PREDICTION OF ONE-REPETITION MAXIMUM BASED ON THE LOAD-VELOCITY RELATIONSHIP: MULTIPOINT AND TWO-POINT APPROACHES

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Purpose

Since the load-velocity relationship displays strong linearity (R^2 usually > 0.9) in response to several multiarticular resistance training exercises, it has been argued that one-repetition maximum (1RM) can be predicted using this method[1,2,3]. However, most past studies (excluding two which examined the bench press) examining the predictive value of the load -velocity relationship in determining 1RM implemented its direct determination to enable testing movement velocity within a predetermined set of relative loads (e.g., 50, 60, 70, 80, 90% 1RM)[4,5]. Whether the two-point approach enables accurate predictions of the back-squat 1RM without requiring its previous determination remains uknown.

The purpose of this study was to determine whether different approaches of establishing the load-velocity profile affect the accuracy of estimating 1RM.

Methods

We studied 26 young healthy male, physical education students, on no medications. All participants were well accostumed to resistance training, including the back-squat exercise.

Predictions based on a practical two-point approach (no pre-determination of 1RM) were compared to those obtained with the conventional multipoint and two-point approaches (with predetermination of the 1RM). After profiling the load-velocity relationship with each approach, 1RM was estimated relying on the general minimum-velocity threshold (MVT: 0.3 m.s^{-1}). Analyses were conducted separately for the Smith-machine concentric back squat and the free-weight eccentric-concentric back squat (n=13 Smith Machine [23.3 ± 3.8 years], n=13 free-weight [22.9 ± 3.2 years]). Differences in the load-velocity profiles obtained with each approach were assessed using slopes and y-intercepts. The accuracy of 1RM prediction was determined by contrasting the actual with predicted 1RM and via Bland-Altman plots.

Results

Individual MVT did not differ from the general 0.3 m.s^{-1} value (0.27 ± 0.11 and 0.31 ± 0.08 m.s^{-1}, for the Smith machine and the free-weight back squat, respectively. The slopes and y-interceps were similar between approaches.

Table 1. Differences in the load-velocity profiles (slope and y intercept) obtained with three different approaches (conventional multipoint, conventional two-point and practical two-point) in response to the back squat exercise (Smith machine concentric squat and free–weight eccentric-concentric squat).

	Smith-machine concentric squat			Free-weight eccentric-concentric squat		
	Conventional MP (n=13)	Conventional 2P (n=13)	Practical 2P (n=13)	Conventional MP (n=13)	Conventional 2P (n=13)	Practical 2P (n=13)
y intercept (kg)	133.3 ± 32.4	134.6 ± 31.9	137.4 ± 29.8	137.7 ± 15.4	141.2 ± 17.3	141.2 ± 16.5
Slope (kg/m.s^{-1})	-100.3 ± 24.5	-103.6 ± 28.1	-107.0 ± 26.2	-98.1 ± 19.1	-101.7 ± 21.5	-101.7 ± 20.1

Note: values are mean ± standard deviation.

Abbreviations: MP, multipoint, 2P, two point.

For the Smith-machine, the 1RM estimated with MVT did not differ from actual 1RM (103.5 ± 23.4 kg) with either approach (conventional multipoint: 103.2 ± 26.6 kg; conventional two-point: 103.4 ± 25.8 kg; practical two-point: 105.3 ± 24.7 kg; mean misestimate: -1.83 to 0.02 kg). However, the limits of agreement were high (~12 kg) and the absolute percent error was larger than zero with all approaches. Estimations of 1RM for the free-weight back squat were poor (conventional multipoint: 108.2 ± 11.1 kg; conventional two-point: 110.6 ± 11.9 kg; practical two-point: 110.7 ± 11.6 kg; mean overestimation of ~ 6 to 8 kg) and significantly different from the actual 1RM (102.3 ± 10.5 kg; $p<0.05$, except with multipoint).

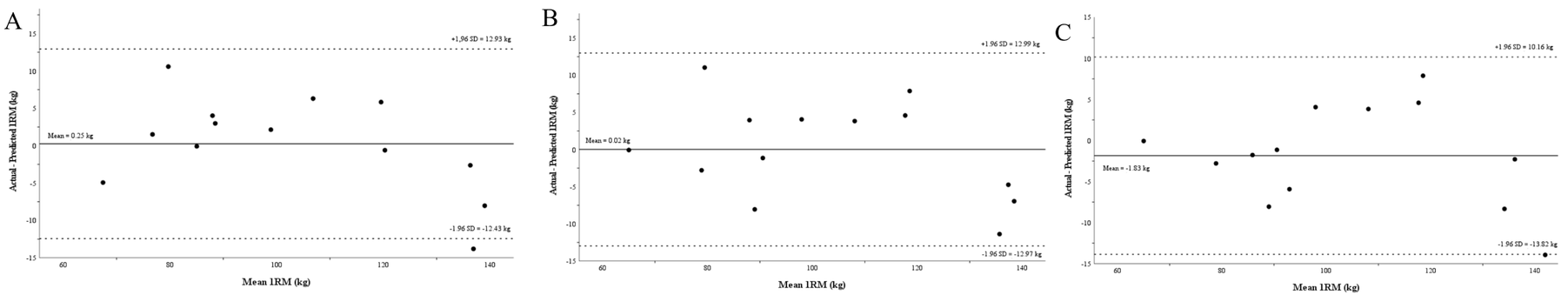

Figure 1. Bland-Altman plots of the difference between actual and estimated 1RM through a reference MVT value in the Smith Machine Concentric Squat (n=13) for the different load-velocity profiling approaches. A- Conventional multipoint; B- Conventional 2-point; C– Practical 2-point. Solid and dashed lines represent mean difference and 95% limits of agreement (mean value ± 1.96 SDs), respectively.

Conclusions

For the Smith-machine concentric back squat, the combination of all profiling approaches with the use of a general MVT value enables accurate 1RM group estimations. For free-weight back squat, group estimations should be based on the multipoint approach. Yet the wide limits of agreement preclude the use of these approaches for estimating 1RM accurately on na individual basis.

Practical Applications

Coaches and athletes can extract the load-velocity relationship without directly determining the 1RM. However, for accurate 1RM individual assessments, coaches and athletes should not rely on estimations based on the load-velocity relationship.

References

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