DETERMINATION OF 1 REPETITION MAXIMUM AND MAXIMAL NEUROMUSCULAR CAPACITIES FOLLOWING A SINGLE-SESSION LOAD-VELOCITY PROTOCOL

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INTRODUCTION

The load-velocity profile (LVP) provides valuable information concerning the individual maximal neuromuscular capacities (MNC) (1). Conventionally, to obtain the individual LVP, two testing sessions are required: one initial session to directly measure one-repetition maximum (1RM), and another involving an incremental loading protocol based on standardized relative loads (1,2). An alternative approach consists of a single-session to determine the LVP together with 1RM, which is based on implementing an absolute load incremental protocol until reaching 1RM (3).

We sought to explore if a single session of absolute incremental loading enables a valid determination of the LVP and 1RM for the free-weight parallel back-squat exercise.

METHODS

- 15 male attended the laboratory for three testing sessions: one session for assessment of the free-weight parallel back-squat 1RM and two sessions for measuring the LVP, with either absolute or relative load increments.
- Inclusion criteria:
  - ✓ 2 years of strength training experience , including free-weight back squats
  - ✓ Free-weight parallel back-squat 1RM ≥ 1.5 times their body mass
- **Back Squat 1RM:** five 1RM attempts were allowed with three minutes passive recovery between sets. Between 0.5-2.5 kg was added to the barbell weight after successful 1RM attempts until no further weight could be lifted with correct technique (4).
- **LVPrel Protocol:** Incremental loads corresponding to 40, 60, 80, 90 and 100%1RM.
- **LVPabs Protocol:** Initial load of 20 kg (empty barbell) and subsequent increments corresponding to 20% of subject's body mass. Once the barbell mean concentric velocity (MCV) dropped below 0.7 m.s-1, subsequent increments ranged from 1.25 to 10 kg until reaching 1RM.

- A multipoint approach was used to determine the individual LVPs (4 points between 40 and 90%1RM) and the following variables, which represent each subject's MNC, were calculated: **L0-** load-axis intercept (load at zero velocity); ***S*-** slope of the LV relationship (kg.m.s^{1}); **V0-** Maximal velocity capacity (m.s^{1}); **Aline-** area under the LV relationship line (kg.m.s^{1}) (1).
- Paired samples *t* tests were used to explore differences between the baseline session and LVPabs for 1RM and velocity at 1RM (v1RM) and also between LVPrel and LVPabs for L0, *S*, V0 and Aline. The absolute percent error between sessions was calculated and classified as follows: low (< 5%), moderate (5-10%) and high (> 10%) (5).
- The agreement between sessions for each variable was analyzed using Bland-Altman plots.

RESULTS

Variables	Baseline	LVP_{abs}	t	p value
1RM (kg)	133.8 ± 24.9	134.3 ± 25.3	-0.642	0.531
v1RM (m.s^{-1})	0.27 ± 0.06	0.27 ± 0.07	0.235	0.235

Table 1 - Comparison of 1RM and v1RM between the baseline session and LVPabs protocol.

Variables	LVP_{rel}	LVP_{abs}	*t*	p value
L_0 (kg)	169.9 ± 35.8	169.4 ± 32.4	0.228	0.823
***S* (kg.m.s^{-1})**	-110.9 ± 29.4	-110.2 ± 25.0	-0.241	0.813
V_0 (m.s^{-1})	1.55 ± 0.14	1.55 ± 0.13	-0.101	0.921
A_{line}(kg.ms.s^{-1})	131.2 ± 25.5	131.1 ± 24.5	0.097	0.924

Table 2- Comparison of variables derived from the LVPrel and LVPabs protocols.

- The absolute percent error was low for 1RM (1.3%), but not for v1RM (12.6%)
- Regarding MNC variables, the absolute percent error between protocols ranged from low (L0, V0, Aline) to moderate (*S*)

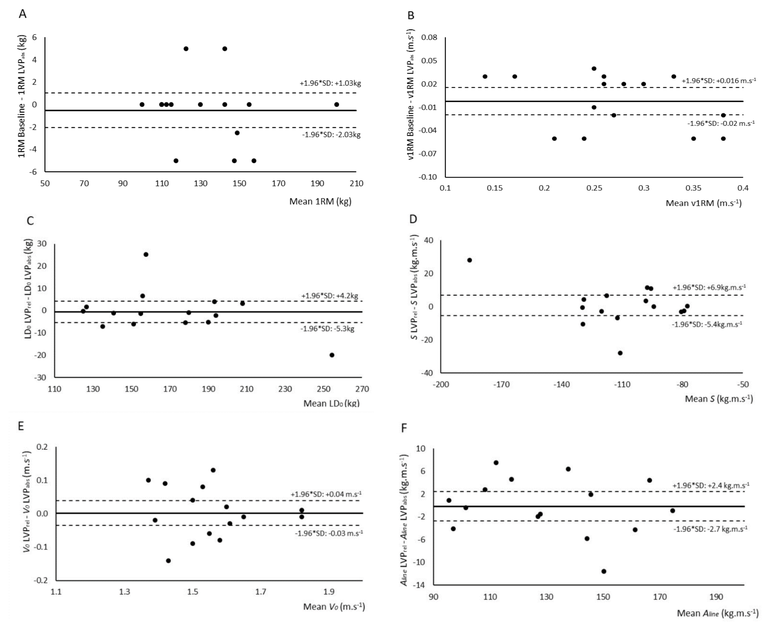

Figure 1. Bland-Altman plots. **A** – difference between 1RM measured at baseline and LVPabs. **B** - difference between v1RM measured at baseline and LVPabs. **C** - difference between L0 obtained following LVPrel and LVPabs. **D** - difference between S obtained following LVPrel and LVPab. **E** - difference between V0 obtained following LVPrel and LVPab. **F** - difference between Aline obtained following LVPrel and LVPabs. Solid and dashed lines represent mean difference and 95% limits of agreement (mean value ± 1.96 SDs), respectively.

CONCLUSIONS

Our data demonstrate that a single-session of a progressive absolute loading protocol does not affect the accuracy of 1RM determination. In addition, the L0 and Aline obtained with this approach exhibit enough accuracy to detect minimal changes in maximal strength and power, respectively. However, the slope of LVP and V0 obtained with this approach may be more fallible if used to monitor minor changes throughout the course of a training program

PRACTICAL APPLICATIONS

The single-session protocol here described provides coaches with a valuable tool for tracking the evolution of different neuromuscular parameters across multiple training cycles, while saving time by avoiding splitting the procedures into two separate sessions (one for 1RM determination and another for LVP assessment).

REFERENCES

1. Perez-Castilla A, Jukic I, Janicijevic D, Akyildiz Z, Senturk D, and Garcia-Ramos A. Load-Velocity Relationship Variables to Assess the Maximal Neuromuscular Capacities During the Back-Squat Exercise. Sports Health 14: 885-893, 2022
2. Cetin O, Akyildiz Z, Demirtas B, Sungur Y, Clemente FM, Cazan F, and Ardigo LP. Reliability and validity of the multi-point method and the 2-point method's variations of estimating the one-repetition maximum for deadlift and back squat exercises. PeerJ 10: e13013, 2022
3. Mendonca GV, Fitas A, Santos P, Gomes M, and Pezarat-Correia P. Predictive Equations to Estimate Relative Load Based on Movement Velocity in Males and Females: Accuracy of Estimation for the Smith Machine Concentric Back Squat. J Strength Cond Res, 2023.
4. Banyard HG, Nosaka K, and Haff GG. Reliability and Validity of the Load-Velocity Relationship to Predict the 1RM Back Squat. J Strength Cond Res 31: 1897-1904, 2017
5. Janicijevic D, Jukic I, Weakley J, and Garcia-Ramos A. Bench Press 1-Repetition Maximum Estimation Through the Individualized Load-Velocity Relationship: Comparison of Different Regression Models and Minimal Velocity Thresholds. Int J Sports Physiol Perform 16: 1074-1081, 2021