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Effects of maximal strength and local muscular endurance training on climbing performance and climbing-specific strength

a randomized controlled trail among recreation climbers.

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Background

- Physical factors to predict climbing performance
  - body composition
  - relative upper body strength
  - endurance/strength in the fingers

  (Balas J, et.al.; Espana Romero V, et.al.; Grant S, et.al.; Mermier CM).
- Beginners and intermediate-skilled climbers
  - low finger strength/endurance
  - upper body strength

  (Balas J, et.al.)
- Finger endurance and upper body endurance was the strongest predictor to predict climbing performance
  - (men; $R^2 = 0.49 - 0.76$ and women; $R^2 = 0.64 - 0.66$)

  (Balas J, et.al)

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Aim

Investigate the effects of maximal strength training compared to local muscular endurance training in a climbing performance test, two climbing-specific strength tests and a general strength test.

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Method

- Thirty participants included in analyses
  - Best onsight climb 4b to 6b (5.5 – 5.10c)
- Three groups
  - Maximal strength training (MST)
  - Local muscular endurance training (LMET)
  - Control
- 10 weeks intervention

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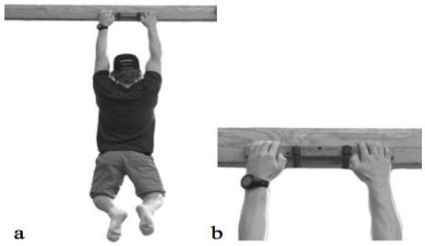
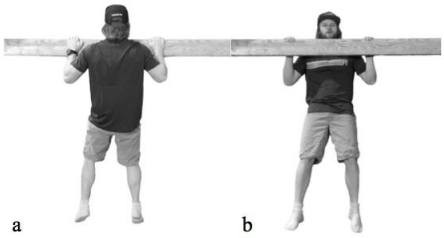
Testing prosedures

1. Dead Hang



1. Bent-arm Hang



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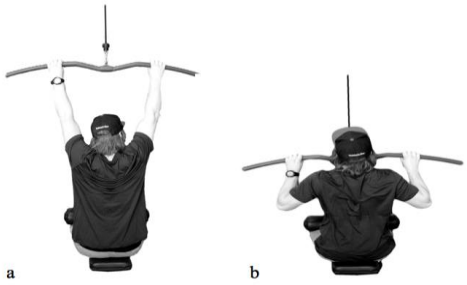
Testing prosedures

3. 12RM in Pull-down



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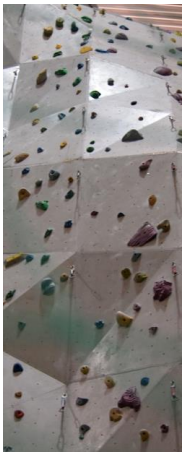
Testing prosedures

4. Climbing performance test

- Artificial route on 18m indoor wall was designed
- Slightly overhanging wall
- Progesively harder (from 5a/5b to 6b)
- All handholds were numbered from 1 to 43
- Top rope to eliminate mentale factors



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Training program

- Two sessions per week
- Seven exercises:
  - Pull-down, seated bench press, seated rowing, seated shoulder press, biceps curl, forearm press and forearm curl.
- MST – 4 set x 5 reps, 3 min rest
- LMET – 2 set x 20 reps, 2 min rest

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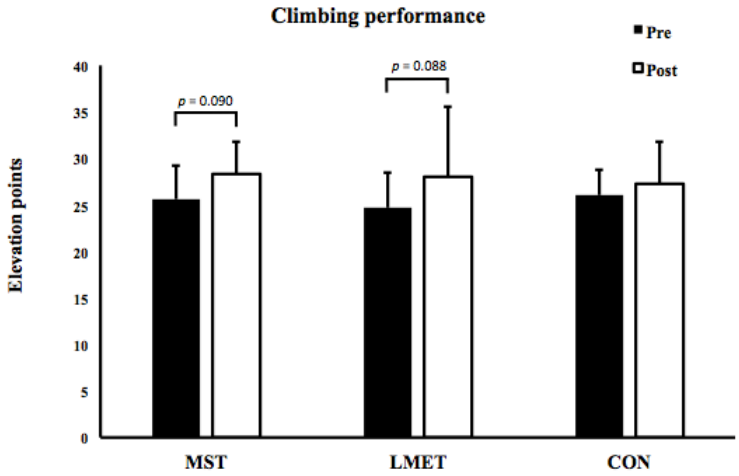
Results



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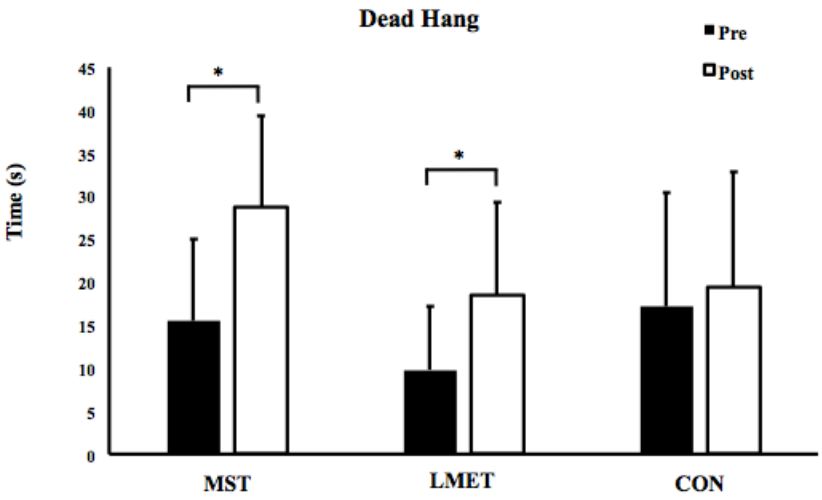
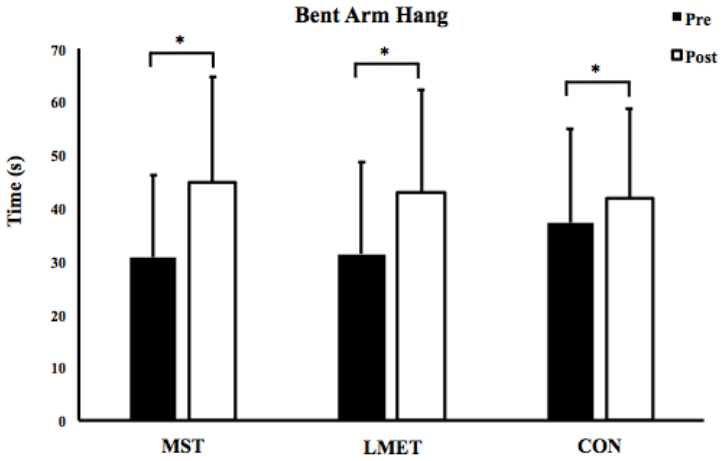
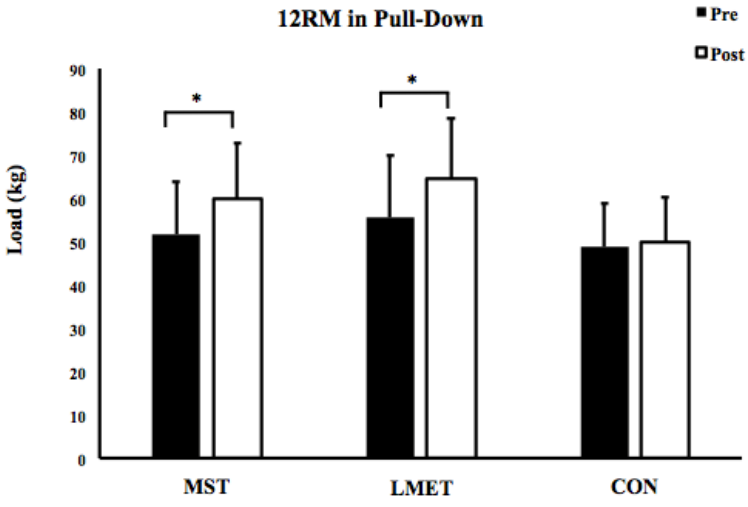
Results



Results



Results



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Conclusion

Maximal strength and local muscular endurance training maintained their climbing performance despite reducing their number of climbing sessions with 50%. Further, both maximal strength and local muscular endurance training programmes improved the strength/endurance in the shoulder girdle and fingers in the specific climbing tests. None of the training intensities demonstrated greater advantage than the other.

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References

- Balas J, Pecha O, Martin AJ, and Cochrane D. Hand–arm strength and endurance as predictors of climbing performance. *Eur J Sport Sci* 12: 16-25, 2012.
- Espana Romero V, Ruiz JR, Ortega FB, Artero EG, Vicente-Rodriguez G, Moreno LA, Castillo MJ, and Gutierrez A. Body fat measurement in elite sport climbers: comparison of skinfold thickness equations with dual energy X-ray absorptiometry. *J Sports Sci* 27: 469-477, 2009.
- Grant S, Hynes V, Whittaker A, and Aitchison T. Anthropometric, strength, endurance and flexibility characteristics of elite and recreational climbers. *J Sports Sci* 14: 301-309, 1996.
- Mermier CM, Janot JM, Parker DL, and Swan JG. Physiological and anthropometric determinants of sport climbing performance. *Br J Sports Med* 34: 359-365; discussion 366, 2000.

Participants

Table 1. Anthropometric data for the three groups. No differences between groups were observed.

	MST (n=10)	LMET (n=10)	CON (n=10)
Age (year)	23.5 ± 2.6	23.0 ± 1.3	24.3 ± 1.7
Heigth (cm)	175.1 ± 8.0	177.7 ± 9.9	171.5 ± 7.9
Weight (kg)	68.2 ± 6.9	75.5 ± 12.3	65.0 ± 10.8
BMI (kg/m²)	22.2 ± 1.0	23.2 ± 2.0	22.0 ± 2.6

MST = Maximal strength training, LMET = Local muscular endurance training, CON = Control, BMI = Body mass index

Training volume

Table 2. The training volume (kg) in the beginning and end of the training period with the percentage improvement.

	Training volume first session (kg)	Training volume last session (kg)	Improvements (%)
MST	6097 ± 297	8453 ± 383	43.3 ± 19.0
LMET	4454 ± 406	6130 ± 559	41.3 ± 16.0

MST = Maximal strength training, LMET = Local muscular endurance training.

Training sessions

Table 3. Numbers of self reported climbing sessions, strength training sessions, other training session (i.e. endurance) and total training volume conducted during the intervention based on the log form for the three groups. No differences between groups were observed.

	Climbing sessions	Strength training sessions	Other training sessions	Total training volume
MST	6.8 ± 1.6	19.5 ± 1.5	11.8 ± 10.6	38.6 ± 10.9
LMET	7.4 ± 3.1	20.0 ± 0.0	16.5 ± 11.1	43.4 ± 11.0
CON	14.9 ± 8.7		20.0 ± 10.6	34.9 ± 12.6

MST = Maximal strength training, LMET = Local muscular endurance training, CON = Control.

Testing procedures

- All participants were instructed to refrain from any hard physical activity 48 hours before testing.
- The participants performed a five-minute general warm-up (jogging or cycling) and a two to five-minute easy climbing traverse using jug holds, before the testing started.
- Tests in the following order; climbing performance, the two specific climbing tests (BAH and DH) and finally 12RM in pull-down. The order of the BAH and DH was randomized, but similar during pre- and post test. Chalk was used on all climbing-related tests (CP, DH and BAH).

Statistics

- 2-way mixed design (testing time [pre, post] x groups [MST, LMET and CON] analysis of variance (ANOVA) with repeated measures were used.
- When differences were detected by ANOVA, paired t-tests with Bonferroni post-hoc corrections were applied to determine where the differences lay.
- To assess differences in training volume (climbing session, other training session and total training session) a one-way ANOVA with Bonferroni post-hoc corrections were used.