommodate non-bar exercises such as dumbbell, kettlebell, and medicine balls. This gives users the ability to test velocity in different types of exercises at chosen intensity.

The force-velocity curve described in the textbook is somewhat a theory-based shape. When lifters perform an exercise at a given intensity over relatively high repetitions (e.g. 10 repetitions), possible velocity variations at given resistance has not yet been identified or cautiously been checked in a practical setting. While identifying load specific velocity changes seem important and necessary from a safety perspective (Ratamess, Alver, Evetoch, Housh, Kibler, Kraemer, & Triplett, 2009), changes in bar velocity from repetition to repetition (rep-to-req) could also aid coaches in identifying an athlete’s capability to maintain bar velocity throughout a set of lifting, and thus provide feedback.

This study specifically focuses on changes and variation of bar velocity in relatively high repetitions. From a practical standpoint, velocity variations would come from various factors such as acute fatigue, due to intensity (high percentage (%)) of repetition maximum (RM)), technique, and training experience. A comparison of bar velocity changes at different intensities has been investigated before, but the same loads over repetitions also seem relevant and would provide practical knowledge to strength and conditioning coaches.

METHODS
Nineteen female collegiate-level athletes participated the study. Participants’ age ranged from 18 to 21, and in collegiate athletic experience maximum of 3 years apart. All participants had been instructed by qualified (certified) strength and conditioning coaches to obtain proper technique to perform a barbell back squat. The data collection is a part of on-going athlete monitoring program and was obtained during regular training days. All participants signed informed consent in accordance with the University Institutional Review Board.

Data were collected during the team’s weight training schedule at identical time. Weekly relative intensity (%1RM) and training volume were already planned prior to the data collection. Data considered for this current study was when athletes performed barbell back squat of 3 sets of 10 repetitions (3x10) at a relative intensity of 78-80% of 1RM.

Velocity data were collected with PUSH™ bands, using application of software on a smartphone to select the exercise (barbell back squat) and the load lifted.

Each individual’s 3x10 are averaged from 3 data per repetition per participant. Ten repetitions’ mean and standard deviation were summarized for data analysis. One-way repeated measured ANOVA was performed to identify the difference of rep-to-rep average bar velocity (IBM SPSS ver. 22, IBM, New York, USA), p value was set at 0.05 for significance. Furthermore, coefficient of variation (CV) from each repetition was examined to capture its changes over the 10 repetitions.

RESULTS
The average bar velocity decrease was statistically significant (F(11,17)=45.06, p<0.0001), indicating that the bar velocity decreased as the repetitions approach the 10th repetition (see Table 1).

As a post-hoc test, a pairwise t-test comparison was done to further examine the actual rep-to-rep differences. Although the back to back repetitions such as 1st and 2nd repetitions or 3rd and 4th repetitions did not show statistical difference, the further the repetitions were away from each other, the greater the p values and r scores. Comparison of average 1st and 10th repetitions differed by 20.42%. Comparison between 2nd, 3rd, 4th, and 5th repetitions with the 10th repetition differed by 14.5%, 13.29%, 11.93%, 10.17%, respectively.

The current study further analyzed the coefficient of variance (CV) from each repetition to see changes over the 10 repetitions. The CV is an estimate of reliability and variations between each athlete. Further analysis was done to investigate the CV changes over the repetitions from each individual. Interestingly, those participants who produced a faster bar velocity (top 6 out of 19, ranging from 0.75-0.88 m/s) showed relatively small CV (ranging from 1.74-2.96%). Athletes with slower bar velocities (bottom 6 out of 19), bar velocity was 0.59-0.70 m/s with the CV of 9.00-14.43%.

DISCUSSION & CONCLUSION
The primary purpose of this study was to examine the changes in bar velocity over the 10 repetitions at a relative intensity of 78-80% of 1RM. It is obvious that the bar velocity started to decrease as the repetitions increased. There was a gradual decrease of velocity in group average and also from each individual, confirming that over the 10 repetitions bar velocity changes with a relative intensity of 78-80% of 1RM.

From a practical standpoint, a minimum threshold of back squat bar velocity from previous study was around 0.25-0.30 m/s to be considered of maximal strength at 77-84% of 1RM and absolute 1RM test (Carroll, 2015; Jovanić & Flanagan, 2014). Based on the information, 0.69 m/s at the 10th repetition may be underestimating the 1RM.

This study also examined changes in bar velocity variations over the 10 repetitions. From the 19 participants, CV was relatively low (up to 14%), indicating the homogeneity of the athletes in the current study. But the study also revealed gradual gain in CV from 7.88% to 14%, indicating that as the repetitions proceeded, individual responses differed. This may indicate a lack of sufficient strength to perform the back squat over 10 repetitions with consistent bar velocity as compared to those who displayed a relatively higher bar velocity. Further investigation in this measure is necessary. To bridge the gap between science and practice, ways to analyze the raw data seems to be next step. While average data as a trend of tested participants, is indeed important data reporting technique. It is also important to investigate each individual response to the stimulus. For example, in the current study, an individual who displayed high velocity had very small CV compared to those who displayed a relatively higher bar velocity. Further investigation in this measure is necessary. To bridge the gap between science and practice, ways to analyze the raw data seems to be next step.

Each individual response to the stimulus. For example, in the current study, an individual who displayed high velocity had very small CV compared to those who displayed a relatively higher bar velocity. Further investigation in this measure is necessary. To bridge the gap between science and practice, ways to analyze the raw data seems to be next step.

REFERENCES

ACKNOWLEDGEMENT
The authors would like to thank East Tennessee State University Research Development Committee for providing the funding to purchase wireless device to conduct data collection for the study.