The Reliability of Maximal Concentric and Eccentric Strength Tests During The Bench Press: A Preliminary Study

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PURPOSE

- To investigate the test-retest reliability of eccentric and traditional bench press 1RM tests.

METHODS

Subjects:

- Ten male resistance-trained subjects (age = 26.4 ± 5.2 yrs, height = 1.7 ± 0.1 m, body mass = 81.2 ± 16.9 kg, relative bench press 1RM = 1.3 ± 0.2 kg/kg).

Maximum Testing:

- Traditional 1RM: A maximum of 5 attempts to achieve maximum (3 minutes rest between attempts).
- Eccentric 1RM: A maximum of 5 attempts to achieve maximum (3 minutes rest between attempts).
  - Standardized 2-second eccentric phase;
  - An unsuccessful eccentric attempt (confirmed by two investigators via video review): 1) eccentric phase <2 seconds, or 2) acceleration at the end of the eccentric phase.

Statistical Analyses:

- *Reliability:*
  - Intra-class correlation coefficient (ICC) with 95% of confidence interval (CI);
  - Coefficient of variability (CV) with 95% of CI;
  - Mean absolute error (MAE) and mean absolute percentage error (MAPE);
  - Limits of agreement (LoA).
- *Paired Sample T-Test:*
  - Differences between traditional and eccentric 1RM within each session;
  - Changes in traditional and eccentric 1RM across sessions;
  - Effect sizes were calculated using Hedge's *g*.

RESULTS

- Descriptive statistics and reliability indices for each test are shown in Table 1.
- Eccentric 1RM was significantly greater than traditional 1RM in Session 2 ($p < 0.001$, $g = 1.18$) and Session 3 ($p < 0.001$; $g = 1.28$).
- Neither traditional 1RM nor eccentric 1RM showed significant differences between testing sessions (both $p > 0.05$).

CONCLUSION

- While eccentric and traditional bench press 1RM tests both are reliable, traditional bench press 1RM test is more precise.
- The interday systematic error is non-significant.

PRACTICAL APPLICATIONS

- The eccentric bench press 1RM is approximately 20% greater than the traditional bench press 1RM. This relationship can guide the programming of accentuated eccentric loading for the bench press exercise.

References

- Harden M, Wolf A, Haff GG, Hicks KM, Howatson G. Repeatability and specificity of eccentric force output and the implications for eccentric training load prescription. *The Journal of Strength & Conditioning Research* 33: 676-683, 2019.
- Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. Journal of chiropractic medicine. 2016;15(2):155-63.

Both **traditional and eccentric-only 1RM tests** demonstrated **excellent reliability**, with **eccentric 1RM** being approximately **20% greater** than traditional 1RM.

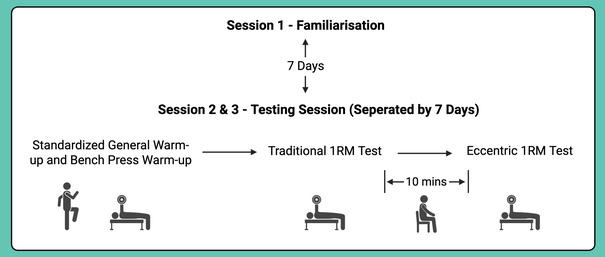

Figure 1. Overall Experimental Study Design of Study Three

Table 1 Descriptive statistics and reliability indices for each test

	Session 2 (Mean ± SD)	Session 3 (Mean ± SD)	ICC (95% CI)	CV (95% CI)	MAE	MAPE
Traditional 1RM	107.9 ± 16.4 kg	107.9 ± 16.0 kg	0.98 (0.93 – 0.99)	1.59 % (0.65 - 2.53 %)	2.4 kg	2.23%
Eccentric 1RM	130.0 ± 19.2 kg	133.1 ± 21.3 kg	0.96 (0.83 - 0.99)	2.53 % (1.42 - 3.65 %)	4.7 kg	3.63%
Eccentric/ Traditional 1RM (Mean ± SD [95% CI])	120.63 ± 3.77% (117.93 - 123.33%)	123.29 ± 4.42% (120.13 - 126.46%)				

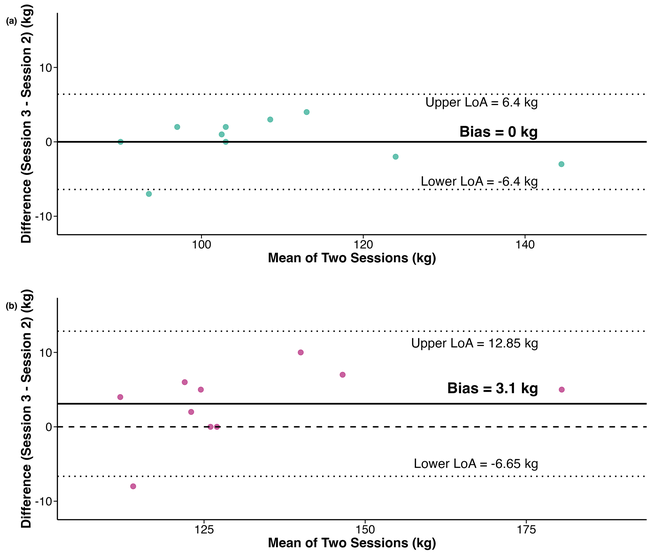

Figure 2. Bland-Altman plots of between-session differences in measures of (a) traditional 1RM, (b) eccentric 1RM

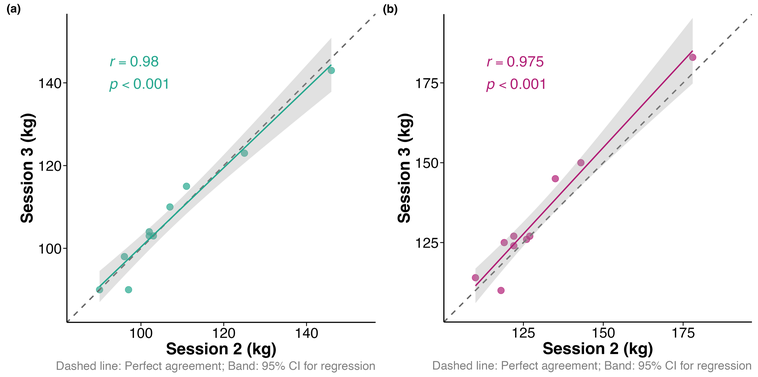

Figure 3. Test-retest correlation plots for (a) traditional 1RM, (b) eccentric 1RM