2nd International Rock Climbing Research Congress – 15/19th September 2014, Pontresina, Switzerland

Internal responsiveness of two methods for assessing maximal strength and peak rate of force development in amateurs lead climbers

Fanchini M, Bortolan L, Pellegrini B, Modena R, Schena F

Department of Neurological and Movement Science and CeRISM, University of Verona, Italy

INVITED COMMENTARY

International Journal of Sports Physiology and Performance, 2009, 4, 269-277

Test Validation in Sport Physiology: Lessons Learned From Clinimetrics

Franco M. Impellizzeri and Samuele M. Marcora

Every instrument (i.e. measures or indicator tool) must possess some key attributes before can be used as dependent variable in a study:

1) Conceptual and measurement model
2) Validity
3) Reliability
4) Responsiveness
5) Interpretability

Scientific Advisory Committee of the Medical Outcomes Trust for Health Status and Quality of Life instruments. Qual Life Res, 2002

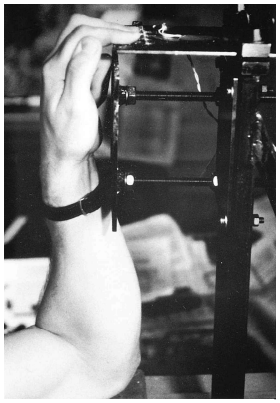
Strength measurement in sport climbing studies

handgrip

General

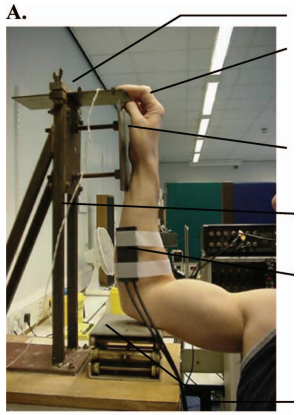
Specific

specific dynamometers



Grant et al.1996

Watts et al. 2003



MacLeod et al. 2007

Attribute	Hand grip	Specific dynam.
Conceptual model	x	x
Validity	x	x
Reliability	x	x
Responsiveness	?	?
Interpretability	?	?

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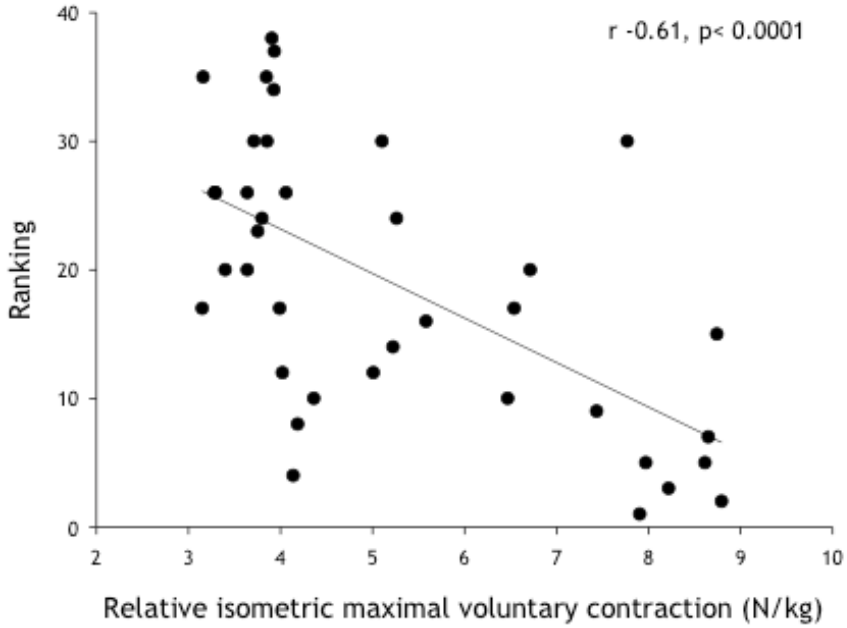
Validity	x	x
Reliability	x	x
Responsiveness	?	?
Interpretability	?	?

Internal responsiveness is the ability to detect changes in the variable measured over specific time frame *(Husted, 2000)*

Isometric maximal voluntary contraction (MVC) of the finger flexors has been suggested to be a determinant in sport climbing performance.



(Fanchini et al, proceedings ECSS 2010)

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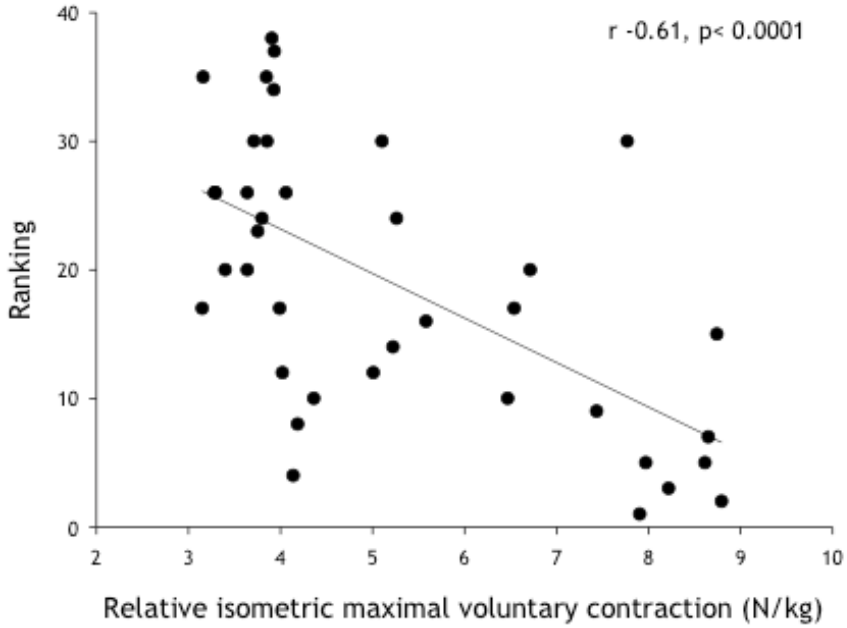


(Fanchini et al, proceeding ECSS 2010)

The peak of rate force development (pRFD) can be more appropriate than MVC for evaluating neuromuscular characteristics.

(Watts, 2004)

The aim of this study was to assess and compare the internal responsiveness of MVC and pRFD measured with a specific climbing dynamometer (SCD) and handgrip (HG) in amateur sport climbers.

Participants
(n=23 amateur)

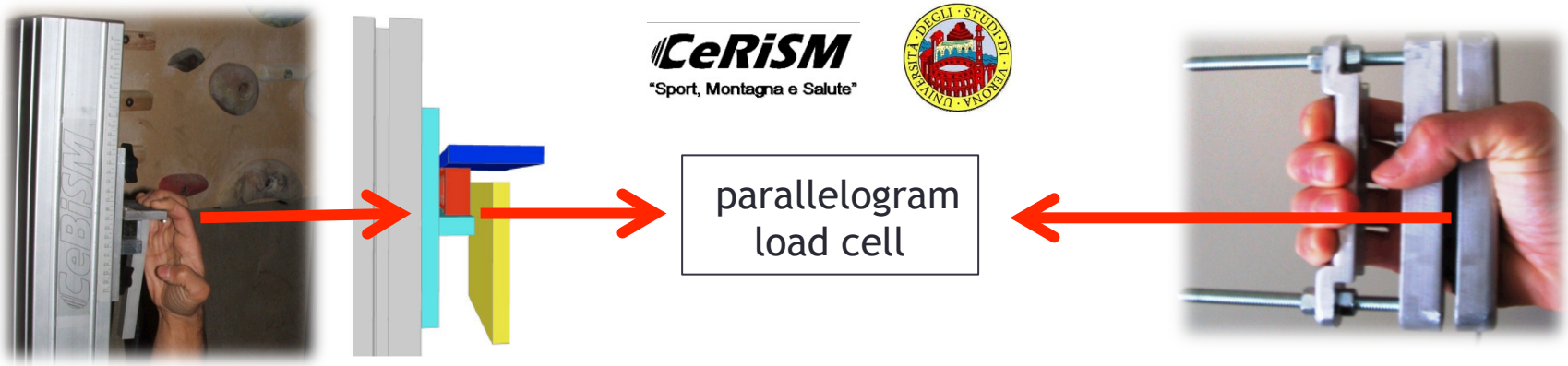
Age (years)	32 ± 9
Height (cm)	177 ± 8
Weight (Kg)	67 ± 8
Experience (years)	10
Climbing ability (French scale) “on-sight” “after-works”	 6a-8a 6b+-8b
Classified (Brent et al 2009)	intermediate - advanced

Table I. Climbing ability conversion table

Climbing level	Study score	Sport grade	British technical grade	Fontainebleau bouldering grade	Yosemite decimal system
Novice	1	≤4+	≤4b	≤4	≤5.8
	2	5	4c	4+	5.9
Intermediate	3	5+	5a	5	5.10a
	4	6a to 6a+	5b/5c	5+	5.10b to 5.10c
	5	6b	5c	6a	5.10d
Advanced	6	6b+ to 6c+	5c/6a	6a+	5.11a to 5.11c
	7	7a to 7b	6a/6b	6b to 6b+	5.11d to 5.12b
	8	7b+ to 7c	6b/6c	6c to 6c+	5.12c to 5.12d
	9	7c+	6c	7a to 7a+	5.13a
Elite	10	8a	6c/7a	7b to 7b+	5.13b
	11	8a+ to 8b	6c/7a	7c to 7c+	5.13c to 5.13d
	12	8b+ to 8c	7a/7b	8a to 8a+	5.14a to 5.14b
	13	8c+	7b	8b to 8b+	5.14c
	14	≥9a	7b	8c to 8c+	≥5.14d

(Brent et al.2009)

Measurement tools



Reliability

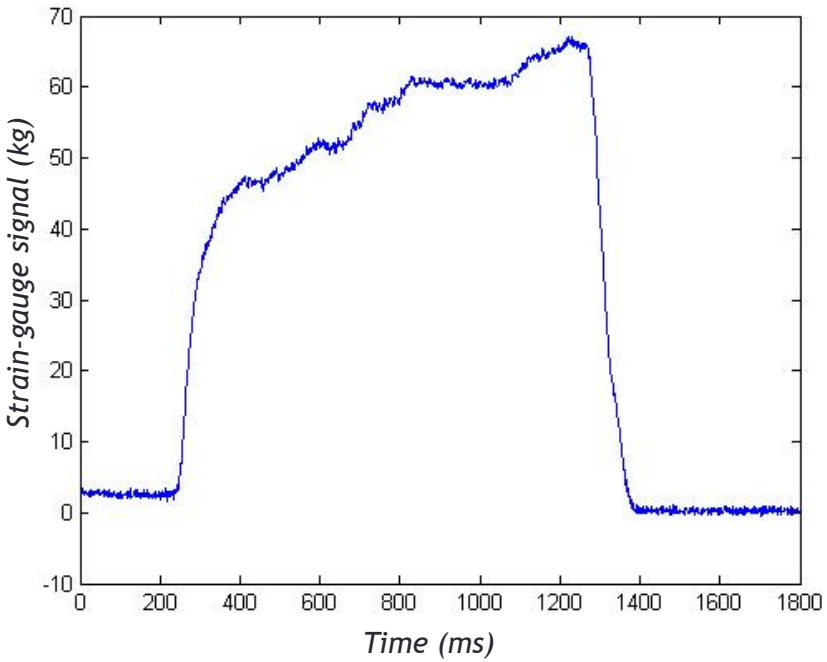
	Typical error% (90% CI)	ICC (90% CI)
Specific climbing dynamometer		
MVC	7 (5 to 10)	0.94 (0.85 to 0.97)
pRFD	16 (12 to 24)	0.83 (0.63 to 0.93)
Handgrip		
MVC	5 (3 to 6)	0.95 (0.88 to 0.98)
pRFD	9 (7 to 13)	0.92 (0.80 to 0.96)

Fanchini et al. 2011, Communication to 16th ECSS congress, Liverpool, UK

Instructions

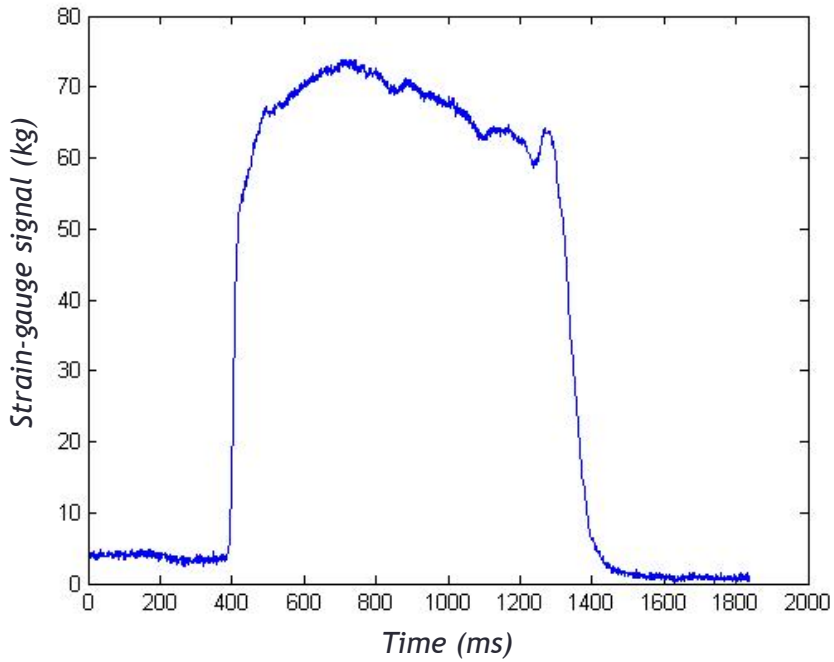
MVC

"as hard as possible"



pRFD

"as hard as quick as possible"



Design

PRE
2 SCD-MVC
2 SCD-pRFD
1 HG-MVC
1 HG-pRFD
(2 min recovery)

POST
2 SCD-MVC
2 SCD-pRFD
1 HG-MVC
1 HG-pRFD
(2 min recovery)

Position

SCD: subject was seated on a chair with forearm vertical to the base of dynamometer and elbow arranged at 90° with a strap secured at the level of arm.

"open-crimp position"

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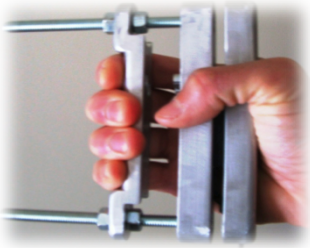
HG: subject was seated on a chair with the elbow extended laterally to the body.



Route characteristics

Overhanging wall

11m heigth

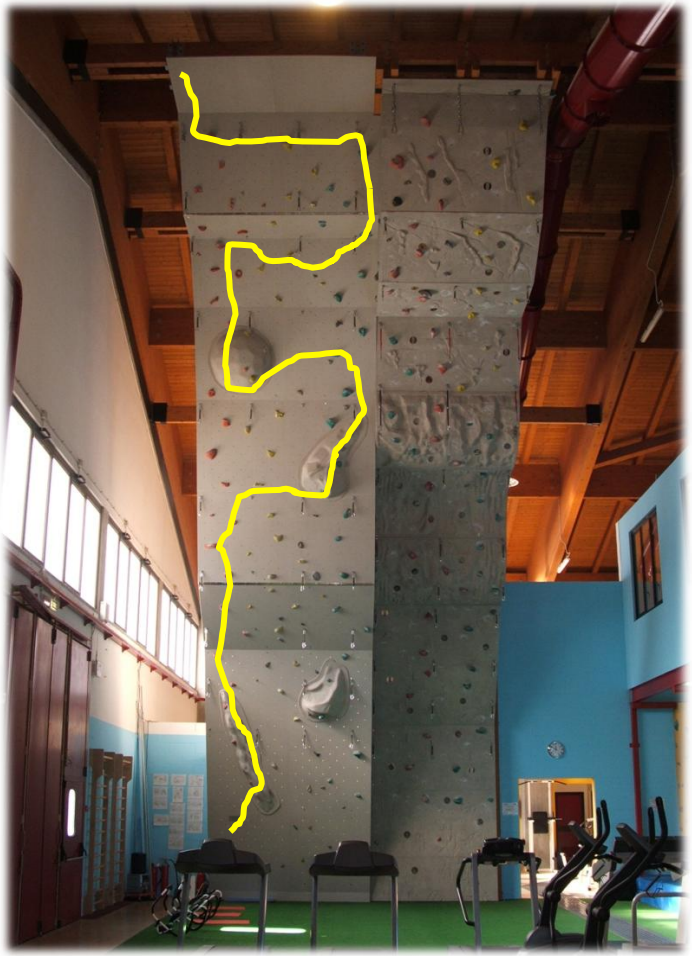
15m development

grade 7b+ (French scale)

N° hand holds 47

Assessment: International Route Setter

Climbing modality: “flash”



Statistical analysis

- Data were normalized to body mass and Log-transformed.
- The strain-gauge signal was smoothed by a digital zero-lag Butterworth filter, cut-off 15 hz (MATLAB 7.0). *(Andersen & Aagaard,2006)*.
- MVC (N/Kg) was defined as the highest peak torque.
- pRFD (Nm/Kg/s) was defined as the slope of the torque–time curve (i.e. D torque/D Time) from the onset of contraction *(Andersen & Aagaard,2006)*.
- Onset of muscle contraction was defined as the instant when torque exceeded the baseline by 2.5% of the MVC.

Statistical analysis

- Percentage changes after the route (90% CI).
- Internal responsiveness (±90%CI):

Cohen's effect size

$$ES = \frac{(\overline{X}_{\text{posttest}} - \overline{X}_{\text{pretest}})}{SD_{\text{baseline}}} = \frac{(\overline{X}_{\text{posttest}} - \overline{X}_{\text{pretest}})}{\sqrt{\sigma_p^2 + \sigma_e^2}}$$

standardize response mean (SRM)

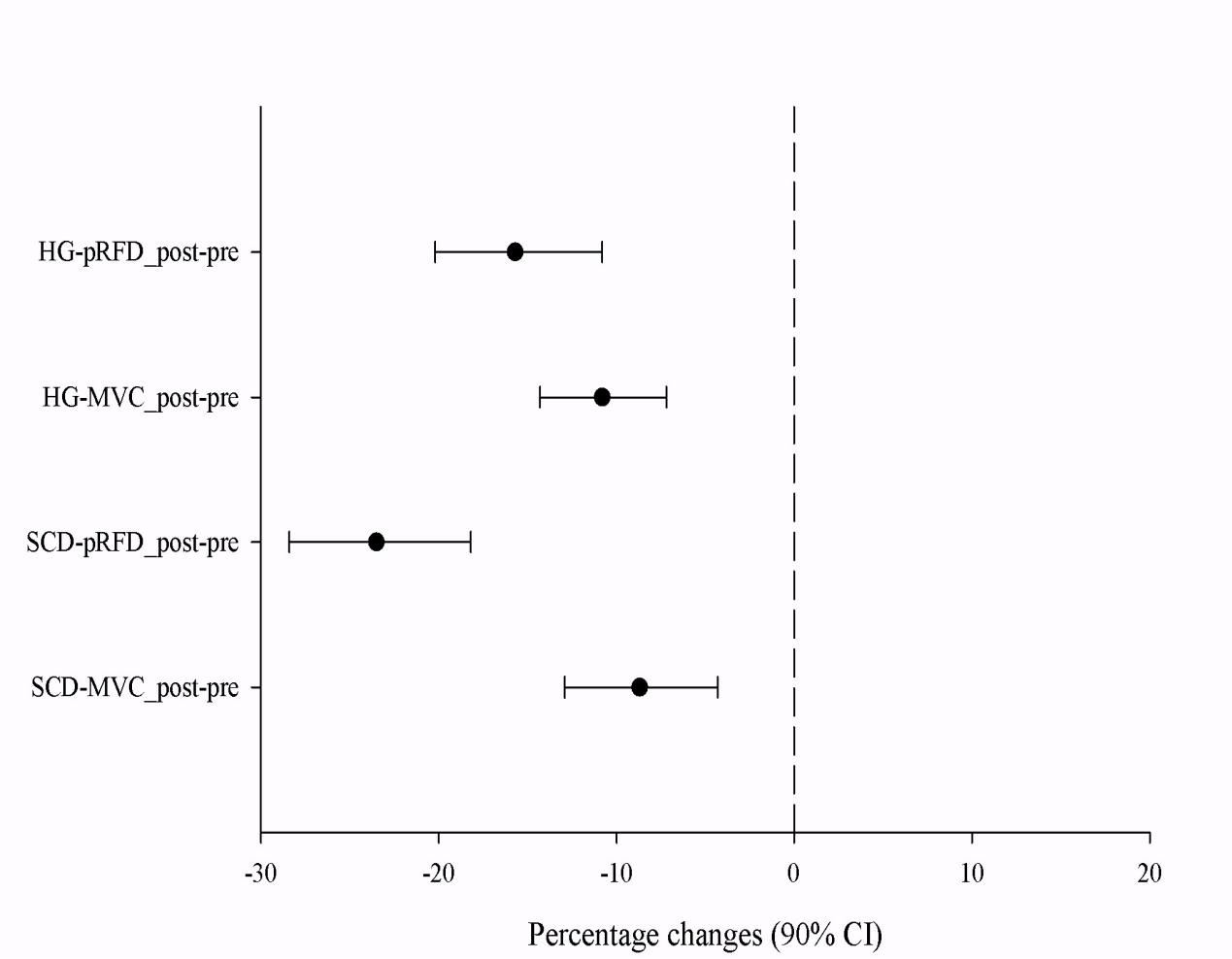
$$\text{SRM} = \frac{(\overline{X}_{\text{post}} - \overline{X}_{\text{pre}})}{SD_{\text{change}}} = \frac{(\overline{X}_{\text{post}} - \overline{X}_{\text{pre}})}{\sqrt{\sigma_{p\times T}^2 + 2\sigma_e^2}}$$

signal-to-noise ratio (S/N)

$$ES_{\text{SEM}} = \frac{(\overline{X}_{\text{posttest}} - \overline{X}_{\text{pretest}})}{\sigma_e}$$

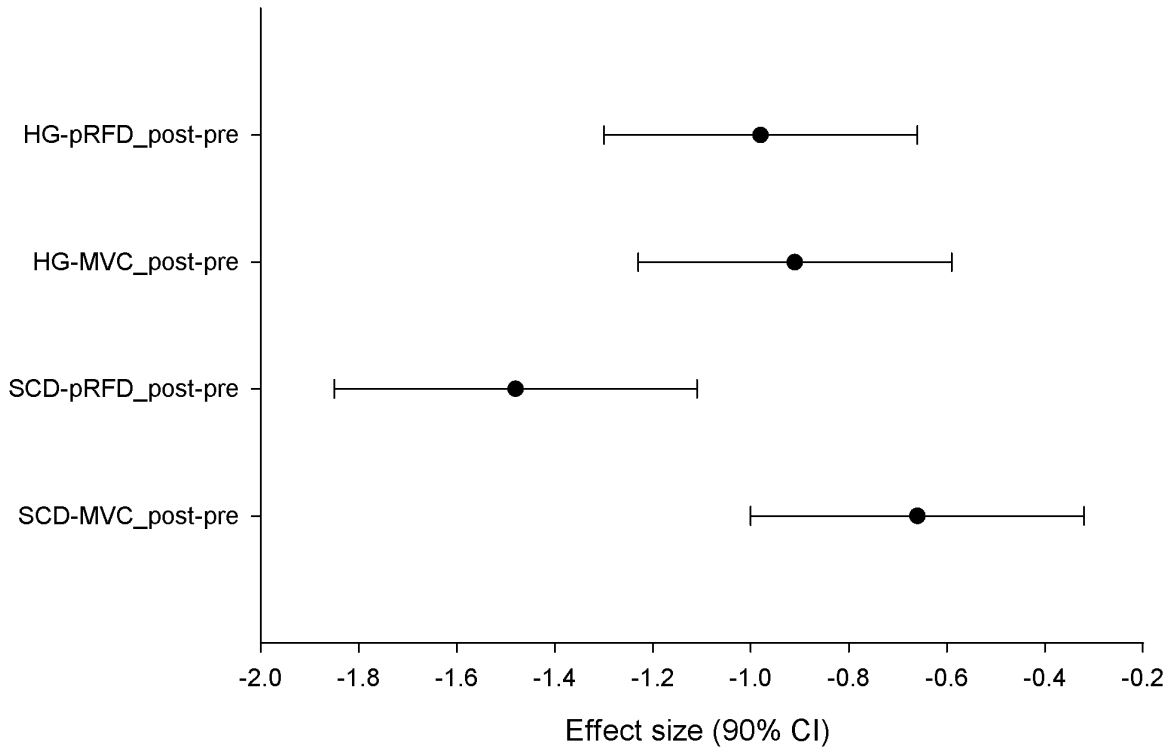
(Husted et al, 2000; Norman et al, 2007; Amman et al, 2009)

Changes after-climbing

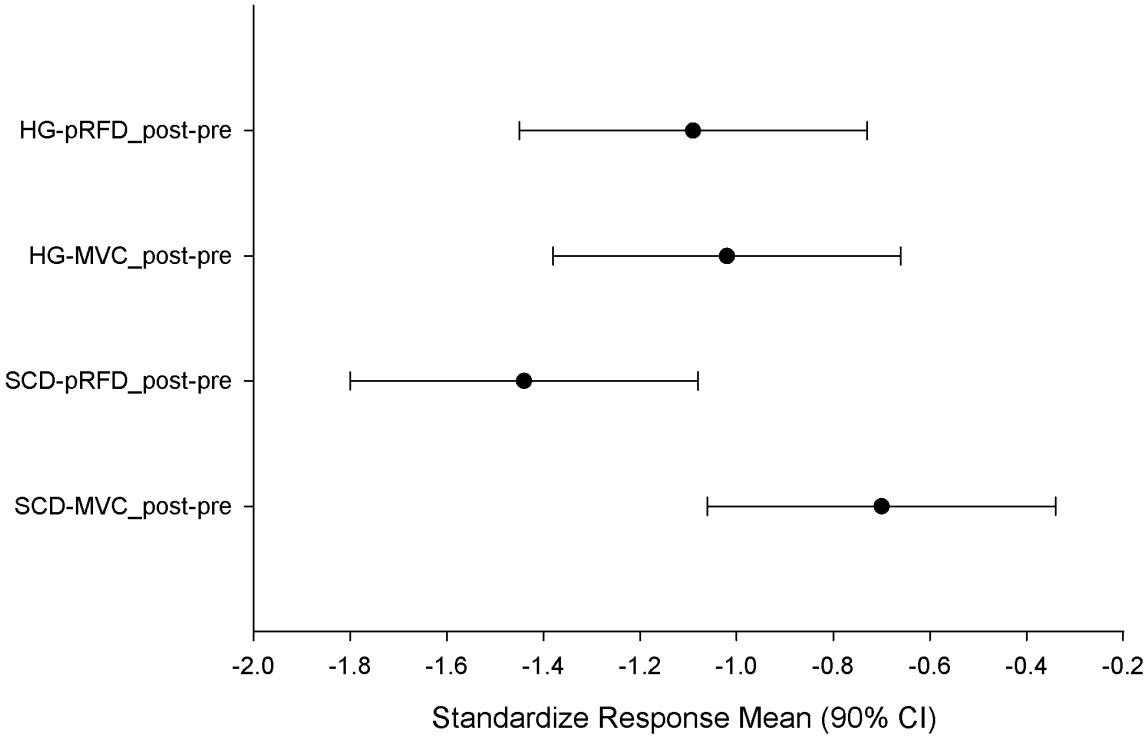


Internal responsiveness

Cohen's effect size

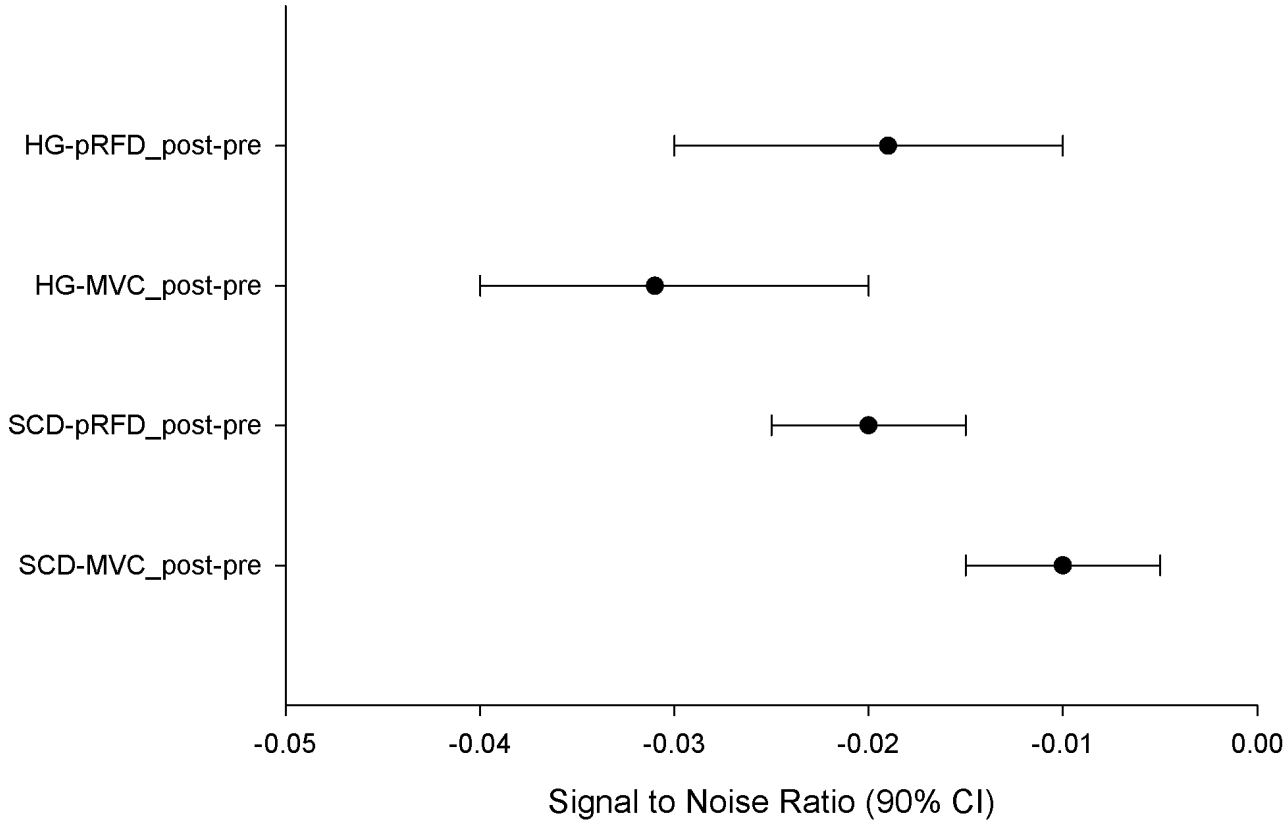


Internal responsiveness
standardize response mean



Internal responsiveness

signal to noise ratio



Conclusions

The decline of all measurements confirmed the occurrence of muscle fatigue.

The SCD-pRFD showed higher ES and SRM.

The S/N for HG-MVC was higher compared to HG-pRFD due to its higher reliability (typical error as CV was 5 and 9%, respectively).

The pRFD can be more appropriate compared to MVC in the specific (SCD) assessment for investigating fatigue in climbing activity.

Since the SCD showed construct validity (i.e. performance as construct) [5] and face validity (as more closely mimic the climbing grip styles), the SCD-pRFD should be considered appropriate to investigate muscle fatigue in sport climbing.

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Acknowledgements:

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Thank you for the attention

maurizio.fanchini@gmail.com