1RM PREDICTION AND LOAD-VELOCITY RELATIONSHIP

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INTRODUCTION

Maximal strength is often estimated using the force-endurance relationship, where tables or formula are used to predict one repetition maximum (1RM) or other loads (e.g. 3RM loads). For some populations (for example the frail or very young) such a procedure may not be appropriate and the accuracy of these methods depends on several parameters such as the number of repetitions, type of exercise, training background and the population used (1). Very recently, 1RM estimation from a load-velocity profiling protocol has been presented (2, 3). The aim of the present study was to investigate the ability of the load-velocity relationship to predict 1RM in different strength exercises and with different assessment devices.

METHODS

Data from four studies including in their protocol 1RM determination and load-velocity relationship profiling were gathered for the present analysis. Five common strength exercises were investigated: bench press, half-squat, horizontal press, leg curl and lat pulldown. Each study included two sessions. During the first "familiarization session" standardized positions were established for each exercise and the actual 1RM was determined. In the second "testing session", velocity was measured at three or four increasing loads ranging from 30 to 95% of the 1RM. A laboratory based inertial dynamometer, combining a linear position transducer and an accelerometer (LPT+acc) (4) was used for the half-squat and bench press exercises to determine average velocity (AvV) and peak velocity (PkV). The Myotest (Myotest, Switzerland) accelerometer was used for the bench press, leg curl, horizontal press and lat pulldown exercises to measure PkV.

The procedure to determine the "predicted 1RM" (P1RM) was as follows (Fig. 1):

1. For each subject and each exercise, the best fit load-velocity (AvV and/or PkV according to the device and exercise) relationship and linear equation was determined.
2. Associated parameters such as slope, intercept point on the Y axis (V0: maximal velocity at load=0kg) and intercept point on the X axis (Ld0: maximal load at velocity=0m.s^{-1}) were calculated for each population and then for each subject.
3. Two different methods were used to determine the 1RM. The first method (M1) consisted of determining the "1RM-Ld0 relationship" of the population and then using the linear regression to calculate individual P1RM from individual Ld0. The second method (M2) consisted of determining for the whole population the velocity corresponding to the 1RM (V1RM) and then calculating the P1RM from individual linear equation and V1RM (Fig. 1).

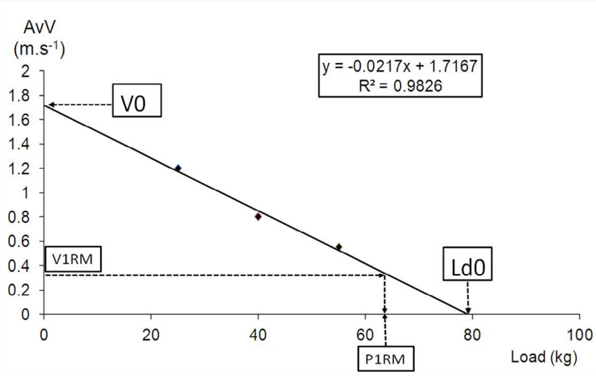

Figure 1 – Linear equation, V0 and Ld0, V1RM and P1RM determined from individual AvV-load relationship.

RESULTS

We found contrasting results for 1RM prediction (Tab. 1). Average velocity appears to be a little more relevant than peak velocity to estimate 1RM. The M2 approach was most highly correlated to actual 1RM and had lower SEE in comparison to M1. Device and parameter seemed to influence the 1RM prediction. The Myotest, that only allows peak velocity measurement, presented a lower correlation and a superior SEE for bench press exercise in comparison with LPT+acc device. Prediction ability was greater for the bench press in comparison to the half squat exercise. Correlations between the 1RM and P1RM were lower but remained acceptable in the half-squat (r=0.75, SEE=10.4%), horizontal press (r=0.71, SEE=12.4%) and lat pulldown (r=0.62, SEE=9.5%) exercises. For the leg curl exercise, the 1RM prediction was very unreliable with $r \leq 0.22$ and $SEE \geq 42\%$.

Exercise	*N*	*Device*	*F-V Profile*	*1RM*	*Parameter*	*Method*	*P1RM±SD*	*r*	*SEE*
Half Squat	*34*	*LPT+acc*	*45-60-75-90% 1RM*	*128(20)*	*AvV*	*M1*	*128±13*	*063*	*121%*
						M2	*129± 17*	*0.75*	*10.4%*
					PeakV	*M1*	*128± 10*	*0.60*	*13.4%*
						M2	*130± 23*	*0.51*	*15.2%*
Bench Press	*112*	*LPT+acc*	*35-50-70-95% 1RM*	*60 (19)*	*AvV*	*M1*	*60±20*	*0.98*	*6.6%*
						M2	*60±19*	*0.98*	*6.3%*
					PeakV	*M1*	*60±20*	*0.98*	*7.2%*
						M2	*60±19*	*0.98*	*6.9%*
Bench Press	*15*	*Myotest*	*30-60-90% 1RM*	*62 (12)*	*PeakV*	*M1*	*62±10*	*0.79*	*11.7%*
						M2	*62±10*	*0.82*	*11.1%*
Horizontal Press	*15*	*Myotest*	*30-60-90% 1RM*	*108 (12)*	*PeakV*	*M1*	*108±12*	*0.67*	*12.6%*
						M2	*109±18*	*0.71*	*12.4%*
Lat Pulldown	*15*	*Myotest*	*30-60-90% 1RM*	*87 (10)*	*PeakV*	*M1*	*87±6*	*0.57*	*10.5%*
						M2	*88±11*	*0.62*	*9.5%*
Leg Curl	*15*	*Myotest*	*30-60-90% 1RM*	*60 (14)*	*PeakV*	*M1*	*106±38*	*0.07*	*95%*
						M2	*66±26*	*0.22*	*42%*

Table 1 *- Descriptive data and prediction characteristics (correlation "r" and standard error of estimation "SEE") for each exercise.*

DISCUSSION

Prediction of 1RM appears to be dependent on mathematical method, selected parameter (peak velocity versus average velocity), device, exercise and equipment. It is more accurate to predict the 1RM from the V1RM (M2) than from the 1RM-Ld0 relationship (M1). V1RM value has been established for each exercise and for each parameter inside our groups but need to be confirmed in a larger population. In most exercises, except for bench press, the load-AvV relationship revealed a better prediction ability than the load-PeakV relationship. AvV is more sensitive to the dynamics associated with lifting heavier loads. The load-PeakV and load-AvV relationships are not necessarily well-fitting with the same kind of equation. The method used in the present study favours the Load-AvV relationship that corresponds in most cases with a linear regression. That the Myotest device measures only PeakV could partly explain its lower prediction ability. Our results also suggest that predicting the 1RM depends on the exercise. It depends on the complexity of the movement (bench press versus squat) and on the characterisics of the machine. Most commercialised machines are not suited to dynamic inertial assessment. Leg curl for example: at the lowest load a couple of subjects would not take the risk of lifting as fast as possible as they thought they might damage the machine. For traditional exercises like bench press and squat used with free weights or guided barbell the use of load-velocity relationshp to predict the 1RM appears as accurate as traditional repetition-to-failure method and present the advantage of assessing at the same time the muscular velocity that is a very important component in many sports

CONCLUSION

Using the load-velocity relationsghip for 1RM prediction is a relevant method when the exercise allows and accurate measurement of the velocity.

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