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Optimal Minimum Velocity Threshold to Estimate the 1-Repetition Maximum: The Case of the Smith Machine Bench Press Exercise

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***Purpose*:** To compare the accuracy in the estimation of the Smith machine bench press 1-repetition maximum (1RM) when using a novel minimum velocity threshold (MVT) called *optimal MVT* (MVT that minimized the differences between the actual and predicted 1RM in a preliminary session) with respect to using the 2 standard MVTs (general and individual MVTs). ***Methods*:** A total of 126 young men (Smith machine bench press 1RM = 80.7 [13.6] kg) completed 2 identical sessions consisting of an incremental loading test until reaching the 1RM load. Four individual load–velocity relationships were modeled in each session considering all loading conditions until reaching the load that showed the closest mean velocity to 0.60, 0.50, 0.40, and 0.30 $m \cdot s^{-1}$. The first testing session was used to determine the preindividual MVT and 4 optimal MVTs (1 for each final test velocity), while the second testing session was used to estimate the 1RM using 4 types of MVT (general MVT, preindividual MVT, actual-individual MVT, and optimal MVT). ***Results*:** The absolute errors in the prediction of the 1RM were significantly lower for the optimal MVT (2.94 [2.40] kg) compared to the general MVT (3.66 [2.99] kg), preindividual MVT (3.80 [3.15] kg), and actual-individual MVT (4.02 [3.21] kg). The optimal MVT (intraclass correlation coefficient ranged from .56 to .62) was always more reliable than the individual MVT (intraclass correlation coefficient = .34). ***Conclusions*:** The optimal MVT provides more accurate estimates of the Smith machine bench press 1RM than the standard MVTs previously used in scientific research (general and individual MVTs).

***Keywords*:** muscle strength, optimal MVT, resistance training, testing, velocity-based training

Velocity-based training (VBT) is a resistance training method that uses movement velocity as a supplement to or in some situations as a replacement for more traditional methods of prescribing, monitoring, and assessing the effects of resistance training. The 4 main applications of VBT are (1) the prescription of the load,[1–3] (2) the prescription of the volume (number of sets and repetitions),[4–6] (3) the provision of real-time velocity feedback for an acute increase in mechanical performance,[7,8] and (4) the assessment of maximal neuromuscular performance and the ability to maintain high mechanical outputs during successive repetitions.[5,9,10] The ability to estimate the 1-repetition maximum (1RM) likely is the VBT application that has received the most scientific attention.[11,12] This interest is justified because the 1RM is the most widely used variable to prescribe the loads during resistance training programs and also because it is generally recognized as the gold standard variable for assessing maximal dynamic strength capacity.[13] The fact that direct 1RM testing is associated with a number of potential problems (eg, time-consuming and prone to fatigue) has contributed to the development of different velocity-based methods that claim to predict the 1RM through less physically and time-demanding testing protocols.

The most accurate VBT method for predicting the 1RM consists of the assessment of the individual load–velocity relationship.[12,14] This procedure requires recording the mean velocity (MV) of the lifting phase against 2 or more loads and then modeling the individual load–velocity relationship through a linear regression.[15] Finally, the 1RM can be estimated by applying the linear regression as the load associated with the minimum velocity threshold (MVT). The biggest problem faced by sport practitioners and researchers is how to select the MVT. The 2 options that have been implemented consist of selecting the same MVT for all subjects (*general MVT*) or selecting the individual velocity obtained during a 1RM trial or during the last repetition of a set performed to failure (*individual MVT*).[2,16,17] The available data indicate that the 1RM can be estimated with a comparable level of accuracy using both types of MVT.[2,16,17] Therefore, the general MVT has been recommended over the individual MVT because it does not require performing a maximal test at any time and also because the individual MVT presents a low interday reliability.[18–20] However, there is also strong evidence, especially notable for lower-body exercises (eg, squat or deadlift), that regardless of whether the 1RM is estimated using general or individual MVTs, its value can be significantly overestimated or underestimated.[19–21] Although at first sight these systematic differences seem to be very problematic, there is a seemingly simple solution to avoid the systematic differences: Use a lower MVT when the 1RM is systematically underestimated, and use a higher MVT when the 1RM is systematically overestimated. But the logical question at this point is the following: How can we decide how much to increase or decrease the MVT? The solution proposed in this article is the use of the *optimal MVT*.

The optimal MVT can be defined as the MVT that minimizes the differences between the actual and predicted 1RM when both 1RMs are obtained in the same test. In a hypothetical subject, the use of 0.17 $m \cdot s^{-1}$ as the MVT could provide an underestimation of the actual 1RM (eg, predicted 1RM = 100 kg and actual 1RM = 105 kg). In this scenario, it would be necessary to reduce the magnitude of the MVT (ie, <0.17 $m \cdot s^{-1}$) until reaching the MVT that provides a perfect estimate of the 1RM (ie, predicted

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1RM = 105 kg). In this hypothetical example, the MVT that minimizes the error in the 1RM estimation (ie, optimal MVT) could be 0.12 m·s^{-1}. Therefore, in subsequent sessions, 0.12 m·s^{-1} should be used as the MVT for this particular subject. The idea behind the optimal MVT is that we should not be concerned about which is the actual velocity of the 1RM, but rather we should determine for each subject which is the specific MVT that minimizes the differences between the actual and predicted 1RM (optimal MVT).

It is well known that the accuracy in the estimation of the 1RM decreases with the increment in the distance between the heaviest experimental point used for the load–velocity relationship modeling and the 1RM.[19,20,22] For this reason, a general recommendation could be that the extrapolation from the lowest MV (obtained against the heaviest load of the incremental loading test) until the MVT should not be higher than 0.30 m·s^{-1}. However, it is unknown whether the magnitude of the optimal MVT could be affected by the distance between the last experimental point and the 1RM. This information is important because if the magnitude of the optimal MVT turns out to be affected by this factor, it would imply that, depending on the final velocity of the test, different MVTs should be used to maximize the accuracy of the 1RM estimation.

This is the first study to explore whether the optimal MVT is capable of providing more accurate estimates of the 1RM than the 2 standard MVTs commonly used in scientific research (general and individual MVTs). In particular, the main objective of the present study was to compare the accuracy (absolute errors) in the estimation of the Smith machine bench press 1RM between 4 types of MVT: (1) *general MVT*—the same velocity of 0.17 m·s^{-1} for all participants, (2) *preindividual MVT*—the velocity attained during the 1RM trial in a preliminary session, (3) *actual-individual MVT*—the velocity attained during the 1RM trial in the experimental session, and (4) *optimal MVT*—the MVT that minimized the differences between the actual and predicted 1RM in a preliminary session. As a secondary objective, we explored the effect of the distance (ie, difference in velocity) between the 1RM and the heaviest experimental point of the incremental loading test (4 final test velocities: ≈0.30 m·s^{-1}, 0.40 m·s^{-1}, 0.50 m·s^{-1}, and 0.60 m·s^{-1}) on (1) the errors in the prediction of the 1RM and (2) the reliability and magnitude of the optimal MVT. We hypothesized that the optimal MVT, regardless of the distance between the 1RM and the heaviest experimental point, would provide the most accurate estimation of the 1RM, while the errors would be comparable for the general MVT, preindividual MVT, and actual-individual MVT.[2,17] We also hypothesized that increasing the distance between the 1RM and the heaviest experimental point (from 0.30 to 0.60 m·s^{-1}) would progressively increase the magnitude of the errors in the prediction of the 1RM. Finally, the optimal MVT was expected to be more reliable than the individual MVT, while we could not formulate any hypothesis regarding the expected changes in the magnitude of the optimal MVT for the different final test velocities.

Methods

Participants

All students belonging to a degree in Sport Sciences at the University of XXX were invited to participate in the study to maximize the statistical power of our study. The inclusion criteria were (1) men aged between 18 and 35 years, (2) having previous experience with the use of the bench press exercise in their usual training programs, and (3) being able to perform the bench press exercise at maximal intended velocity with proper technique against different external loads. The first and second inclusion criteria were checked through an online questionnaire, and the third inclusion criterion was later verified by an experienced researcher before the start of data collection. Participants were excluded if they presented any injury that could affect bench press performance. A total of 126 men (age = 21.3 [4.4] y [range = 18–36 y], body mass = 73.6 [14.4] kg, height = 1.72 [0.05] m, bench press 1RM = 80.7 [13.6] kg) participated in this study. Prior to the commencement of the first testing session, participants were informed about the potential risks of the study, and they signed a written informed consent form. Participants were asked to come in a rested condition (eg, without fatigue or muscle soreness) to each testing session. However, the physical activity performed prior to the testing sessions was not controlled. The study protocol adhered to the tenets of the Declaration of Helsinki and was approved by the Institutional Review Board.

Study Design

A repeated-measures design was used to explore the accuracy of 4 types of MVT (general MVT, preindividual MVT, actual-individual MVT, and optimal MVT) for determining the bench press 1RM. Participants completed 2 identical testing sessions separated by 48 to 96 hours. An incremental loading test was used to determine the actual bench press 1RM and the MV against the different external loads applied during the test. The incremental loading test of the first session (preliminary test) was used to determine the preindividual MVT and 4 optimal MVTs (an optimal MVT for each final test velocity). The incremental loading test of the second session (experimental test) was used to estimate the 1RM using 4 types of MVT: (1) MV of 0.17 m·s^{-1} for all subjects (*general MVT*), (2) MV of the 1RM trial obtained in the preliminary test (*preindividual MVT*), (3) MV of the 1RM trial obtained in the experimental test (*actual-individual MVT*), and (4) MV that minimized the differences between the actual and predicted 1RM in the preliminary test (*optimal MVT*). Four individual load–velocity relationships were modeled in each session. The load–velocity relationships considered all loading conditions from the first load in which the MV was <1.25 m·s^{-1} until the load that showed the closest MV to 0.60 m·s^{-1} (V0.60), 0.50 m·s^{-1} (V0.50), 0.40 m·s^{-1} (V0.40), and 0.30 m·s^{-1} (V0.30). The study protocol was not prospectively registered.

Testing Procedures

A standardized warm-up was performed at the beginning of each session: 5 minutes of jogging, upper-body dynamic stretching, and 5 repetitions of the bench press exercise performed as fast as possible against an external load of 20 kg. The initial external load of the incremental loading test was set to 20 kg, and it was increased in 10 kg increments when the MV of the barbell was greater than 0.50 m·s^{-1} and in 1 to 5 kg increments when the MV was lower than 0.50 m·s^{-1} until the 1RM load was achieved. Three repetitions were performed at each lighter load (MV > 1.00 m·s^{-1}), 2 for the medium (0.65 m·s^{-1} ≤ MV ≤ 1.00 m·s^{-1}), and only 1 for the heavier loads (MV < 0.65 m·s^{-1}). Intraset rest was 10 seconds (participants were required to rack the barbell, and 2 spotters unracked the barbell for the next repetition), and interset rest was 3 to 5 minutes.

The bench press exercise was performed in a Smith machine (Smith machine, FFittech) using the touch-and-go and 5-point body contact position technique (head, upper back, and buttocks firmly on the bench with both feet flat on the floor). Subjects were allowed to self-select the grip width. The position of the bench was adjusted so that the vertical projection of the bar corresponded to each subject's intermammary line. Participants were instructed to perform the lifting phase of all repetitions as fast as possible, and they received MV feedback immediately after completing each repetition to encourage them to give maximal effort. Two trained spotters were present on each side of the barbell to ensure safety.

Measurement Equipment and Data Analysis

Q5 Body mass (Tanita BC 418 segmental) and height (Seca 202, Seca Ltd) were assessed at the beginning of the preliminary session. A validated linear velocity transducer (T-Force System, Ergotech) was attached to the bar of the Smith machine and sampled the velocity–time data at a frequency of 1000 Hz.[23] The MV was calculated as the average velocity from the start of the lifting phase (ie, onset of positive velocity) until the barbell reaches maximum height (ie, zero velocity).

Four individual load–velocity relationships were determined in each testing session by means of linear regression models. The first experimental point was always the first load in which the MV was above 1.25 $m{\cdot}s^{-1}$. Repetitions with an MV lower than 1.25 $m{\cdot}s^{-1}$ were not considered because they are not commonly used in practice as they are very far from the 1RM load. The load–velocity relationships differed in the last experimental point considered for the modeling. We used 4 different final test velocities: the closest MV to 0.60 $m{\cdot}s^{-1}$ (V0.60), 0.50 $m{\cdot}s^{-1}$ (V0.50), 0.40 $m{\cdot}s^{-1}$ (V0.40), and 0.30 $m{\cdot}s^{-1}$ (V0.30). Therefore, the 4 individual load–velocity relationships differed in the distance (ie, difference in velocity) between the 1RM and the heaviest experimental point used for the load–velocity relationship modeling. Although the individual load–velocity relationships also differed in the number of loads (Table 1), it should be noted that this is not problematic because there is compelling evidence that the number of loads does not affect the accuracy in the 1RM prediction.[2,17,22]

The optimal MVTs were calculated in both testing sessions for the 4 individual load–velocity relationships (a total of 8 optimal MVTs). The optimal MVT represents the MV that minimizes the differences between the actual and predicted 1RM when both 1RMs are obtained in the same test. The optimal MVTs were computed in both testing sessions to determine their interday reliability, while only the optimal MVTs obtained in the preliminary session were used to estimate the 1RM of the experimental session. In particular, 16 predicted 1RMs were considered in this study based on the combination of 4 types of MVT (general MVT, preindividual MVT, actual-individual MVT, and optimal MVT) and 4 final test velocities (V0.30, V0.40, V0.50, and V0.60).

Statistical Analyses

Descriptive data are presented through means and SDs. The normal distribution of the data was confirmed by the Shapiro–Wilk test ($P > .05$). A 2-way repeated-measures analysis of variance with the factors "type of MVT" (general MVT vs preindividual MVT vs actual-individual MVT vs optimal MVT) and "final test velocity" (V0.30 vs V0.40 vs V0.50 vs V0.60) was applied to the absolute differences between the actual and predicted 1RMs. Pairwise comparisons were identified using Bonferroni post hoc corrections. The validity of the 16 predicted 1RMs (4 types of MVT × 4 final test velocities) with respect to the actual 1RM was also examined through the analysis of the raw differences, paired sample t tests, and Cohen d effect size. The magnitude of the effect size was interpreted following the scales proposed by Hopkins et al.[24]

A 1-way repeated-measures analysis of variance with Bonferroni post hoc corrections was used independently for each testing session to compare the magnitude of the individual MVT and the 4 optimal MVTs (V0.30 vs V0.40 vs V0.50 vs V0.60). The interday reliability of the individual MVT and the 4 optimal MVTs was assessed through the intraclass correlation coefficient (ICC; Model 3.1). A greater reliability was deemed when the ICC of 1 condition was above the upper limit of the 95% confidence interval of the compared condition. In addition, ICC Q6 values were interpreted following the guidelines proposed by Koo and Li[25] (poor [ICC < .50], moderate [ICC = .50–.75], good [.75–.90], and excellent [ICC > .90] reliability).

Reliability assessments were performed by means of a custom Excel spreadsheet,[26] while other statistical analyses were performed using SPSS software (version 25.0). Statistical significance was set at an alpha level of .05. The final database with all 1RM values can be downloaded through the following link: https://osf.io/vmuqr/?view_only=b5f95ff1148b48558eb515839183bcc6.

Table 1 Characteristics of the Preliminary (Session 1) and Experimental (Session 2) Incremental Loading Tests

	Preliminary test					Experimental test				
Target, $m{\cdot}s^{-1}$	Number of loads	Goodness of fit, r	Initial velocity, $m{\cdot}s^{-1}$	Final velocity, $m{\cdot}s^{-1}$	V1RM, $m{\cdot}s^{-1}$	Number of loads	Goodness of fit, r	Initial velocity, $m{\cdot}s^{-1}$	Final velocity, $m{\cdot}s^{-1}$	V1RM, $m{\cdot}s^{-1}$
0.30	5.6 (1.2) (4–10)	1.00 (0.00) (0.98–1.00)	1.10 (0.08) (0.93–1.23)	0.32 (0.06) (0.22–0.51)	0.17 (0.04) (0.06–0.27)	5.5 (1.2) (4–9)	1.00 (0.00) (0.97–1.00)	1.08 (0.08) (0.86–1.24)	0.32 (0.05) (0.25–0.54)	0.17 (0.04) (0.06–0.27)
0.40	4.8 (1.0) (3–8)	1.00 (0.01) (0.97–1.00)		0.42 (0.06) (0.30–0.62)		4.7 (1.0) (3–8)	0.99 (0.01) (0.97–1.00)		0.42 (0.06) (0.30–0.62)	
0.50	4.2 (0.8) (3–7)	1.00 (0.01) (0.5–1.00)		0.51 (0.06) (0.40–0.64)		4.1 (0.9) (3–7)	0.99 (0.01) (0.95–1.00)		0.51 (0.06) (0.41–0.65)	
0.60	3.6 (0.8) (2–6)	0.99 (0.01) (0.91–1.00)		0.61 (0.06) (0.49–0.82)		3.5 (0.7) (2–6)	0.99 (0.01) (0.96–1.00)		0.62 (0.06) (0.50–0.86)	

Abbreviations: r, Pearson correlation coefficient depicting the strength of the load–velocity relationship; V1RM, velocity recorded during the 1-repetition maximum trial.
Note: Descriptive data presented as mean (SD) (range).

Results

The analysis of variance applied to the absolute errors revealed a significant main effect of the "type of MVT" ($F = 35.9$, $P < .001$) and "final test velocity" ($F = 11.3$, $P < .001$), but their interaction was not significant ($F = 1.2$, $P = .320$). The significant main effect of the type of load was caused by the lower errors of the optimal MVT (2.94 [2.40] kg) compared to the general MVT (3.66 [2.99] kg; $P = .002$), preindividual MVT (3.80 [3.15] kg; $P < .001$), and actual-individual MVT (4.02 [3.21] kg; $P = .003$), while no significant differences were observed between the general MVT, preindividual MVT, and actual-individual MVT ($P = .229$–1.000). The significant main effect of the final test velocity was due to the fact that the absolute errors progressively increased with the increment in the distance between the 1RM and the heaviest experimental point of the incremental loading test: V0.30 (2.55 [2.09] kg) < V0.40 (3.18 [2.54] kg) < V0.50 (4.02 [3.22] kg) < V0.60 (4.65 [3.44] kg). The comparison of the absolute errors between the types of MVT separately for each final test velocity is presented in Figure 1.

The optimal MVT was the only type of MVT that never showed systematic differences between the actual and predicted 1RMs (Figure 2). The raw differences were lower for the optimal MVT (from 0.0 to 0.4 kg) compared to the general MVT (from 0.5 to 2.1 kg), preindividual MVT (from 0.3 to 2.0 kg), and actual-individual MVT (from 0.2 to 1.9 kg). However, the magnitude of the differences with respect to the actual 1RM was trivial for the 16 predicted 1RMs (effect size < 0.20).

The magnitude of the optimal MVT was progressively reduced with the increment in the final test velocity (V0.30 > V0.40 > V0.50 > V0.60; Table 2). The individual MVT was comparable to the optimal MVT of the V0.40 condition, lower than the optimal MVT of the V0.30 condition, and higher than the optimal MVT of the V0.50 and V0.60 conditions. Regardless of the final test velocity, the reliability of the optimal MVT (ICC ranged from .56 to .62; moderate reliability) was always greater than the reliability of the individual MVT (ICC = .34; poor reliability; Figure 3).

Discussion

This study explored for the first time whether the optimal MVT can provide a more accurate estimate of the 1RM than the MVTs previously used in scientific research (general and individual MVTs). Our results are promising showing that, regardless of the final test velocity, the optimal MVT always provided the most accurate estimate of the 1RM. These results, together with the moderate reliability of the optimal MVT, suggest that the use of the optimal MVT could increase the accuracy in the estimation of the 1RM and also avoid the frequent systematic overestimation or underestimation of the 1RM.

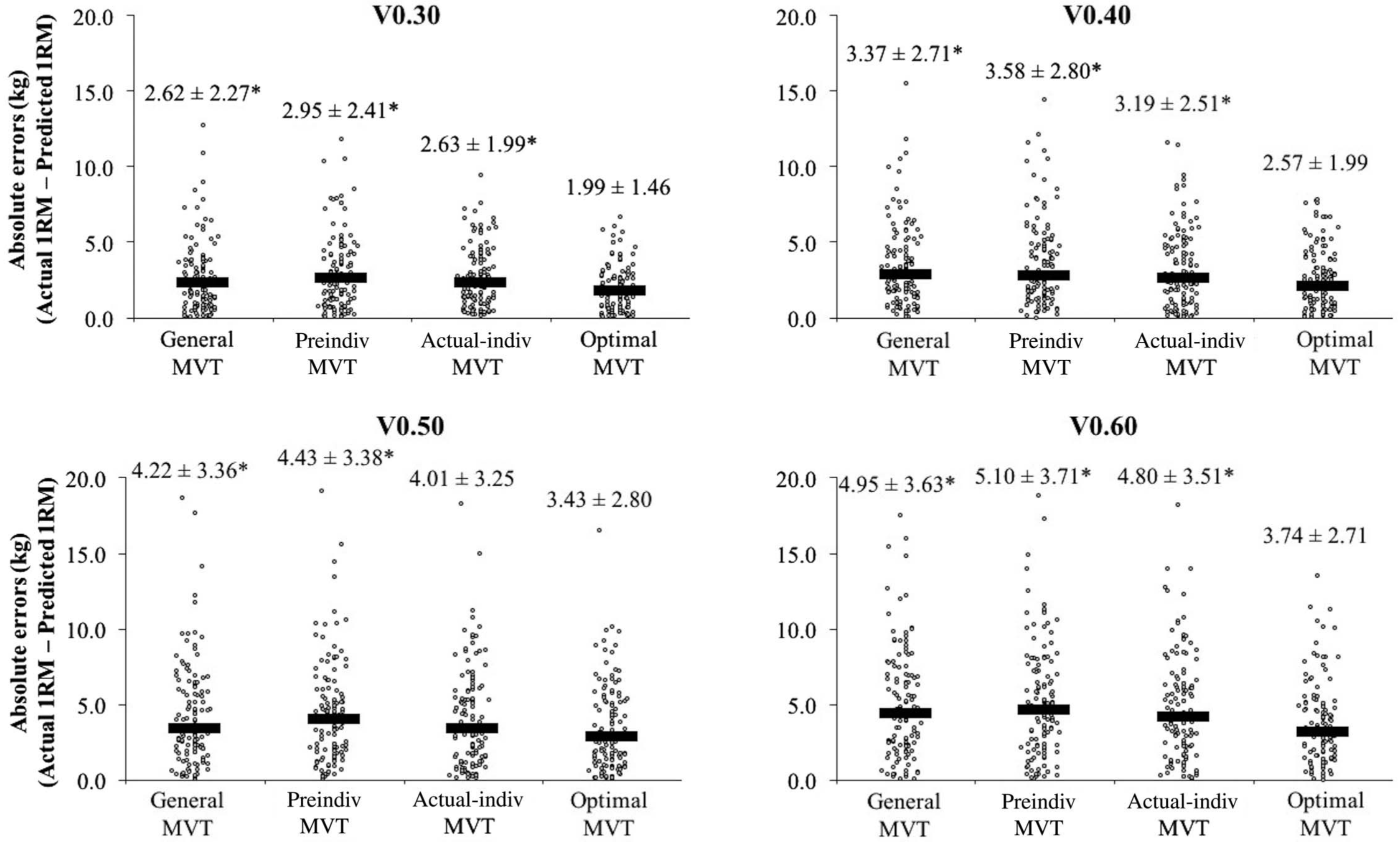

Figure 1 — Comparison of the absolute errors in the estimation of the actual 1RM between 4 types of MVTs for final test velocities of approximately 0.30 $m \cdot s^{-1}$ (V0.30; upper-left panel), 0.40 $m \cdot s^{-1}$ (V0.40; upper-right panel), 0.50 $m \cdot s^{-1}$ (V0.50; lower-left panel), and 0.60 $m \cdot s^{-1}$ (V0.60; lower-right panel). Individual (dots) and median (thick lines) differences are depicted. Numbers indicate means and SDs. *Significantly greater errors compared to the optimal MVT ($P < .05$). 1RM indicates 1-repetition maximum; MVT, minimal velocity threshold.

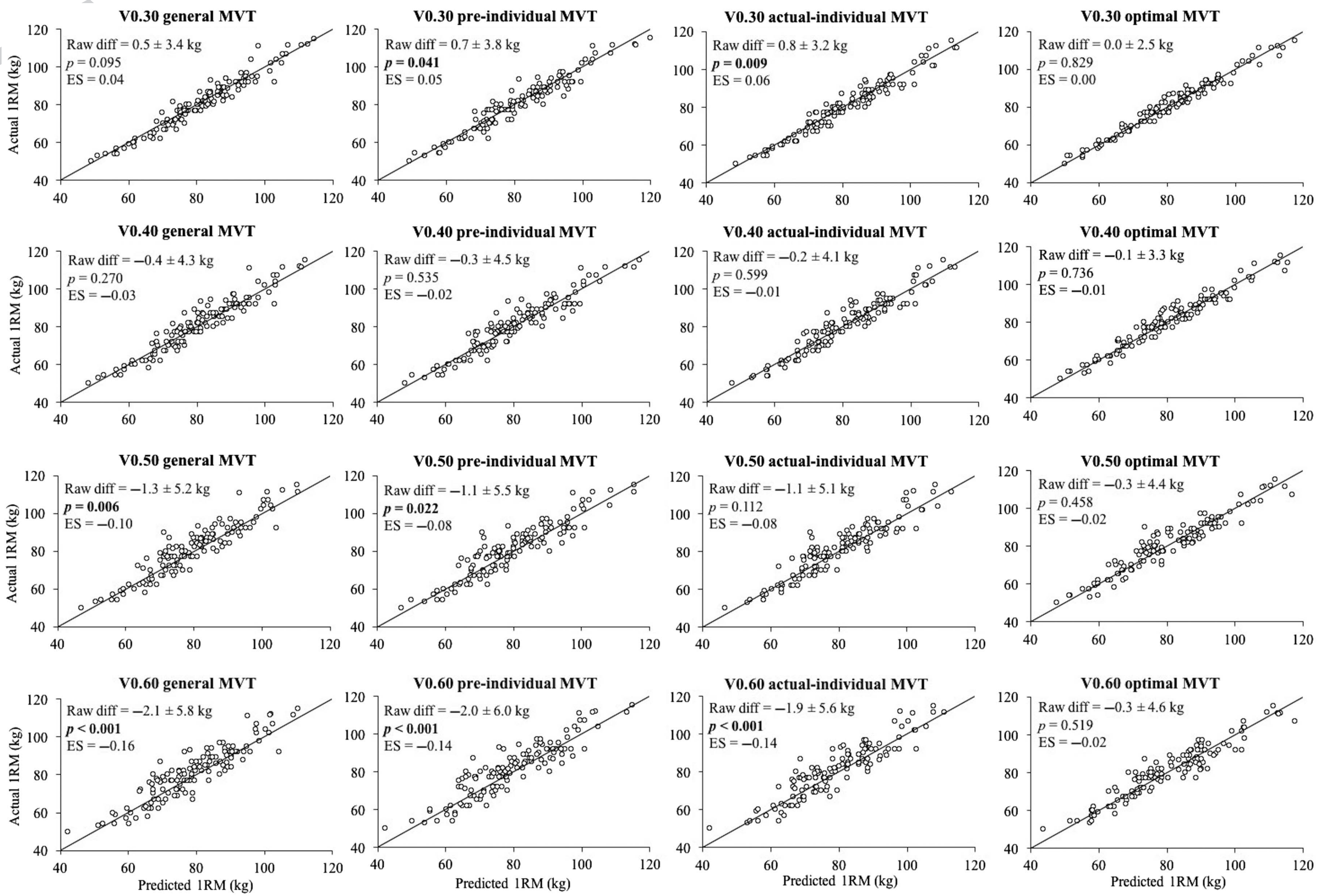

Figure 2 — Comparison of the actual 1RM and the 1RM estimated by the sixteen 1RM prediction methods based on the combination of 4 types of MVTs (general MVT, preindividual MVT, actual-individual MVT, and optimal MVT) and 4 final test velocities (V0.30, V0.40, V0.50, and V0.60). The identity line is also depicted. 1RM indicates 1-repetition maximum; ES, Cohen *d* effect size ([predicted 1RM – actual 1RM]/SDboth); MVT, minimal velocity threshold; *P*, *P* values obtained from paired sample *t* tests; Raw diff, raw differences.

Table 2 Comparison of the Reliability and Magnitude of the Individual MVT and the Optimal MVT Obtained for Different Final Test Velocities

Method	Final test velocity	Preliminary test	Experimental test	ICC (95% CI)
Individual MVT		0.168 (0.043)	0.166 (0.041)[b]	.34 (.17–.48)
Optimal MVT	V0.30	0.183 (0.060)	0.183 (0.064)	.73 (.63–.80)[a,b,c]
	V0.40	0.169 (0.073)[b]	0.166 (0.081)[b]	.68 (.57–.76)[a,b]
	V0.50	0.156 (0.087)[b,c]	0.148 (0.102)[b,c]	.56 (.43–.67)[a]
	V0.60	0.138 (0.101)[a,b,c,d]	0.129 (0.116)[a,b,c]	.62 (.50–.72)[a]
ANOVA		$F = 15.2$ $P < .001$	$F = 17.8$ $P < .001$	

Abbreviations: ANOVA, analysis of variance; CI, confidence interval; ICC, intraclass correlation coefficient; MVT, minimal velocity threshold. Note: Descriptive data presented as mean (SD).
[a]Significantly more reliable than the individual MVT, [b]optimal MVT V0.50, and [c]optimal MVT V0.60.
[a]Significantly lower values than the individual MVT, [b]optimal MVT V0.30, [c]optimal MVT V0.40, and [d]optimal MVT V0.50.

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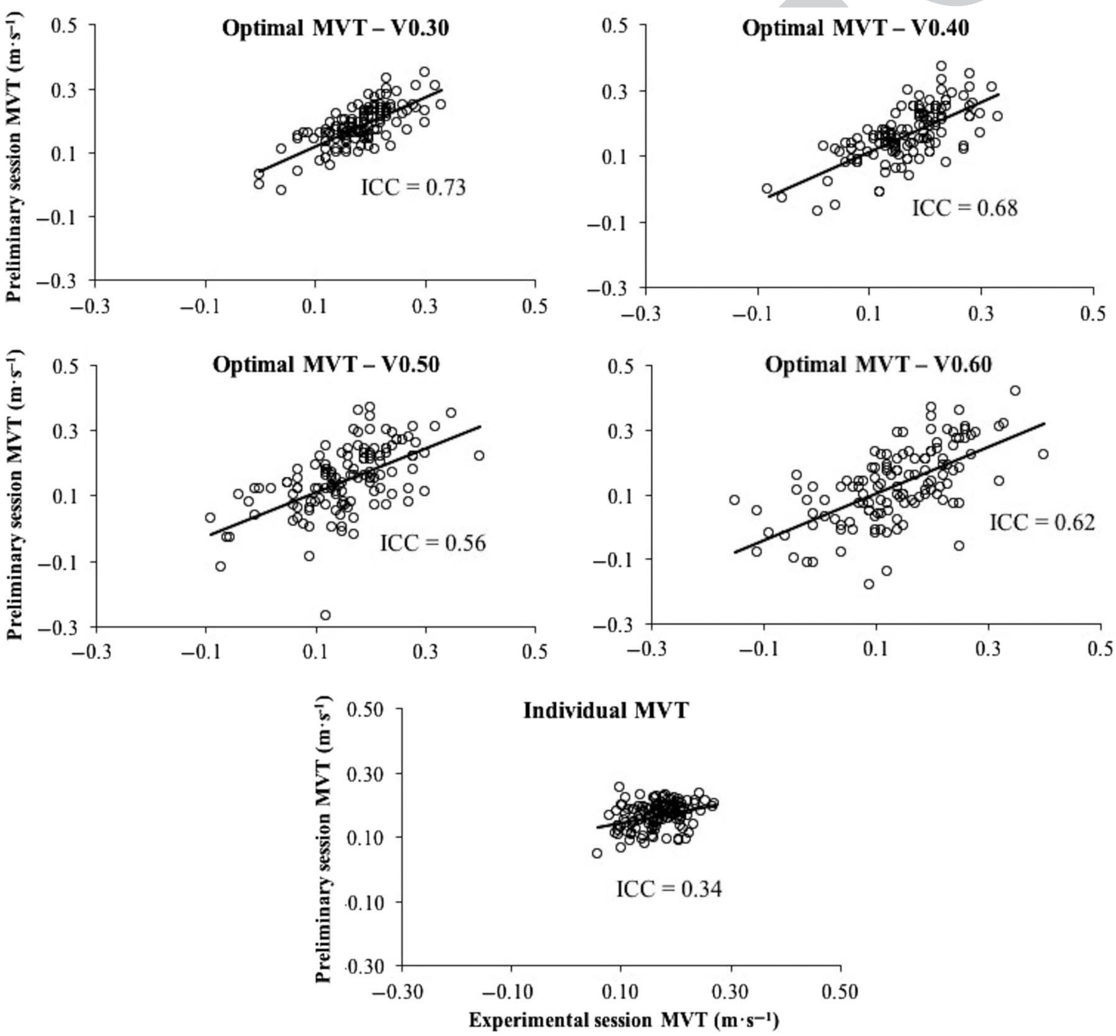

Figure 3 — Relationship between the optimal (4 final test velocities: V0.30, V0.40, V0.50, and V0.60) and individual MVTs obtained in the preliminary (session 1) and experimental (session 2) incremental loading tests. ICC indicates intraclass correlation coefficient; MVT, minimal velocity threshold.

The findings of this study are in line with previous studies that have shown negligible differences between the general and individual MVTs in the accuracy in the estimation of the 1RM.[2,16,17] While previous studies suggested that the type of MVT was not a decisive factor because all options provided a comparable accuracy, the lower absolute errors observed in this study for the optimal MVT in all conditions (ie, final test velocities) seem to place the optimal MVT as the most recommended MVT. Of note, unlike other types of MVT, the optimal MVT never overestimated or underestimated the actual 1RM. Note that several studies have discouraged the use of individual load–velocity relationship under the assumption that they systematically overestimate or underestimate the 1RM.[19–21] Furthermore, the 4 optimal MVTs were obtained with a moderate reliability, the reliability being considerably higher than that observed for the individual MVT in this and previous studies.[18–20] These results collectively support the optimal MVT over other types of MVT to estimate the 1RM through the individual load–velocity relationship. However, a limitation of the optimal MVT compared to the general MVT is that the former requires a previous assessment of the individual's 1RM and load–velocity relationship. In case the optimal MVT is unknown because the individual's 1RM and load–velocity relationship were not assessed in a preliminary session, the general MVT (0.17 $m \cdot s^{-1}$) is still a valid option to estimate the 1RM during the Smith machine bench press exercise.

The accuracy in the estimation of the 1RM was reduced with the increment in the distance (ie, difference in velocity) between the 1RM and the heaviest experimental point of the incremental loading test. These results are in line with the findings of Banyard et al[20] who reported a higher validity in the estimation of the squat 1RM when the heaviest experimental point represented the 90% 1RM in comparison to when the heaviest experimental point was the 80% 1RM or 60% 1RM. These results leave no doubt about the importance of, regardless of the type of MVT considered, finalizing the incremental loading test as close as possible to the 1RM to maximize the accuracy in the 1RM estimation. However, the important finding regarding the optimal MVT is that its magnitude was affected by the final test velocity (greater optimal MVTs for lower final test velocities). This information is of practical importance because it highlights that similar final test velocities should be used for both determining the optimal MVT and estimating the 1RM in subsequent sessions.

The main limitation of this study is that, given that this is the first study to explore the accuracy of the optimal MVT to estimate the 1RM, it is unknown whether the superiority of the optimal MVT over the standard MVTs (general and individual MVTs) observed in this study could be transferrable to other exercises and training conditions. For example, it should be explored whether the superiority of the optimal MVT revealed in this study for a test–retest design (48–96 h apart) is maintained throughout a training cycle in which neuromuscular performance is expected to change. It should also be explored whether the benefits of the optimal MVT are maintained during more technically demanding exercises (eg, squat, deadlift, or Olympic lifts). It would also be of interest to explore the individual factors (eg, anthropometric characteristics and strength values) that might affect the magnitude of the optimal MVT and also the effect of different types of training on the optimal MVT. A limitation of the study is that the physical activity performed prior to the testing sessions was not controlled, and this could be a confounding factor as residual fatigue could affect the load–velocity relationship.[27] Therefore, although the results of this study are undoubtedly promising when it comes to optimizing the precision in the estimation of the 1RM through the monitoring of lifting velocity against submaximal loads, more research is definitely needed to verify whether the superiority of the optimal MVT is maintained in other training conditions.

Practical Applications

The optimal MVT (ie, the MVT that minimizes the differences between the actual and predicted 1RM when both are obtained in the same test) should be used in subsequent sessions to maximize the accuracy in the estimation of the 1RM. The final test velocity should be similar in the session used to determine the optimal MVT and in the following sessions in which the 1RM is to be estimated.

Conclusions

The optimal MVT is capable of providing more accurate estimates of the Smith machine bench press 1RM than the standard MVTs previously used in scientific research (general and individual MVTs). The optimal MVT presents a higher interday reliability than the individual MVT (moderate reliability vs poor reliability). Finally, it should be noted that the final test velocity is an important variable to be considered because it affects (1) the accuracy in the estimation of the 1RM (greater errors for higher final test velocities) and (2) the magnitude of the optimal MVT (greater optimal MVTs for lower final test velocities).

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Queries

Q1. Please ensure author information is listed correctly here and within the byline.

Q2. As per journal style, "mean ± SD" should be represented as "mean (SD)." Hence, the values are changed accordingly. Please check and confirm.

Q3. Please provide ORCID ID if available for the author "Amador García-Ramos."

Q4. Please update 'XXX' cited throughout the article.

Q5. Please provide manufacturer details for "Tanita BC 418 segmental".

Q6. Please check whether the edits made in the sentence "In addition, ICC ... excellent [ICC > .90] reliability)." convey the intended meaning.

Q7. Please note that for footnotes "a to d", two different definitions are given. Please differentiate the footnotes cited in Table 2 (i.e., change "a-d" to "d-g" in "aSignificantly lower values than the individual MVT, boptimal MVT V0.30, coptimal MVT V0.40, and doptimal MVT V0.50." and change respective citations inside the table).

Q8. Please provide complete details for Ref. 26.