LOAD-VELOCITY BEHAVIOR DURING THE FIRST AND SECOND PULL OF THE SNATCH AND CLEAN

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The purpose of the study was to examine the effect of barbell load on the velocity during the first and second pull of the snatch and clean. Fifteen elite weightlifters (M= 6, F = 9) performed multiple repetitions of the snatch and clean at 75%-100% of their one-repetition max. Load-velocity (L-V) regression models were created for the first pull and second pull for each of the two lifts. The slopes of the L-V relationships were extracted from each model to determine how load affects each pull of the corresponding lifts. The results suggested that the L-V slopes for the snatch (p = 0.006) and clean (p = 0.015) differed between the first and second pull. For the snatch, the L-V slopes were greater during the second pull, whereas the opposite was true for the clean. Interestingly, differences in L-V slopes during the snatch were less pronounced in weaker lifters.

KEYWORDS: sports, biomechanics, snatch, load-velocity, strength

INTRODUCTION: Success in the sport of weightlifting is determined by the total amount of weight successfully lifted relative to the lifter's bodyweight. The total amount of weight lifted is a combined total from two separate lifts: the snatch and the clean and jerk. The snatch and the clean can further be broken into five separate phases: first pull, transition, second pull, turnover, and the catch phase. Analysis of biomechanical variables during specific phases of the different lifts can provide helpful information for coaches and athletes.

Previous research has emphasized the importance of the pulling phase of the lifts (Bartonietz, 1996). Specifically, research has focused on the specific velocities reached during the different phases, as well as the definition of a threshold velocity. The threshold velocity is individual to the lifter but is a large determinant on how much weight the athlete can successfully lift (Sandau, 2023). While some velocity curves exhibit two distinct peaks during the first and second pull, it has been suggested that better lifters show a velocity curve with one single velocity peak, which represents a monotonic increase in velocity until maximum threshold velocity is reached (Baumann, 1988). For many different resistance training exercises, an inverse relationship between barbell load and velocity exists i.e., as load is increased, the velocity of the barbell decreases (Conceição, 2016). Though the basic load-velocity (L-V) relationship is well established, few studies examined the effects of load specifically on the first and second pull of the snatch and clean lift. Furthermore, there is a gap in the literature on how the relative strength of a lifter influences the phase-specific L-V relationships for the two lifts. Therefore, the purpose of the current study was to examine the effect of barbell load on the velocity during the first and second pull of the snatch and clean and to determine whether this effect depended on the relative strength of the lifters.

METHODS: Fifteen weightlifters (male = 6, female = 9; 81.2 kg ± 26.9 kg; 24.5 years ± 5.4 years) who currently, or within the previous year, competed at the international level (either junior or senior world championships, continental championship, or Olympic games) participated in the current study. The study was approved by the local University's Institutional Review Board and all weightlifters provided written informed consent before participating in the study.

Each lifter completed an individualized general and specific warm-up. All weightlifters performed multiple repetitions of the snatch and clean at increasing loads that ranged from 75%-100% of their one-repetition max (snatch: 112.8 kg ± 26.7 kg; clean and jerk: 143.0 kg ± 30.9 kg). Position data of the barbell during each lift were collected via three motion capture cameras (Bonita, Vicon, Los Angeles, CA, USA) using a single reflective marker attached on the right end side of the barbell. Barbell velocity was calculated with the central difference method. Peak velocities during the first and second pull were then extracted for analysis (Figure 1). L-V regression models were then created for the peak velocities from the first and second pull for each of the two lifts (snatch and clean) for every lifter (Figure 2). The phase-specific slopes of the L-V regressions were extracted from each model. The units for the L-V regression lines are kg/m/s, and thus represent the change in velocity that occurs in response to an increase in load.

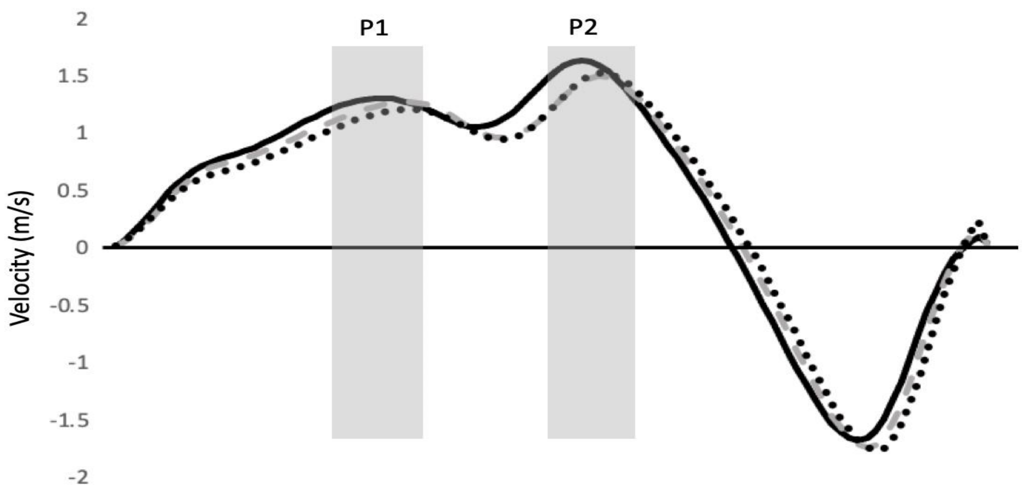

Figure 1: Velocity profiles during the clean for one weightlifter across three different loads. Peak velocities were extracted from the first (P1) and second (P2) pull phases of the lift.

The coefficient of determination (R^2) of each L-V slope was used to determine the overall fit of the individual regression models for the first and second pull of the snatch and clean (i.e., 4 models per weightlifter). Paired samples t-tests were used to compare the L-V slopes between the first and second pull for the snatch and the clean separately. In addition, Pearson correlation coefficients (r) were calculated and used to investigate the relationship between the L-V slopes and the lift-specific relative strengths of each weightlifter, which were calculated as the ratio of snatch and clean and jerk 1RM to body mass. Shapiro-Wilk tests were used to test for normality and the criterion for statistical significance was set at an alpha level of 0.05. All statistical analyses were performed in JASP (version 0.15; Amsterdam, NL). Descriptive data are reported as mean±SD.

RESULTS: The overall fit (R^2) for the L-V regression models for the first and second pull during the snatch were 90.4 ± 9.1 and 90.4 ± 11.1, respectively. Similarly, the overall fit for the L-V regression models for the first and second pull during the clean were 89.6 ± 14.2 and 85.0 ± 21.8, respectively.
Paired samples t-tests were used to look at the L-V slopes for the snatch and clean lift. The L-V slopes for the snatch differed (p = 0.006) between the first (-.004 ± .029 kg/m/s)
and second (-.008 ± .008 kg/m/s) pull. The L-V slopes for the clean differed (p = 0.015) between the first (-.007 ± .023 kg/m/s) and second (-.009 ± .003 kg/m/s) pull.

Pearson correlation analysis showed relationships between relative strength of the lifter and the L-V slopes. Specifically, the associations between relative snatch strength and the L-V slopes during the first and second pull were r = 0.47 (p = 0.038) and r = 0.27 (p = 0.251), respectively. The associations between relative clean strength and the L-V slopes during the first and second pull were r = 0.26 (p = 0.261) and r = -0.19 (p = 0.420), respectively.

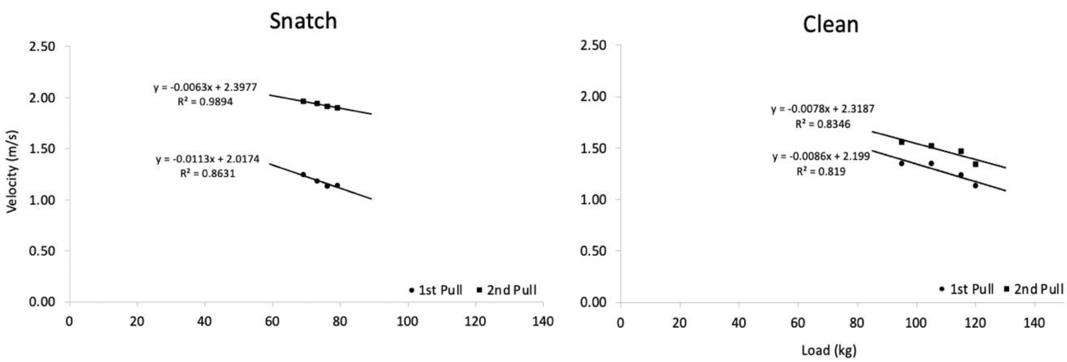

Figure 2: Load-velocity regression models for peak velocities from the first and second pull for the snatch (left) and clean (right) for one weightlifter.

DISCUSSION: The purpose of the current study was to examine the effect of barbell load on the velocities during the first and second pull of the snatch and clean, and to determine if this effect depended on the relative strength of the lifters. The results showed that L-V slopes differed significantly between the first and second pull for the snatch and the clean.

For the snatch, the average L-V slopes of the second pull were larger than the L-V slopes of the first pull, which indicated that the effect of load produced a greater change in velocity during the second pull and suggested that the velocity of the second pull is more affected than the velocity of the first pull. These results disagree with work by Sandau and Granacher, who showed that increases in barbell load led to higher losses in velocity during the first pull than during the second pull of the snatch (Sandau & Granacher, 2020). However, Sandau and Granacher (2020) also found large discrepancies in the responses between lifters. It has been proposed that the velocity of the barbell should progressively increase from the end of the first pull to the end of the second pull, without a noticeable decrease during the transition phase (Bartonietz, 1996). However, the association between the velocities during the different phases of the pull has not been extensively investigated in the literature. We observed a significant association between the relative snatch strength of the lifter and the L-V slope during the first pull of the snatch. These results suggest that, compared to stronger lifters, relatively weaker lifters will experience a greater change in first pull velocity in response to an increase in load. Furthermore, these results may indicate that as the barbell load is increased, a poor first pull during the snatch may subsequently affect the velocity of the second pull, leading to a velocity below the lifter’s individual velocity threshold. Bartonietz (1996) suggested that too fast of a first pull results impedes the transition phase and leads to a noticeable decrease in the velocity during the second pull of the snatch.

Unlike for the snatch, the first pull of the clean was more affected by load of the barbell than the second pull. Furthermore, velocities during the first and second pull decrease to differing effects as barbell load is increased from 85%-100% of 1RM. Specifically, a decrease in first pull velocity is observed at loads of 100% compared to 85%, while a decrease in second pull velocity is observed at barbell loads of 90% and 100% compared to 85% (Ammar, 2018). The current study’s results suggest that the load affects the velocity during the first pull of the clean to a greater extent than during the second pull. One thing that remains to be determined is whether there exist correlations between peak first and second pull velocities during a single lift, which may be something to consider in future studies.

One limitation of the current study is that sex differences were not accounted for within any of the analyses, which could therefore be an area of focus for future studies. Future research could also investigate the relationship between the L-V slopes of the first and second pull of the snatch and clean and the relative training age of athletes to better understand the influence of experience and perhaps technical proficiency.

CONCLUSION: The results show that the L-V slopes differed between the first and second pull for both lifts. In addition, the effect of bar on the L-V slopes depends on the relative strength of the lifter. More specifically, during the clean, load affects the first pull whereas during the snatch lift, load affects the second pull. Moreover, the load-related effects observed during the snatch depend on the relative strength of the lifter.

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