6th International Congress
Mountain, Sport & Health
Updating study and research from laboratory to field
12-13 November 2015 Rovereto (TN) Italy

Specific Strength in sport climbing disciplines

Fanchini M[1], Schena F[1], Pellegrini B[1], Bortolan L[1], Limonta E[2]

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Summary of the presentation

- Instruments and outcomes
- Quality of measurement
- Sport climbing disciplines
- Take home message & training applications

Summary of the presentation

- **Instruments and outcomes**
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- Sport climbing disciplines
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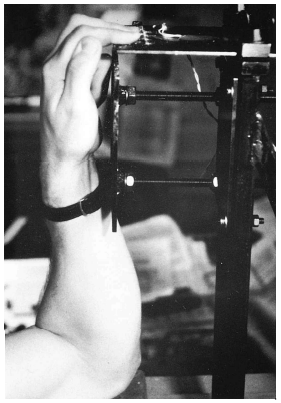
Instruments

handgrip

General

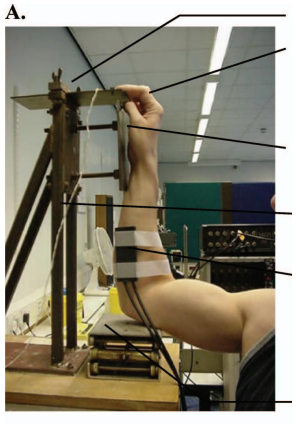
Specific

specific dynamometers



Grant et al.1996

Watts et al. 2003



MacLeod et al. 2007

CeRiSM

"Sport, Montagna e Salute"

Outcomes finger strength

Isometric maximal voluntary contraction (MVC)

“as hard as possible”

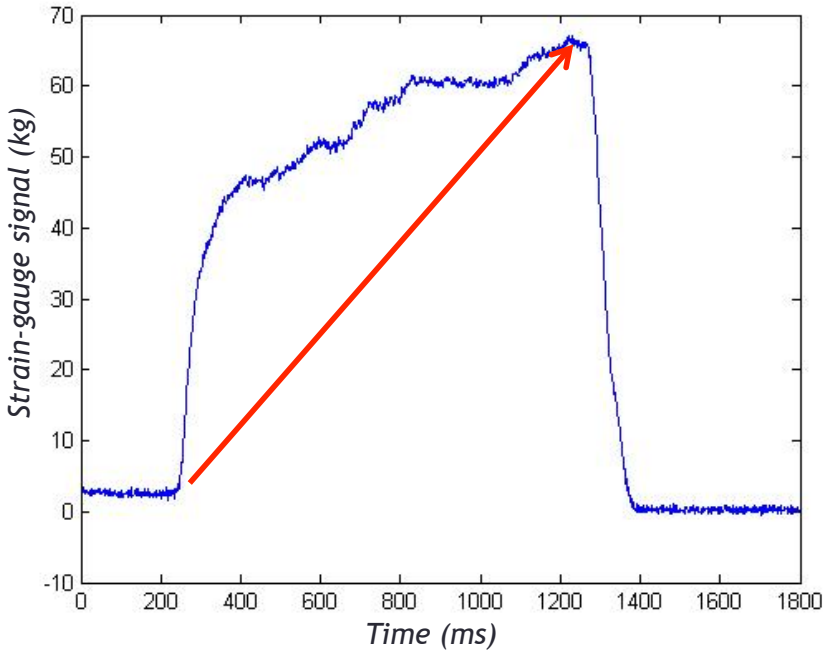
Rate of force development (RFD)

“as hard as quick as possible”

Outcomes finger strength

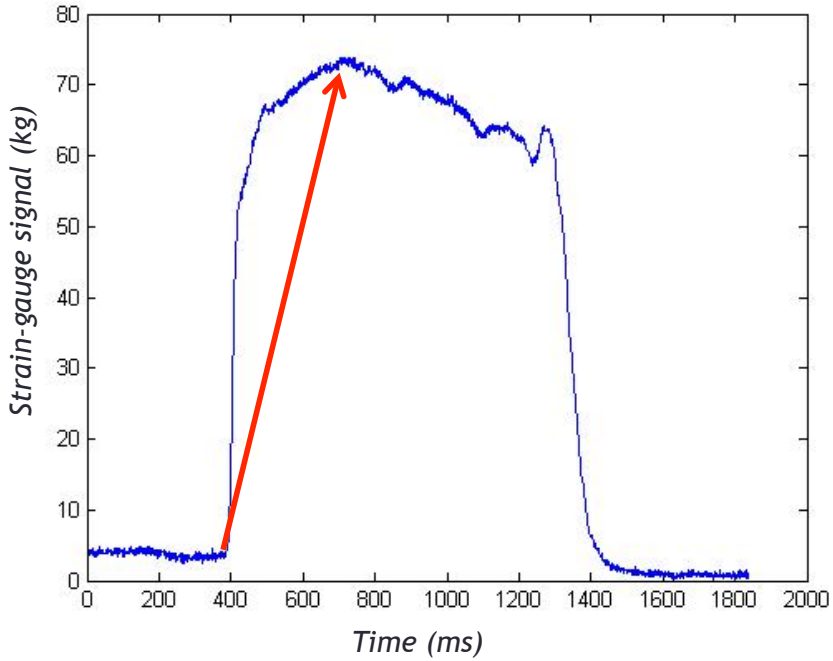
Isometric maximal voluntary contraction (MVC)

"as hard as possible"

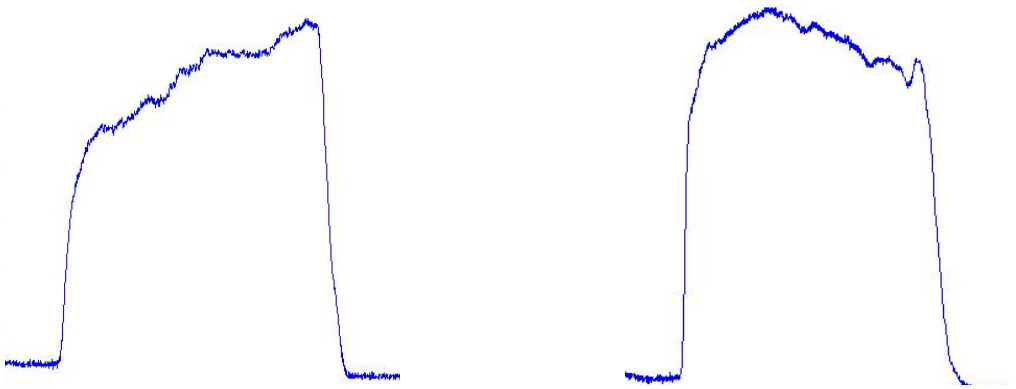


Rate of force development (RFD)

"as hard as quick as possible"



Outcomes finger strength



Variable	"as hard as possible"	"as hard as quick as possible"	T-test P level
MVC (N)	56 ± 13	56 ± 13	*0.74*
RFD30 (N/s)	141 ± 59	230 ± 77	*<0.0001*
RFD50 (N/s)	143 ± 68	254 ± 87	*<0.0001*
RFD100 (N/s)	152 ± 69	266 ± 76	*<0.0001*
RFD200 (N/s)	126 ± 43	188 ± 46	*<0.0001*
pRFD (N/s)	194 ± 78	308 ± 89	*<0.0001*

(46 sport climbers)

Summary of the presentation

- Instruments and outcomes
- **Quality of measurement**
- Sport climbing disciplines
- Training applications

Quality of measurement

INVITED COMMENTARY

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

Test Validation in Sport Physiology: Lessons Learned From Clinimetrics

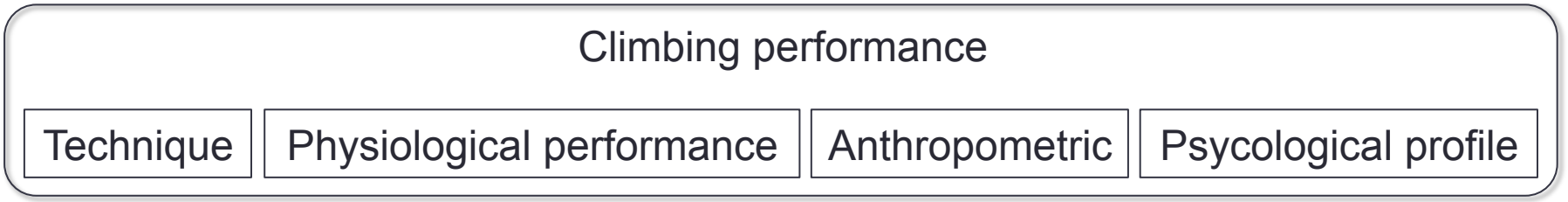
Franco M. Impellizzeri and Samuele M. Marcora

Key attributes:

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

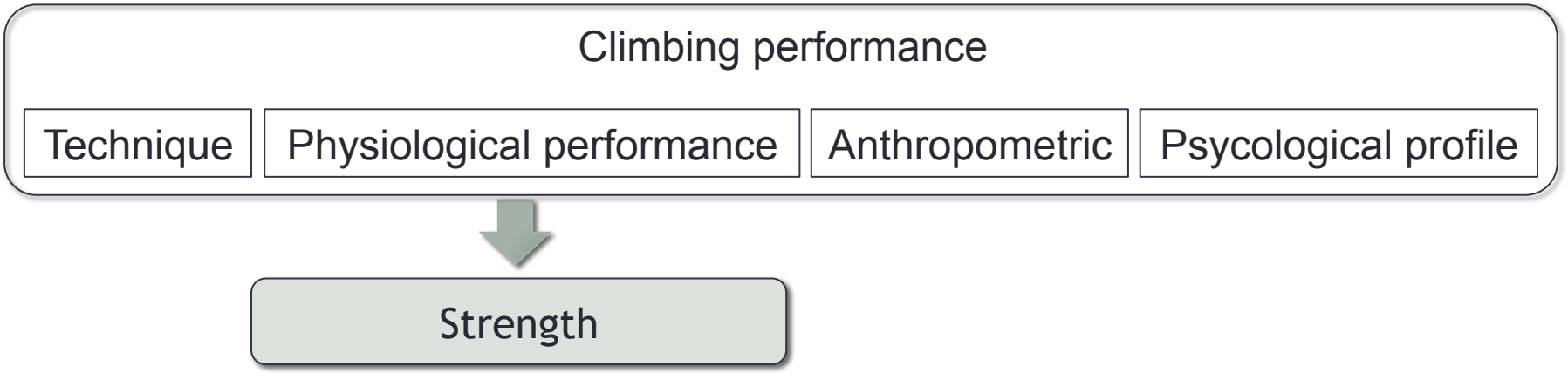
Scientific Advisory Committee of the Medical Outcomes Trust for Health Status and Quality of Life instruments. Qual Life Res, 2002

Conceptual model



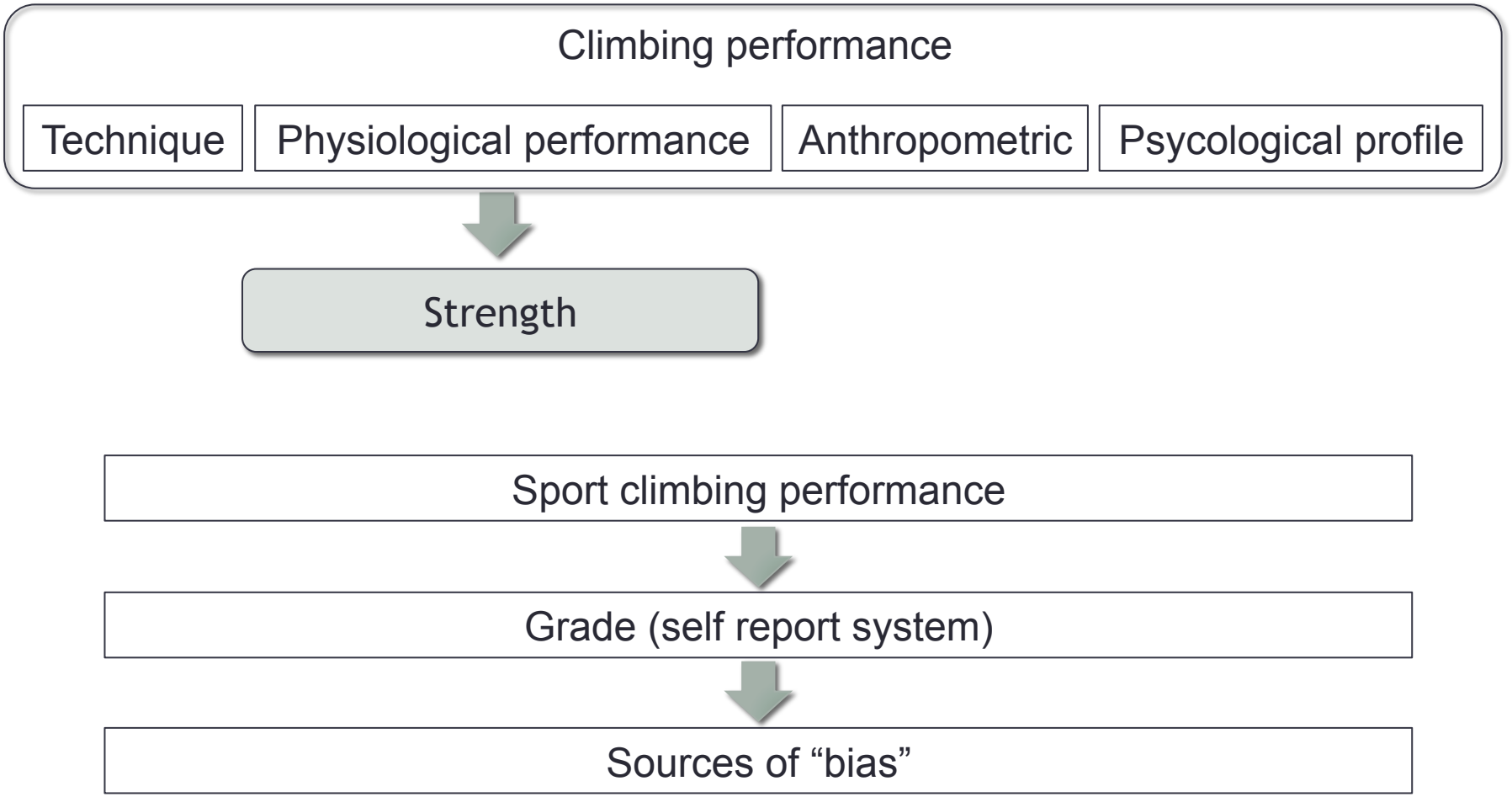
Mermier 2000, Magiera 2013, Laffaye 2015

Conceptual model



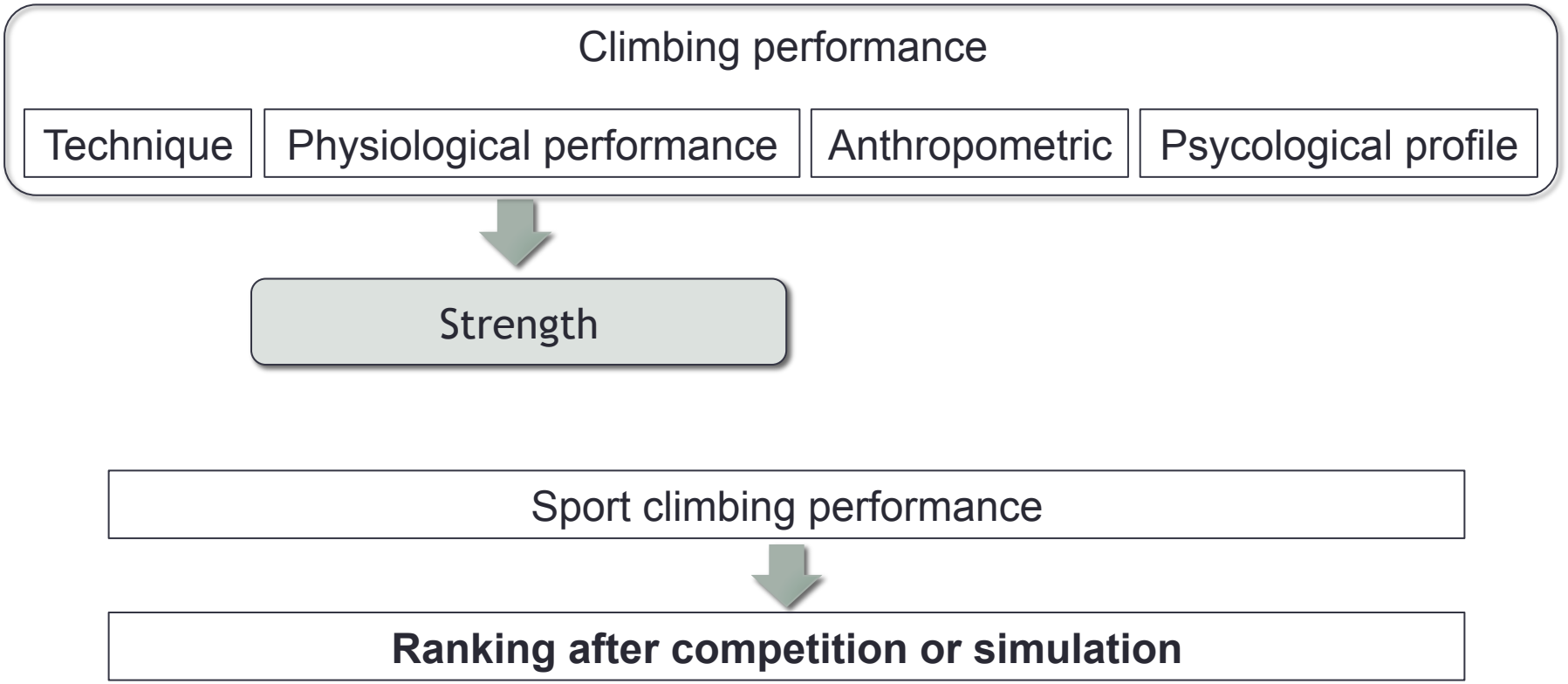
Mermier 2000, Magiera 2013, Laffaye 2015

Conceptual model



Mermier 2000, Magiera 2013, Laffaye 2015

Conceptual model

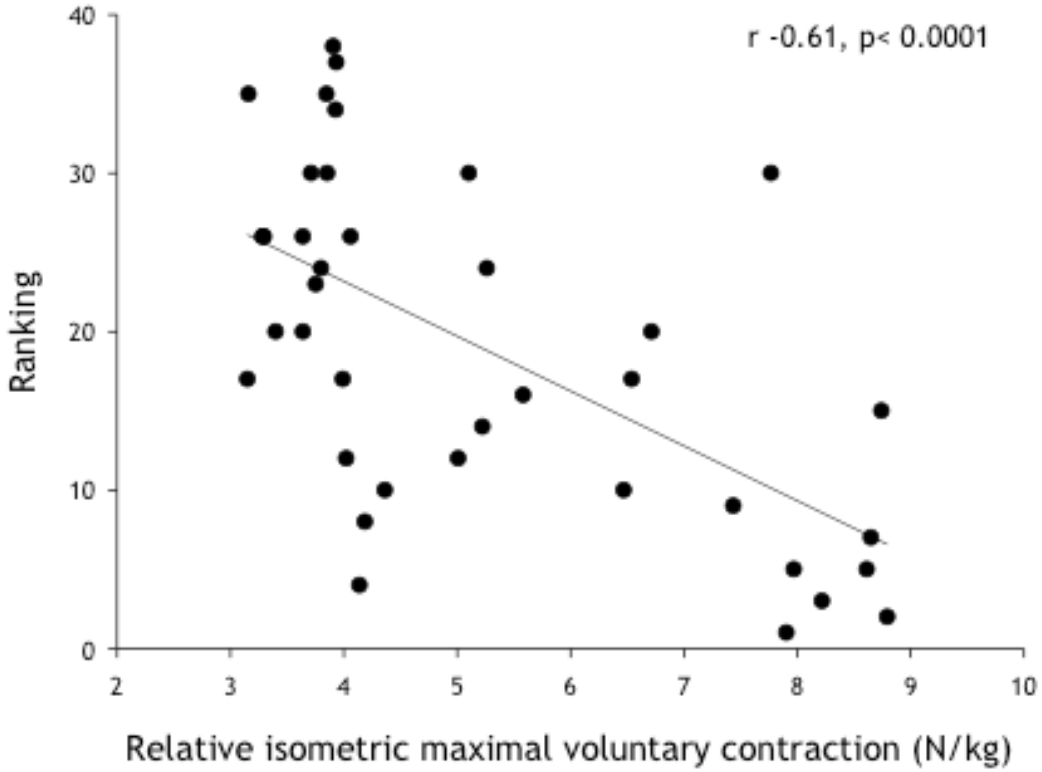


Mermier 2000, Magiera 2013, Laffaye 2015

Construct validity

Method	Hand grip	Specific dynamometer
Known group difference technique *(climbers vs. no climbers, between different level)*	Watts 1993, 2003, Mermier 2000, Esposito 2008, Limonta 2008, Green 2009, Ferguson 1997, Balas 2011, Limonta 2015, Fyer 2014	Grant 1996, 2001, Quaine 2003, McLeod 2007, Macdonald 2011, Vigouroux 2006, 2014 Fanchini 2010 (ECSS proceedings), Philippe 2012, Laffaye 2015
Relationship with construct indicator *(performance=climbing reported level/ability)*	Watts 1993, Gajewskj 2009, Balas 2011	Laffaye 2015
Relationship with construct indicator *(performance=ranking)*	Mermier 2000	**?**

Construct validity of specific strength

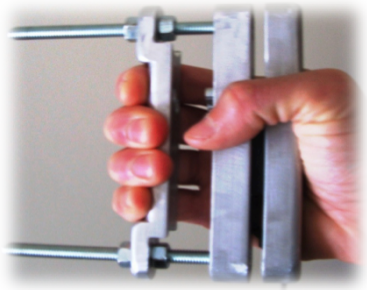


(Fanchini et al, proceedings ECSS 2010)

Reliability

Attribute	Hand grip	Specific dynamometer
Reliability	Balas 2014 (ICC 0.97)	Watts 2003 (ICC 0.90-0.95), Laffaye 2015 (ICC 0.93, CV 3.2%), Balas (ICC 0.95-0.98 diff. position)
Typical Error (%)*		
Maximal voluntary contraction (90% CI)	**4 (3 to 5)**	**8 (6 to 10)**
Peak rate of force development (90% CI)	**8 (6 to 10)**	**16 (13 to 22)**
ICC*		
Maximal voluntary contraction (90% CI)	0.95 (0.91 to 0.98)	0.91 (0.83 to 0.95)
Peak rate of force development (90% CI)	0.92 (0.85 to 0.96)	0.82 (0.68 to 0.90)

**Methods*
28 amateur climbers,
age 32 ± 7 yrs, height 175 ± 5 cm, weight 69 ± 5 kg
Test - Retest (24 hors),
4" contraction 2' rest,
3 x MVC + 3 x pRFD with HG and SCD

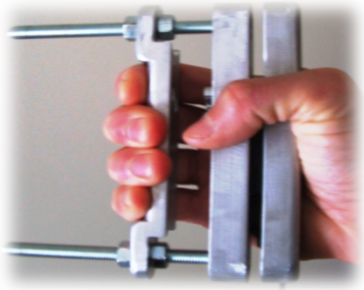


Fanchini et al. 2011, Communication to 16th ECSS congress, Liverpool, UK

Internal responsiveness or sensitivity to change (Fatigue)

Variable	Hand grip	Specific dynamometer
Maximal Voluntary Contraction		
ES (±90%CL)	-0.91 (± 0.32)	-0.66 (± 0.34)
SRM (±90%CL)	-1.02 (± 0.36)	-0.70 (± 0.36)
Signal/Noise (±90%CL)	-0.03 (± 0.01)	-0.01 (± 0.01)
Rate of Force Development (peak)		
ES (±90%CL)	-0.98 (± 0.32)	**-1.48 (± 0.37)**
SRM (±90%CL)	-1.09 (± 0.36)	**-1.44 (± 0.36)**
Signal/Noise (±90%CL)	-0.02 (± 0.01)	-0.02 (± 0.005)

Methods
23 amateur climbers,
age 32 ± 9 yrs, height 177 ± 8 cm, weight 67 ± 8 kg
4" contraction 2' rest,
random order, pre -post climbing route
2 x MVC + 2 x pRFD with SCD
1 x MVC + 1 x pRFD with SCD



Fanchini 2014 (IRCRA proceedings)

Validation Process

Strength can be considered a indicator of physical performance in sport climbing (i.e. conceptual model)

Specific dynamometer showed construct validity and superior face validity compared to hand grip (i.e. construct validity)

MVC showed higher reliability (lover noise) however the acceptability of these typical errors depends on the magnitude of the changes (signal)

Peak-RFD in specific dynamometer showed higher internal responsiveness to MVC for investigating fatigue in climbing activity

The peak-RFD with SCD can be considered appropriate to investigate specific strength and muscle fatigue in sport climbing

Summary of the presentation

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- **Sport climbing disciplines**
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Sport climbing disciplines

Characteristics	Lead	Bouldering
Wall	High (12-18 m)	Low (4-5 m)
Effective Climbing time (White 2010)	Long	Short (problems)
Material	Rope and quickdraws	No rope
Performance/ranking	Height reached	N°problems/attempts

Sport climbing disciplines

The Expert's Opinion

SPORTS TECHNOLOGY

The Expert's Opinion

DOI: 10.1002/jst.116

Bouldering: one of the last sports defying technology? Interview with Kilian Fischhuber

*Günther Niegl**

Austrian Alpine Association, Vienna, Austria

Günther Niegl (GN): What characterizes a good climber?
Kilian Fischhuber (KF): Strength, strength endurance, technique, cognitive and mental strength.

GN: Commonly, strength endurance is regarded as critical for lead climbing and maximal strength for bouldering. Do you agree, especially with regard to boulder competitions?
KF: Maximal strength is for sure one of the most relevant parameters concerning bouldering. Since the boulder competitions only distinguish between 'top' (boulder completed till the last hold) and 'bonus hold' (one hold usually in the middle of the boulder), the sport is far more tactical than lead climbing. The athlete has to know his/

What are the more important factors related to performance in lead and boulder?

lack of endurance (moderate intensity route without rest)

lack of strength forearm

lack of arm strength

route interpretation

difficult technical movement

lack high intensity resistance

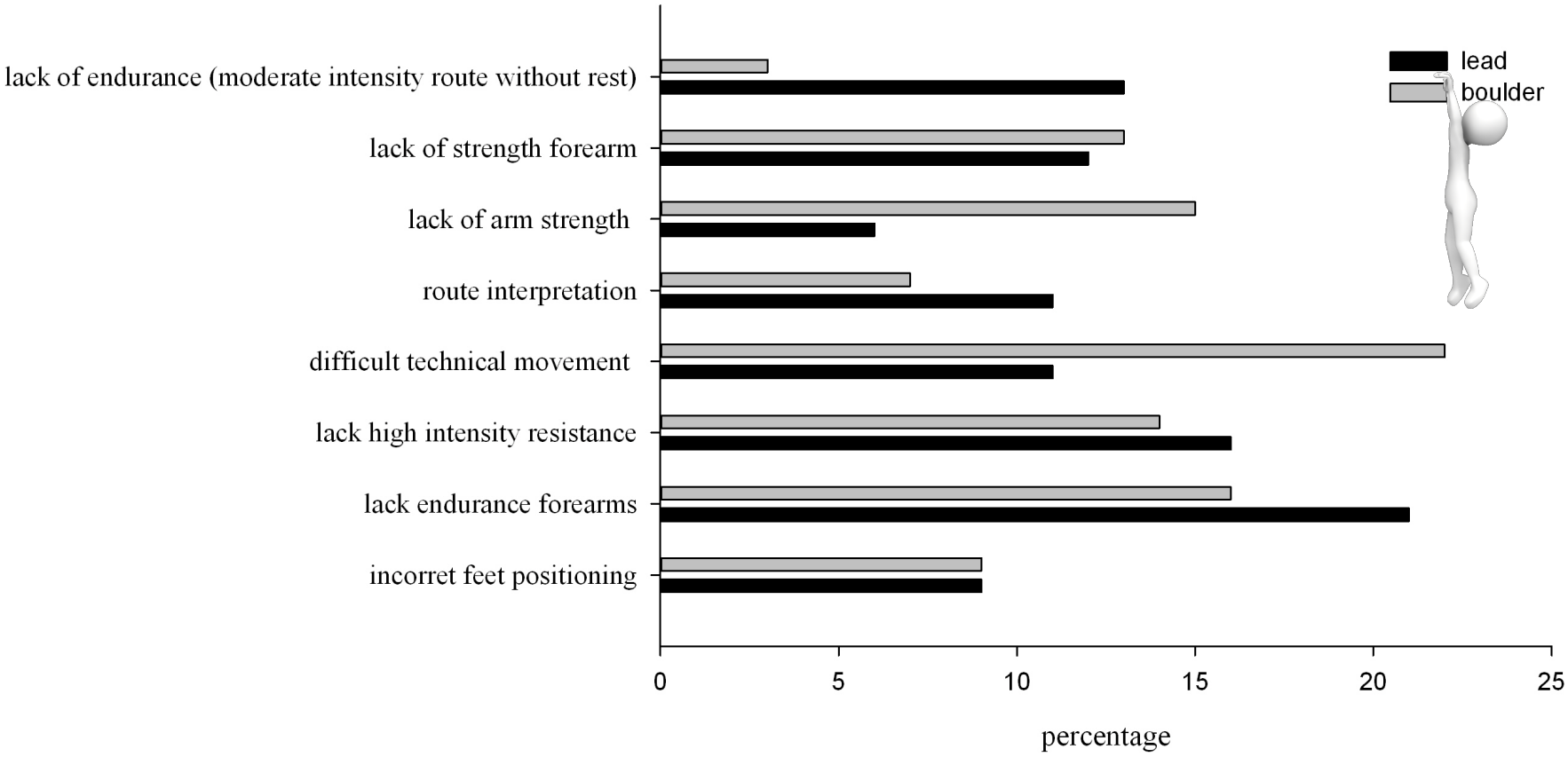
lack endurance forearms

incorret feet positioning

Sport Climbing Survey 2015 = 26 amateurs climbers participating in the first level course for instructor of the Italian Federation Sport Climbing.

Sport Climbing Survey

What are the more important factors related to performance in lead and boulder?

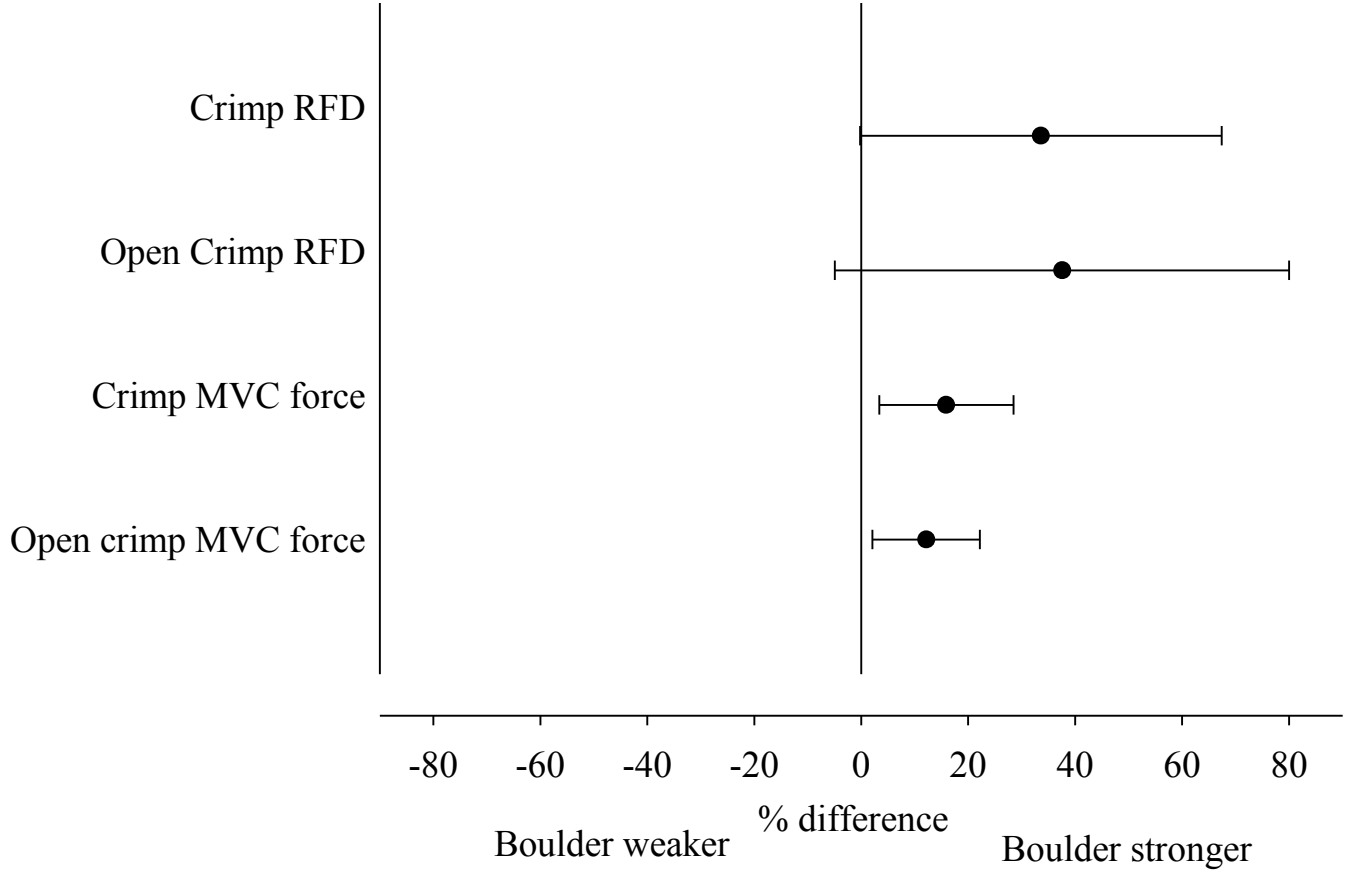


Sport Climbing Survey 2015 = 26 amateurs climbers participating in the first level course for instructor of the Italian Federation Sport Climbing.

Differences in Climbing-Specific Strength Between Boulder and Lead Rock Climbers

Maurizio Fanchini,[1] Frédéric Violette,[2] Franco M. Impellizzeri,[1,3] and Nicola A. Maffiuletti[2,3]

[1]CeRiSM, Research Center for "Sport, Mountain and Health", University of Verona, Rovereto, Italy; [2]UFR STAPS, Faculty of Sport Sciences, University of Burgundy, Dijon, France; and [3]Neuromuscular Research Laboratory, Schulthess Clinic, Zurich, Switzerland



J Strength Cond Res 27(2): 310–314, 2013

Muscle fatigue during rock climbing lead competition and simulation

Fanchini M[1], Maffiuletti NA[3], Rosponi A[2], Schena F[1,2], Bortolan L[1,2], Pellegrini B[1,2], Impellizzeri FM[2,3]

[1]University of Verona, Italy; [2]Research Center for Sport, Mountain and Health, CeRiSM, [3]Neuromuscular Research Laboratory, Schulthess Clinic, Zurich, Switzerland

Aims

✓ examine Muscle Fatigue (MF) as decline after exercise of MVC and pRFD

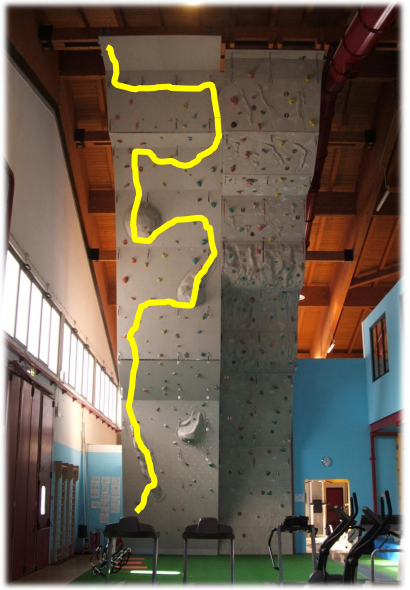
✓ examine differences in MF between competitive (CC) and well-trained but not competitive climbers (NC) in the same route.

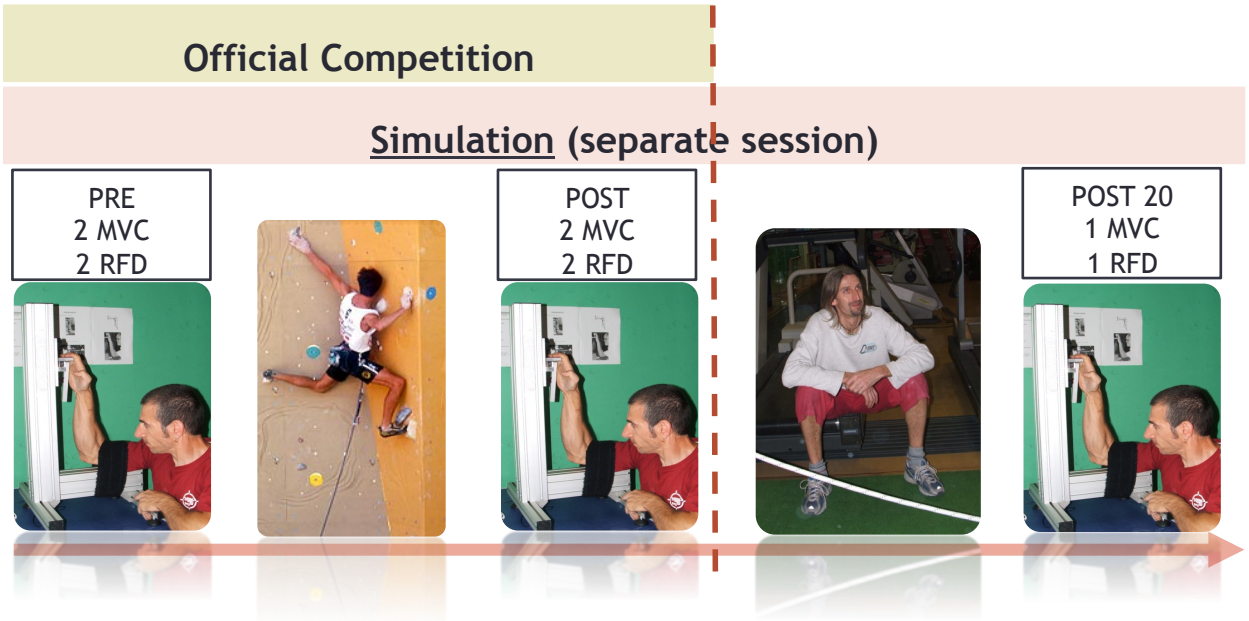
Methods

	Competitors (n 13)			No Competitors (n 25)		
Age (years)	25.8	±	11.7	32.6	±	9.4
Height (cm)	173.6	±	7.7	176.6	±	5.8
Weight (kg)	63.4	±	8.7	67.8	±	7.8
Level (au) (French scale)						
on-sight	3.1 (7b)	±	0.9	2.1 (6c)	±	0.7 *
after-work	4.1 (8a)	±	1.0	2.72 (7a+)	±	0.7 **

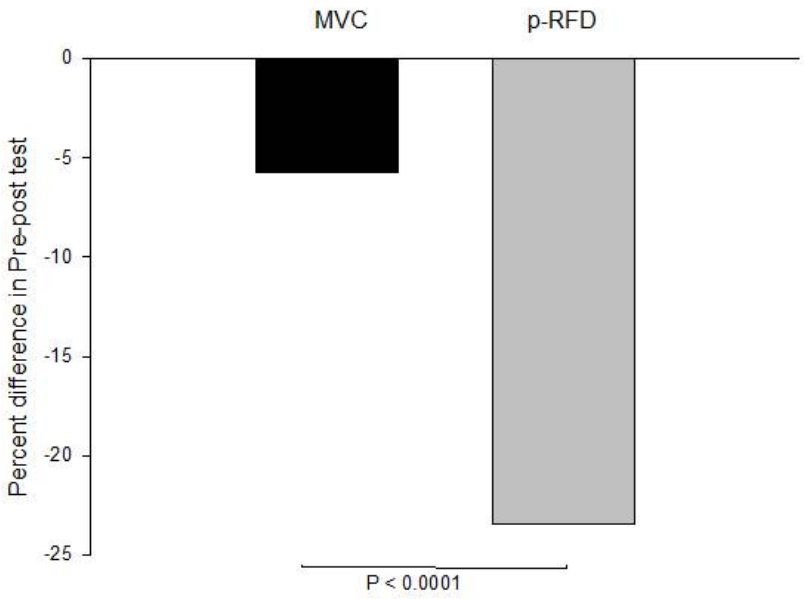
*p = 0.001, ** p < 0.0001

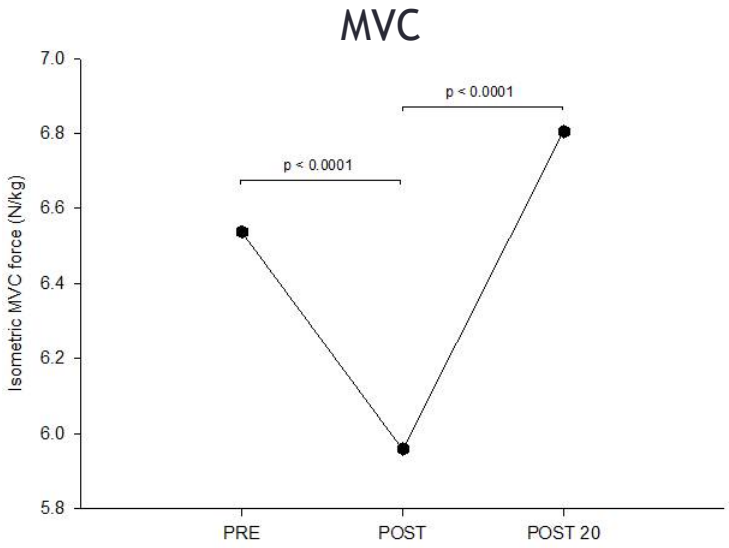
Route:
Overhanging wall, 11 m height, 15 m development, grade 7b+ (French scale), n° of hand-holds 47

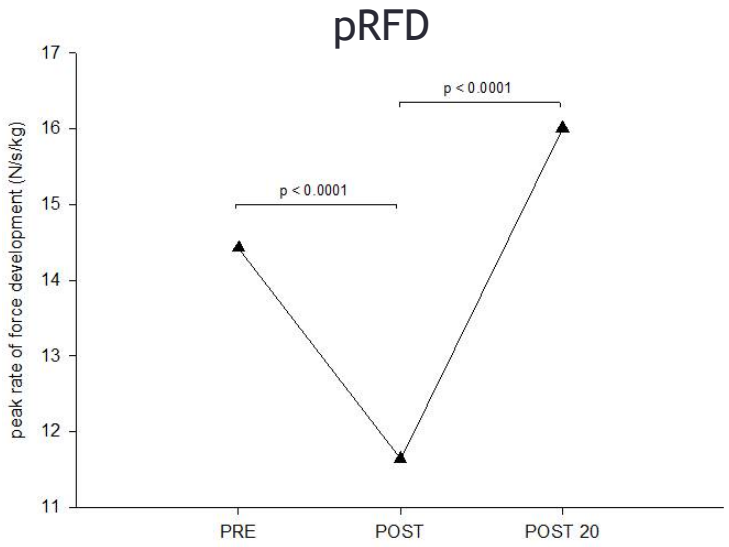




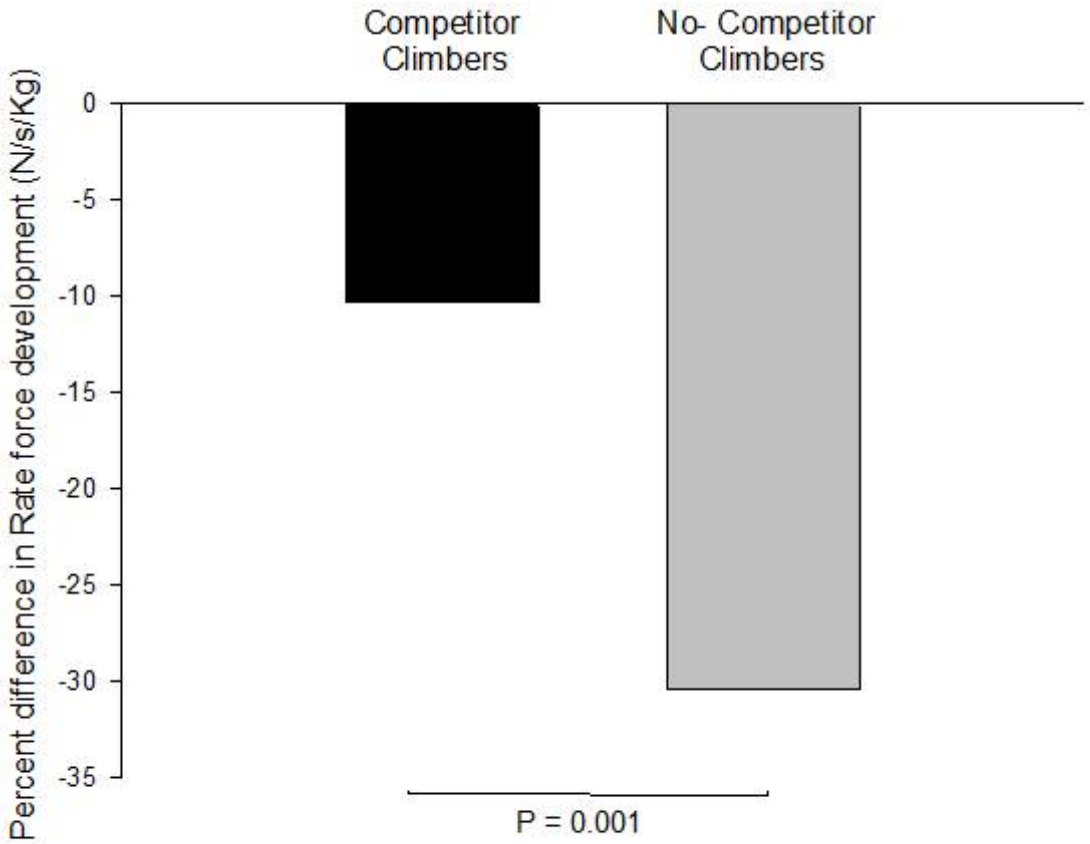
Muscle fatigue & recovery after 20 min







Muscle Fatigue
Known-groups differences technique



Muscle fatigue after sport climbing lead and boulder

Fanchini M[1], Schena F[1], Pellegrini B[1], Bortolan L[1] Degasperi Luca[1], Limonta E[2]

[1] Department of Neurological and Movement Science and CeRISM University of Verona, Italy
[2] Department of Biomedical Sciences for Health, University of Milan, Italy

Aims

to measure muscle fatigue occurrence (i.e. decline in MVC and RFD parameters) after sport climbing lead and boulder competition simulation

Participants
15 (age 29 ± 10 yrs, height 175 ± 8 cm, body mass 67 ± 8 kg)

Climbing level
• *IRCRA (International Rock Climbing Research Association) scale*
Moderate to advanced

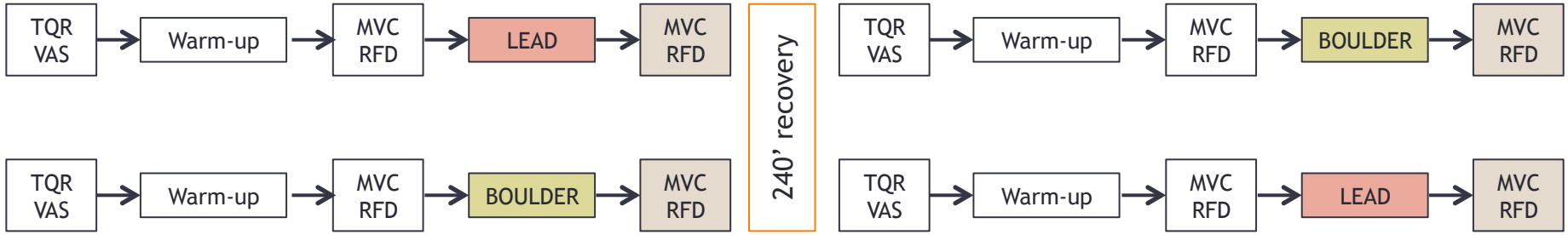
• *Sport scale*

Climbing discipline/ modality	French scale *mean (range)*	IRCRA scale *mean ± SD*
Lead on sight	6c (6b-7b)	15 ± 2
Lead after-work	7a+ (6c-8a)	18 ± 2
Boulder on sight	6b (6a-7a)	13 ± 2
Boulder after-work	6c+ (6b-7c)	16 ± 3

Methods

Design

Counterbalance with two condition (i.e. Lead and Boulder), randomized assignment



Competition simulation (semi-final)

Lead: one route

Boulder: four problems (5' work 5' recovery)

Outcomes

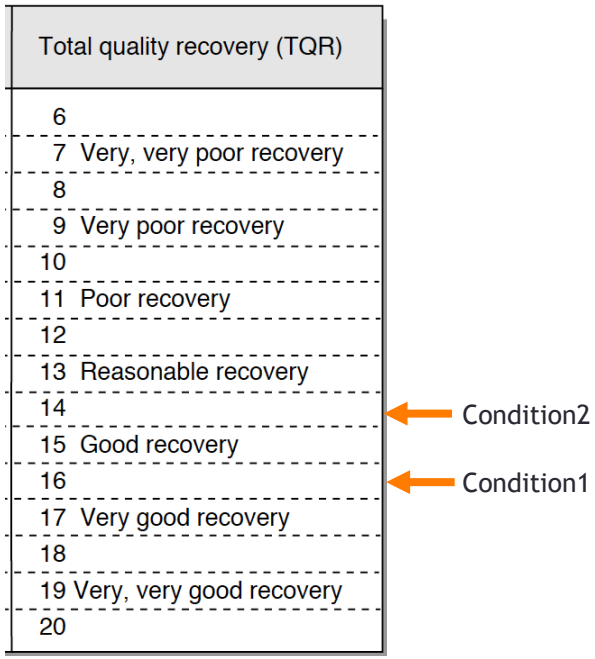
Total Quality Recovery Scale (TQR, *Kentaa 1996*) and Visual Analogic Scale (VAS) for starting condition

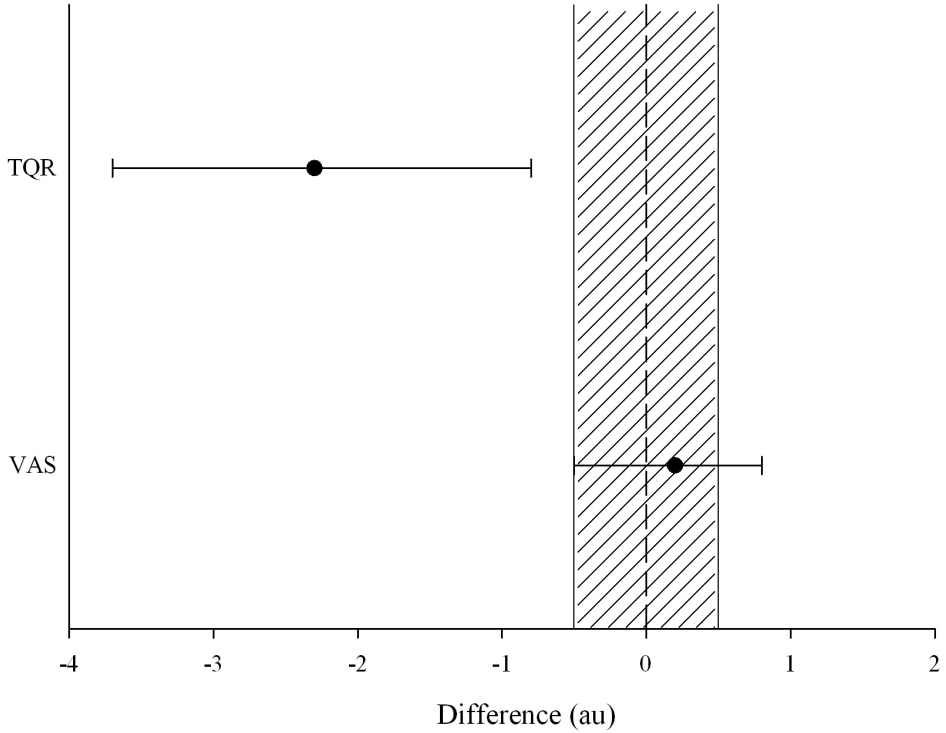
Maximal Voluntary Contraction (MVC)

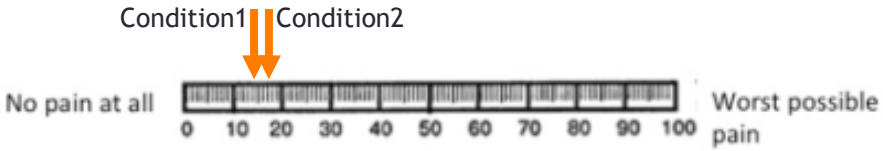
Rate of Force Development (RFD): 30 ms, 50 ms, 100 ms, 200 ms, peak

Rate of Perceived Exertion (RPE) Borg CR100

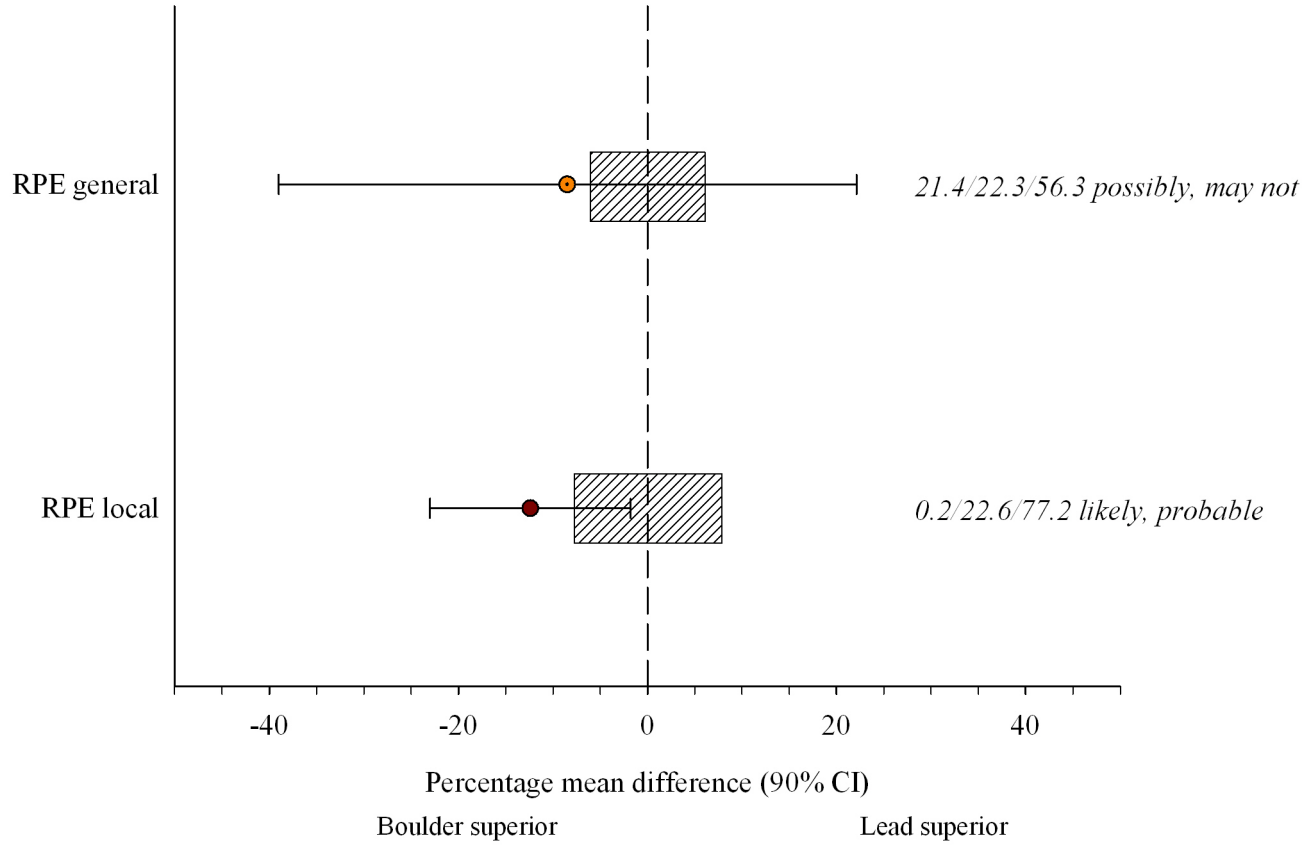
Pre climbing conditions





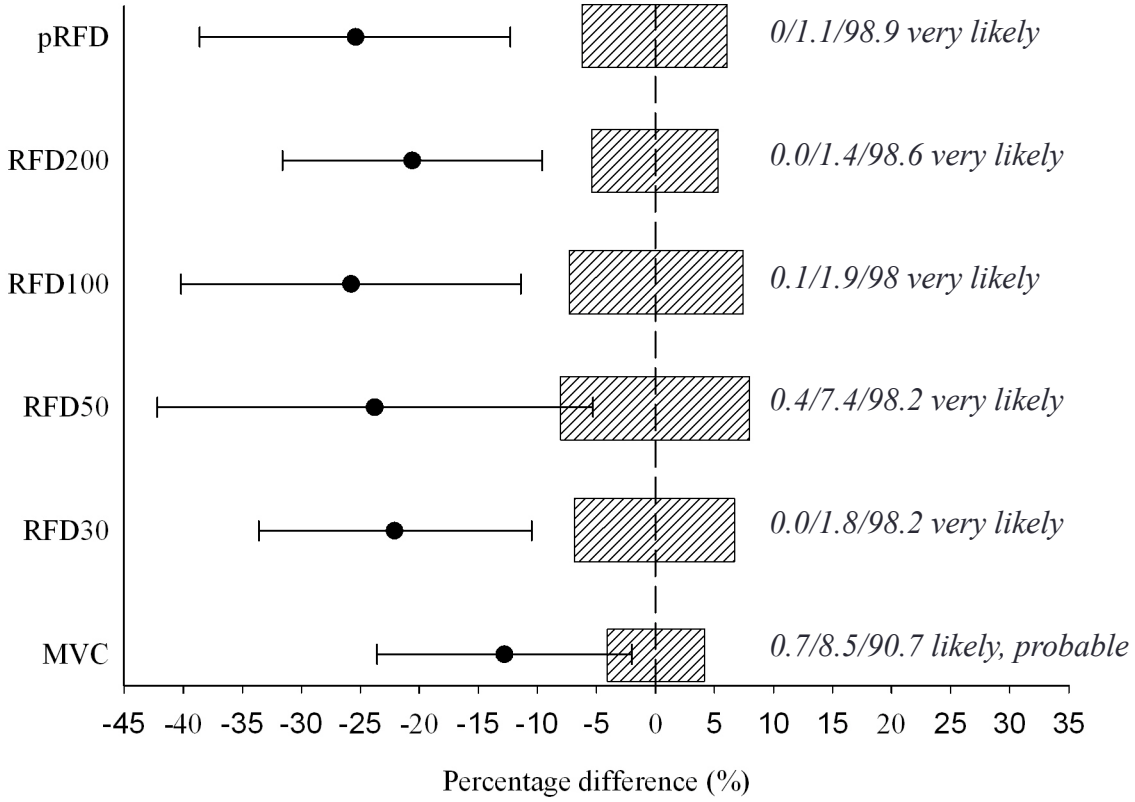


General and Local Rate of Perceived Exertion (CR100 Borg scale) in boulder and Lead



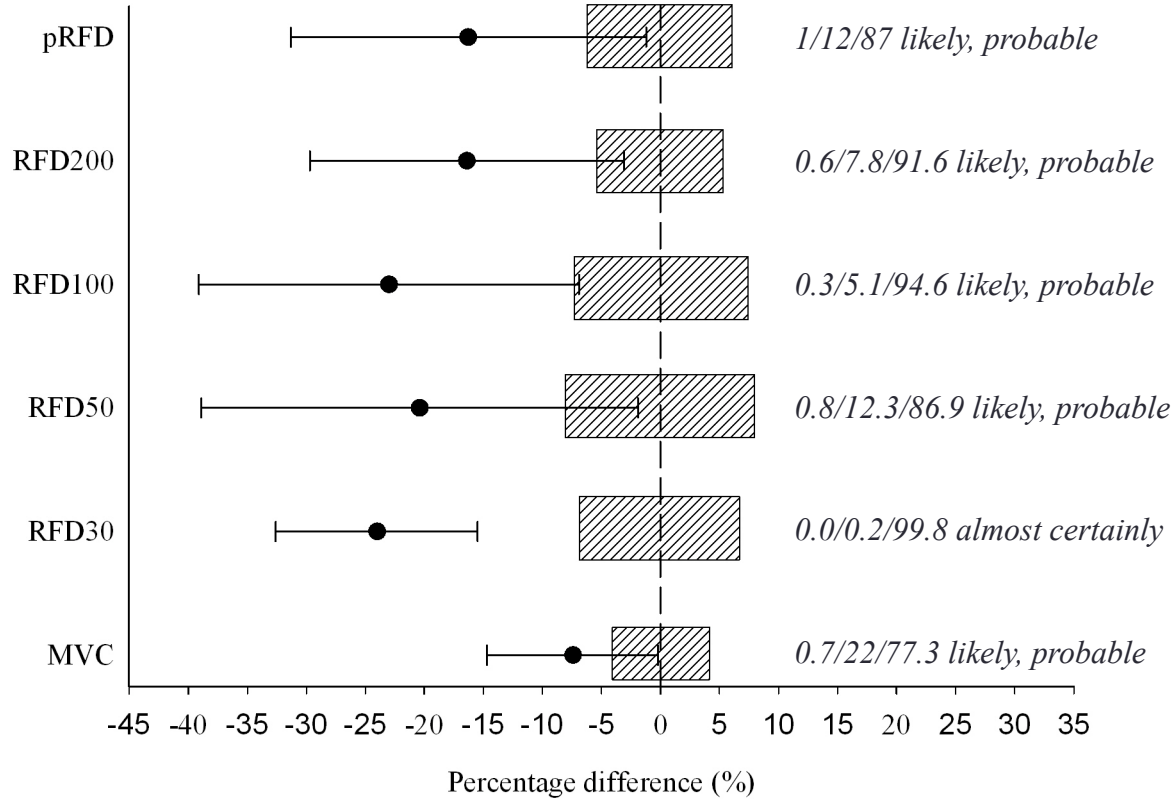
Chances (%) that the true value of the statistic is improved, trivial or worsen compared to the small worthwhile change (trivial area)

Percentage differences post Lead



Chances (%) that the true value of the statistic is improved, trivial or worsen compared to the small worthwhile change (trivial area)

Percentage differences post Boulder



Chances (%) that the true value of the statistic is improved, trivial or worsen compared to the small worthwhile change (trivial area)

Discussion

- The decline in strength after Lead and Boulder simulation of competition confirms the occurrence of muscle fatigue and confirmed previous results attained after a Lead official competition and simulation for pRFD (-19%) and MVC (-6%).

- The decline in RFD parameters underlined the importance of rapidly exerting the strength (i.e. contact strength) during both disciplines.

Summary of the presentation

- Instruments and outcomes
- Quality of measurement
- Sport climbing disciplines
- **Take home message & training applications**

Take home message & training applications

1. Specific strength is a determinant in both Lead and Boulder performances

2. Strength training is important for both Lead and Boulder

3. Explosive strength training can be more important in Boulder (need studies)

4. Boulder can be used to training strength in Lead

Thank you for the attention

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