

Grip Strength, Bilateral Asymmetry, and Strength Changes During Repeated Exhaustive Tasks Across Climbing Ability Levels in Male Lead Climbers

Somang Son, Jooyoung Lee, Jihwan Park, Jaeyeop Lee, Dae Taek Lee*
Exercise Physiology Laboratory, Kookmin University, Seoul, Republic of Korea



INTRODUCTION

- Finger flexor strength is a major physical factor in climbing performance [1], but general handgrip strength (HG) may not adequately reflect climbing-specific strength [2].
- Bilateral strength asymmetry was not explained by ability level among advanced and elite climbers [3], and level-related differences in the work performed and strength changes during repeated exertion have not been sufficiently clarified.
- Accordingly, this study examined the relationships of HG and maximal finger strength (FS) with climbing ability in male lead climbers, and compared bilateral asymmetry and the work performed and post-set strength during repeated exhaustive exercise across levels.

METHODS

Participants

- Eighteen male lead climbers participated in this study.
- Participants were classified into LOW (n=5), MID (n=6), and HIGH (n=7) groups based on their redpoint (RP) performance converted to the IRCRA scale.

Table 1. Participant characteristics by group

Variable	LOW	MID	HIGH
Age (years)	33.60	32.40	46.71
Climbing experience (months)	8.20	28.40	196.29
RP (score)	8.80	13.10	21.21
Height (cm)	175.22	173.56	169.69
Weight (kg)	71.25	66.04	65.17

Strength Measurements and Repeated Exhaustive Exercise

- HG was measured using a handgrip dynamometer, and crimp-grip FS was measured using a finger strength device.
- Both tests were performed bilaterally, with the higher value used for analysis.
- Bilateral asymmetry (%) was calculated as: $100 \times |L - R| \div \max(L, R)$
- Participants performed three sets of finger flexion and relaxation until exhaustion, using a load equivalent to 80 % of their FS and a tempo of 70 bpm.
- The number of repetitions and the duration of performance for each set were recorded.
- FS was measured immediately after each set, followed by a one-minute rest period

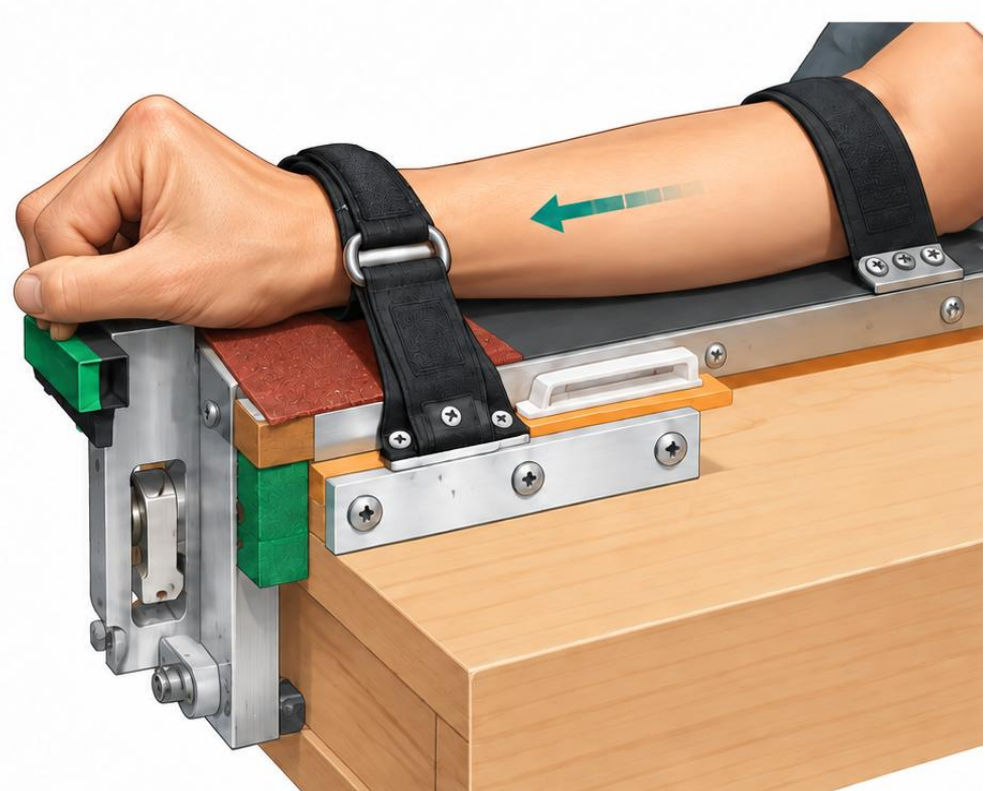


Figure 1. FS Measurement



Figure 2. Repeated Exhaustive Exercise Procedure

Statistical Analysis

- Participant characteristics and measured variables were presented using descriptive statistics.
- Group differences were examined using one-way ANOVA, with Welch's ANOVA used when Levene's test indicated unequal variances.
- Bonferroni post hoc tests were performed following significant conventional ANOVA.
- The significance level was set at $\alpha = .05$.

Keywords: climbing, grip strength, finger strength, strength asymmetry, repeated exhaustion

RESULTS

Association with Climbing Ability

- Climbing ability (RP) was positively correlated with both HG ($r = .578$, $p = .012$) and FS ($r = .789$, $p < .001$), with a numerically higher coefficient for FS.
- FS differed significantly between ability groups ($p = .001$), whereas HG did not ($p = .075$). Bonferroni post hoc comparisons showed higher FS in MID and HIGH than in LOW ($p = .045$ and $p < .001$, respectively), with no significant difference between MID and HIGH ($p = .209$).

Bilateral Strength Asymmetry

- Asymmetry was larger for FS than for HG.
- FS asymmetry decreased markedly from LOW to MID and was similar between MID and HIGH, but the group difference was not significant ($p = .468$).

Table 2. Asymmetry ratio by grip type by group (M $\pm$ SD)

Variable	LOW	MID	HIGH	p
HG Asymmetry (%)	5.3 $\pm$ 6.8	4.7 $\pm$ 2.5	7.8 $\pm$ 6.7	.587
FS Asymmetry (%)	14.1 $\pm$ 10.0	8.6 $\pm$ 6.3	7.9 $\pm$ 2.2	.468

Strength Changes During Repeated Exhaustive Exercise

- Repetitions, time, and post-set FS decreased across sets in all groups.
- Repetitions and time did not differ between groups, whereas FS did in all sets.

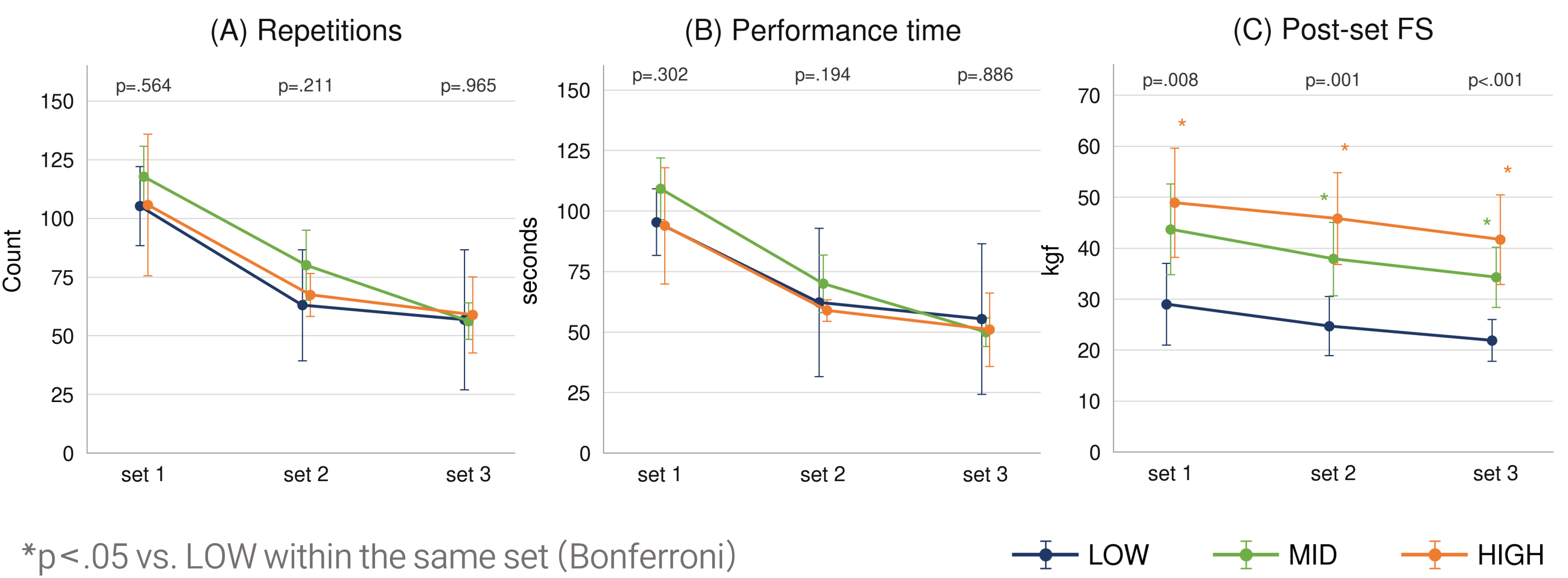


Figure 3. Changes in repetitions, time, and FS during repeated exercise to exhaustion

CONCLUSIONS

- Maximal finger strength was associated with climbing ability, with a numerically stronger correlation than HG, supporting its potential use in climbing-specific strength assessment.
- Bilateral asymmetry, repetitions, and performance time did not differ significantly between ability groups.
- Although HIGH showed greater post-set FS than LOW, this may reflect baseline strength differences rather than superior fatigue resistance. These findings should be interpreted cautiously given the small sample.

REFERENCES

- Saul, D., Steinmetz, G., Lehmann, W., & Schilling, A. F. (2019). Determinants for success in climbing: A systematic review. *Journal of Exercise Science & Fitness*, 17(3), 91-100.
- González-Martín, D., Santos-Pérez, J., Maroto-Izquierdo, S., de Paz, J. A., & Gallego-Selles, Á. (2025). Comparison of finger flexor strength and muscle quality between climbers and non-climbers: Influence of sex and grip type. *Applied Sciences*, 15(13), Article 7161.
- Hartley, C., Taylor, N., Chidley, J., Baláš, J., & Giles, D. (2023). Handedness, bilateral, and interdigit strength asymmetries in male climbers. *International Journal of Sports Physiology and Performance*, 18(12), 1390-1397.