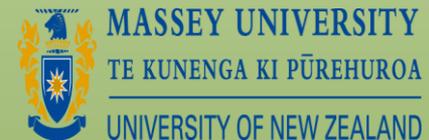


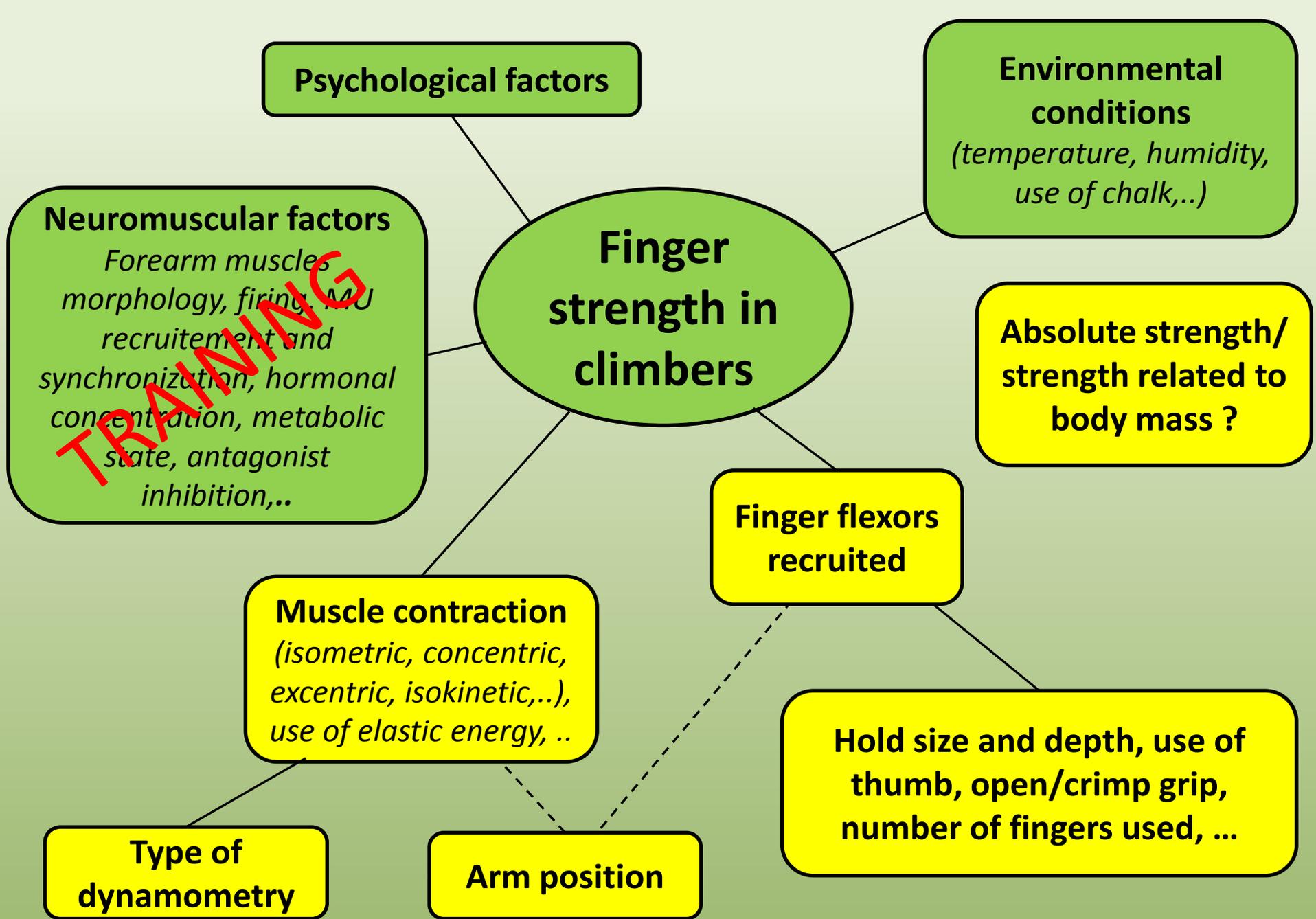


# The effect of arm position and grip during finger flexor strength measurement in sport climbers

Jiří Baláš, Michaela Panáčková, Jan Kodejška, Darryl J. Cochrane, Andrew J. Martin, Jonáš Mrskoč, Nick Draper







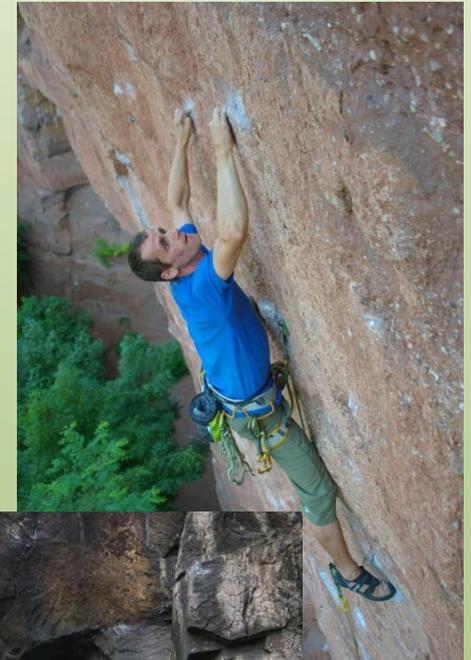
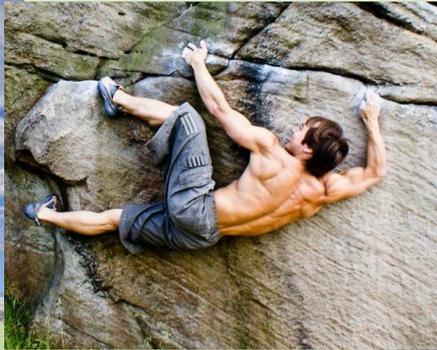
# Evaluation of climbers finger strength

- What is the best arm and body position?
- What is the suitable grip? How many fingers should be used?
- How deep should be the testing hold?
- What type of contraction should be tested?
- And the other variables such as material of the hold, inclination of the hold,...

# **The role of arm position during finger flexor strength measurement in sport climbers**

Jiří Baláš, Michaela Panáčková, Jan Kodejška,  
Darryl J. Cochrane, Andrew J. Martin

# Arm position and finger strength during climbing



# Arm position and finger strength - during testing



Handgrip

# Arm position and finger strength - during testing

*Journal of Sports Sciences*, 1996, 14, 301-309

Anthropometric, strength, endurance and flexibility characteristics of elite and recreational climbers

S. GRANT,<sup>1\*</sup> V. HYNES,<sup>1</sup> A. WHITTAKER<sup>2</sup> and T. AITCHISON<sup>3</sup>

*Journal of Sports Sciences*, 2001, 19, 499-505

A comparison of the anthropometric, strength, endurance and flexibility characteristics of female elite and recreational climbers and non-climbers

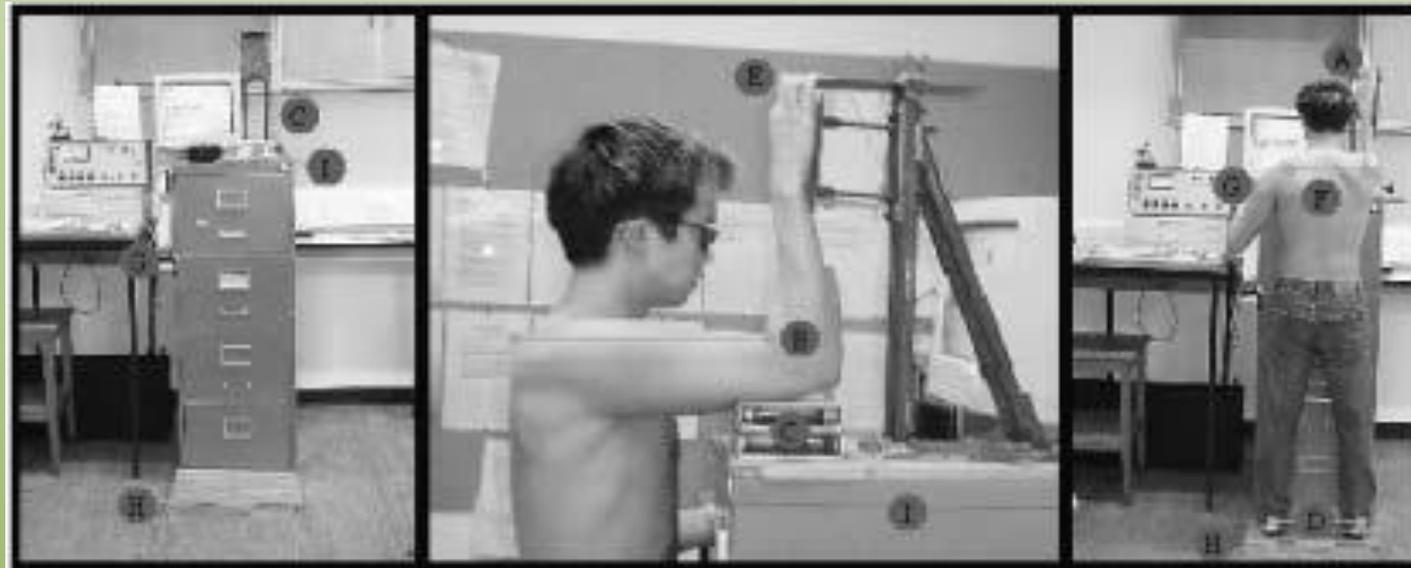
S. GRANT,<sup>1\*</sup> T. HASLER,<sup>1</sup> C. DAVIES,<sup>2</sup> T.C. AITCHISON,<sup>2</sup> J. WILSON<sup>1</sup> and A. WHITTAKER<sup>3</sup>



## Climbing-specific finger endurance: a comparative study of intermediate rock climbers, rowers and aerobically trained individuals

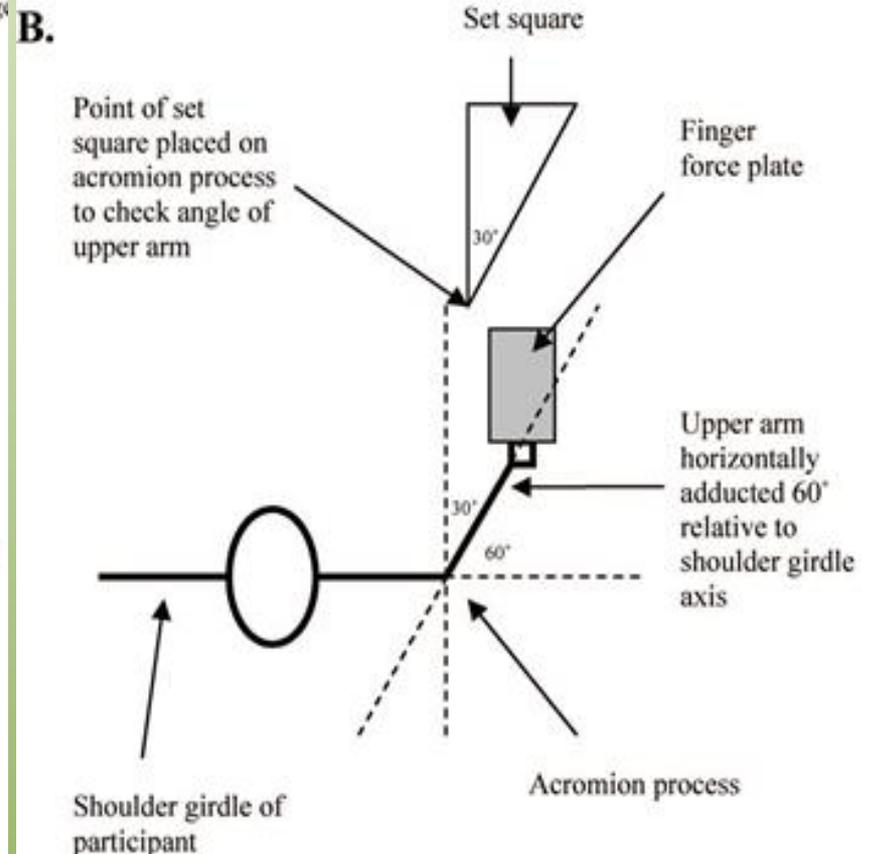
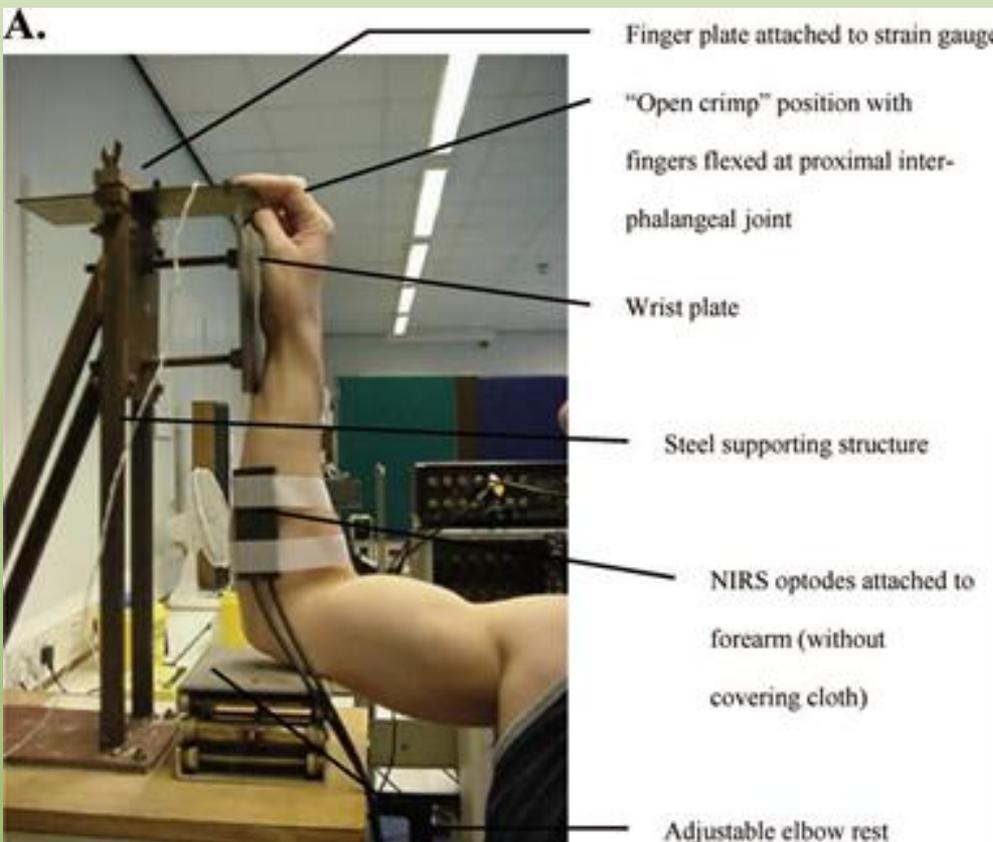
S. GRANT,<sup>1\*</sup> C. SHIELDS,<sup>1</sup> V. FITZPATRICK,<sup>1</sup> W. MING LOH,<sup>1</sup> A. WHITAKER,<sup>2</sup>  
I. WATT<sup>1</sup> and J.W. KAY<sup>3</sup>

<sup>1</sup>*Institute of Biomedical and Life Sciences, University of Glasgow, Glasgow, UK,* <sup>2</sup>*Mechanical Engineering, University of Glasgow, Glasgow, UK and* <sup>3</sup>*Statistics Department, University of Glasgow, Glasgow, UK*



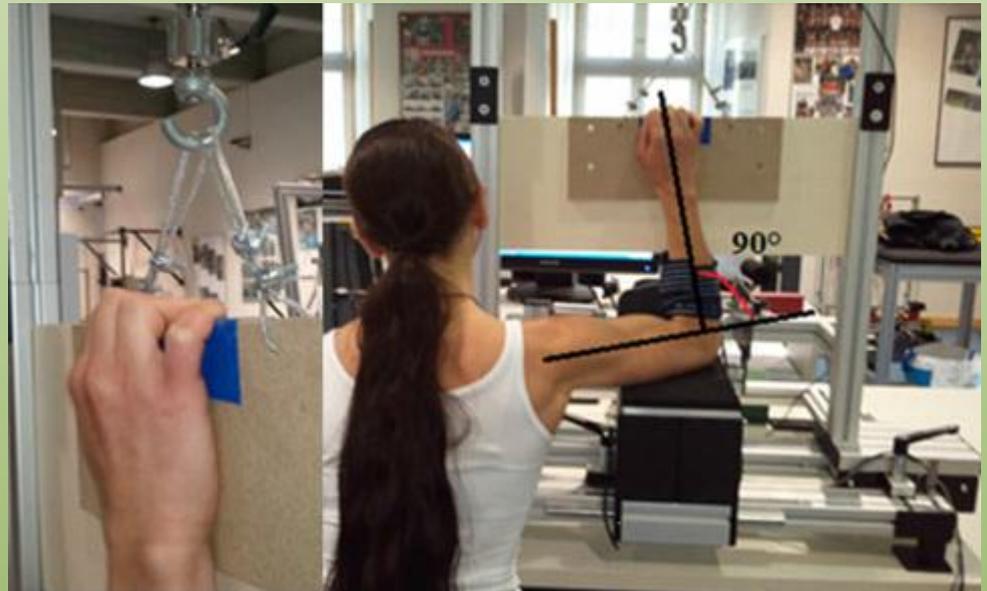
## Physiological determinants of climbing-specific finger endurance and sport rock climbing performance

D. MACLEOD<sup>1</sup>, D. L. SUTHERLAND<sup>1</sup>, L. BUNTIN<sup>1</sup>, A. WHITAKER<sup>2</sup>, T. AITCHISON<sup>3</sup>,  
I. WATT<sup>1</sup>, J. BRADLEY<sup>4</sup>, & S. GRANT<sup>1</sup>



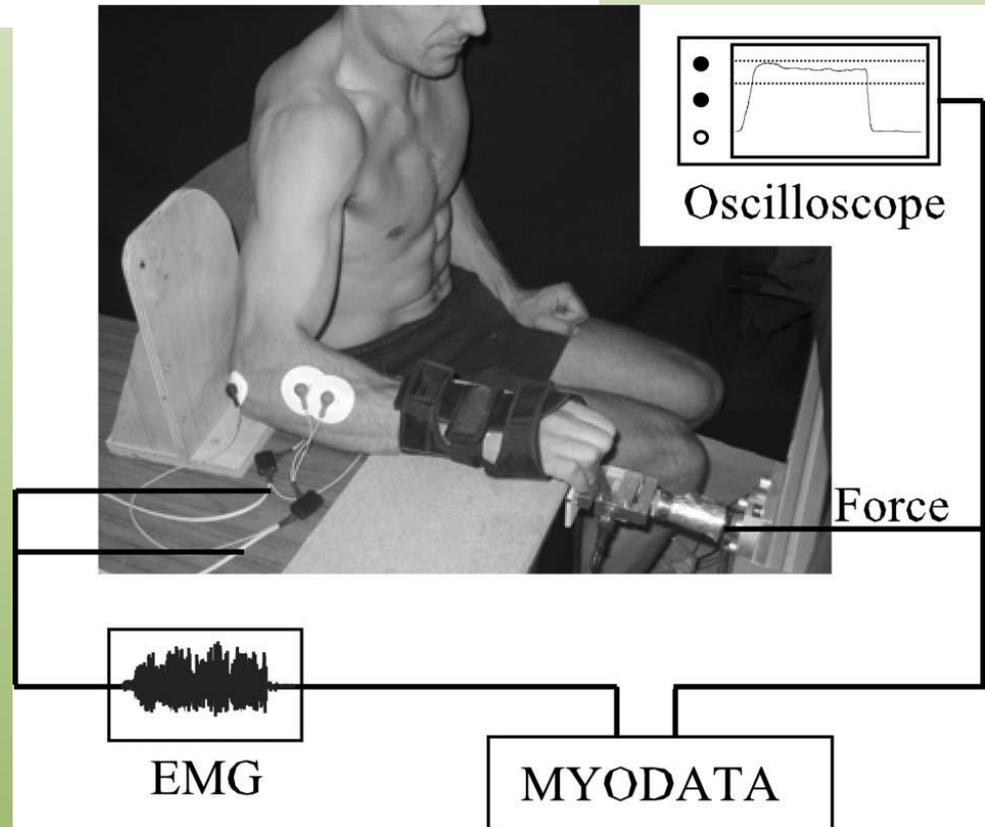
## Climbing-specific finger flexor performance and forearm muscle oxygenation in elite male and female sport climbers

Marc Philippe · Daniel Wegst · Tom Müller ·  
Christian Raschner · Martin Burtscher



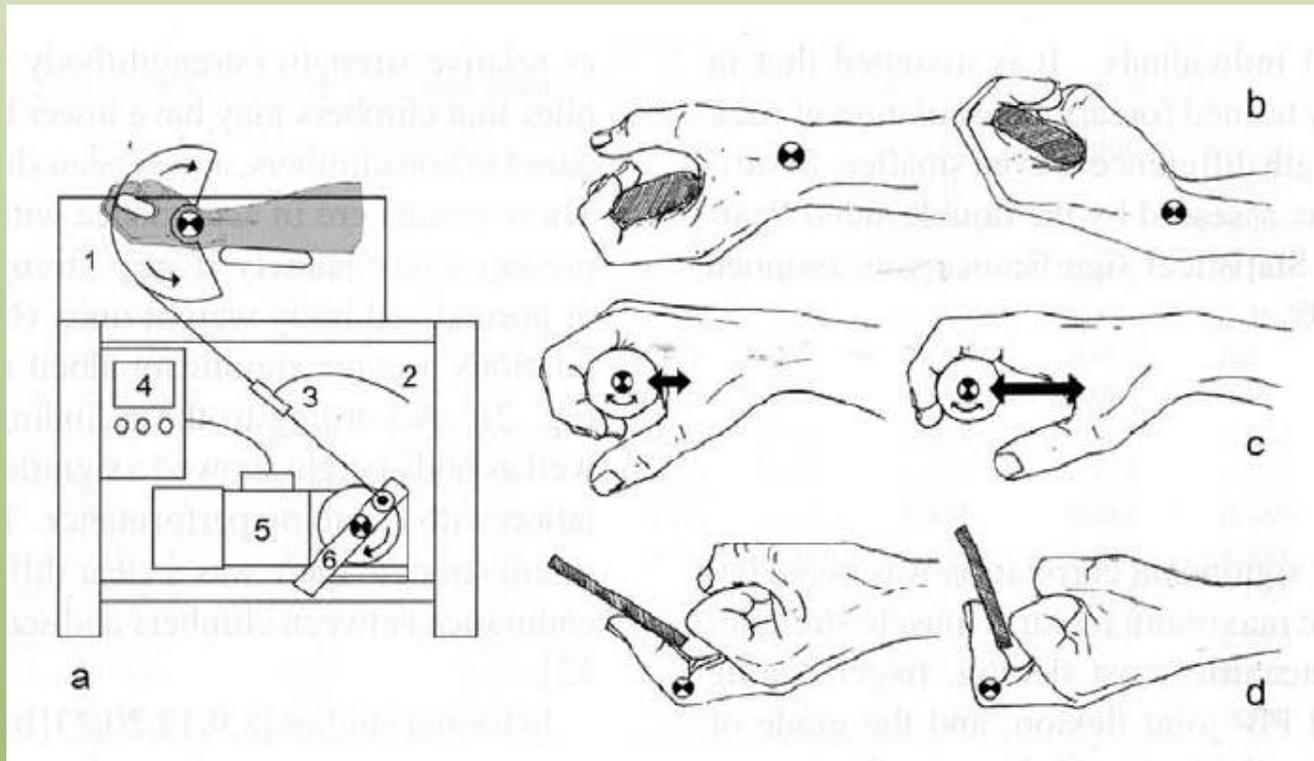
## **Fingertip force and electromyography of finger flexor muscles during a prolonged intermittent exercise in elite climbers and sedentary individuals**

LAURENT VIGOUROUX & FRANCK QUAINÉ



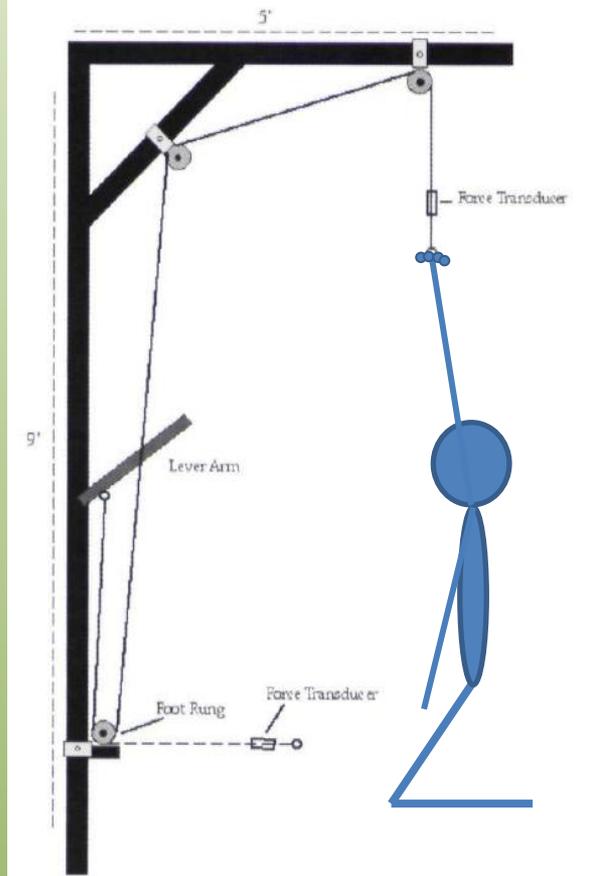
# Correlation of forearm strength and sport climbing performance

A. Schweizer\* and M. Furrer



# PREDICTION OF INDOOR CLIMBING PERFORMANCE IN WOMEN ROCK CLIMBERS

CHRISTOPHER B. WALL,<sup>1</sup> JOANNA E. STAREK,<sup>1</sup> STEVEN J. FLECK,<sup>2</sup> AND WILLIAM C. BYRNES<sup>1</sup>



# DIFFERENCES IN CLIMBING-SPECIFIC STRENGTH BETWEEN BOULDER AND LEAD ROCK CLIMBERS

MAURIZIO FANCHINI,<sup>1</sup> FRÉDÉRIC VIOLETTE,<sup>2</sup> FRANCO M. IMPELLIZZERI,<sup>1,3</sup> AND NICOLA A. MAFFIULETTI<sup>2,3</sup>

27(2)/310-314

*Journal of Strength and Conditioning Research*

© 2013 National Strength and Conditioning Association



# ANTHROPOMETRIC AND STRENGTH CHARACTERISTICS OF WORLD-CLASS BOULDERERS

Michail L. Michailov<sup>1 (A,B,C,D,E,F)</sup>, Lubomir V. Mladenov<sup>2 (A,B,F)</sup>, Volker R. Schöffl<sup>3 (D,E,F)</sup>

## Medicina Sportiva

Med Sport 13 (4): 231–238, 2009

DOI: 10.2478/v10036-009-0036-z

Copyright © 2009 Medicina Sportiva

G. Köstermeyer  
J. Weineck

**Notwendigkeit des einfingerigen Trainings der Fingerbeugemuskelatur zur Leistungssteigerung im Sportklettern. Vergleich der Kraftentwicklung bei ein- und vierfingeriger Maximalkontraktion**

---

Necessity of one-finger-training for the increase of performance in climbing. Comparison of force development between one- and four-finger maximum voluntary contraction

---

DEUTSCHE ZEITSCHRIFT FÜR SPORTMEDIZIN

JÄHRGANG 46. Nr. 7/8 (1995)



# Arm positions during testing x climbing

## During testing

- 1. shoulder flexed at  $90^\circ$  (externally rotated or not) with an elbow flexed at  $90^\circ$
- 2. shoulder abducted at  $45^\circ$  and elbow flexed at  $90^\circ$
- 3. shoulder flexed at  $180^\circ$  and elbow fully extended

## During climbing

→ primary position of the arm when applying force on the hold is with the shoulder above  $90^\circ$  abduction or flexion!

# The aim of the study

The aim of the study was to evaluate the validity and reliability of 4 different arm positions for finger flexor strength measurement in sport climbers.

# Methods

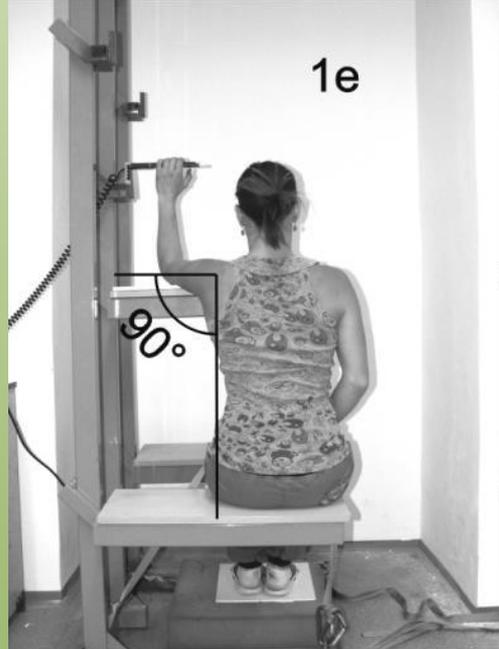
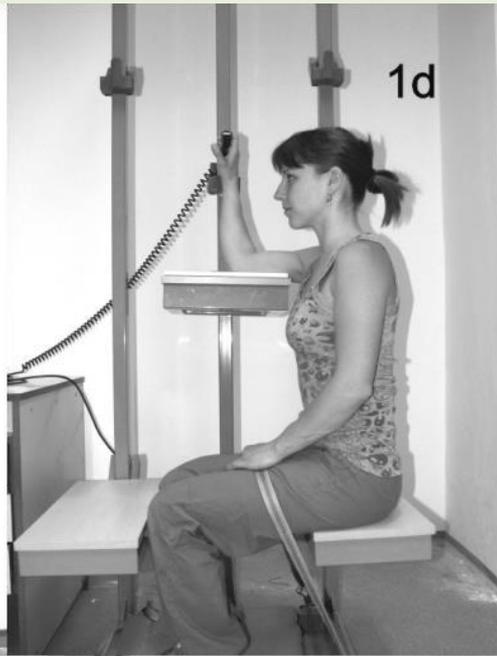
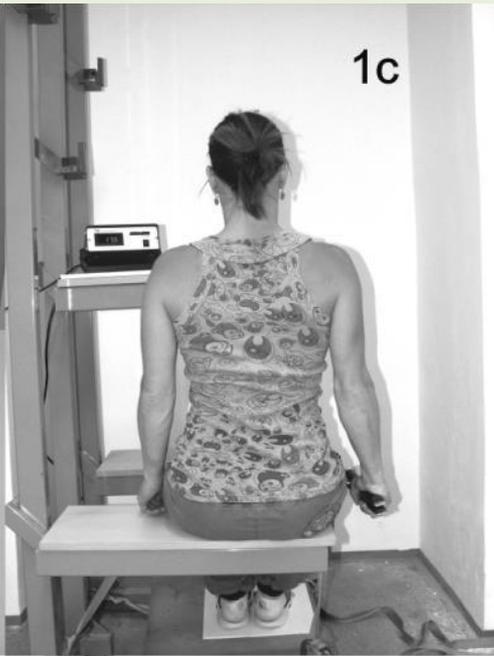
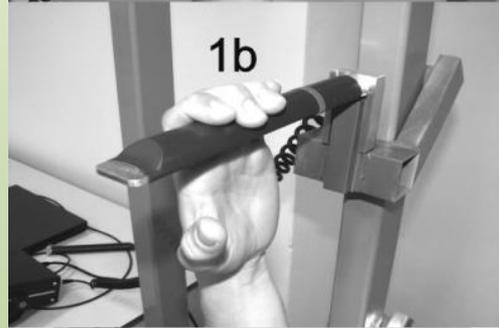
- 25 male and 21 female climbers with self reported RP between III and X+ on the UIAA scale
- climbers were divided according to their reported climbing grade from lower grade ( $\leq$  VI+ UIAA; 6a French scale; 5.10a YDS) to advanced climbers ( $>$  6+ UIAA)

- 11 lower grade **female** climbers ( $24.2 \pm 3.2$  years;  $61.5 \pm 8.3$  kg,  $167.2 \pm 5.2$  cm)
- 10 **female** advanced climbers ( $25.0 \pm 2.5$  years;  $57.2 \pm 8.6$  kg,  $165.6 \pm 7.3$  cm)
- 13 lower grade **male** climbers ( $25.5 \pm 3.5$  years;  $74.3 \pm 6.7$  kg,  $178.7 \pm 5.3$  cm)
- 12 advanced **male** climbers ( $28.4 \pm 6.7$  years;  $67.9 \pm 8.0$  kg,  $175.7 \pm 5.4$  cm)

## 4 different arm positions with other variables held constant

- the same finger position on the gauge
- sitting position
- randomly assigned arm position





# Statistical analysis

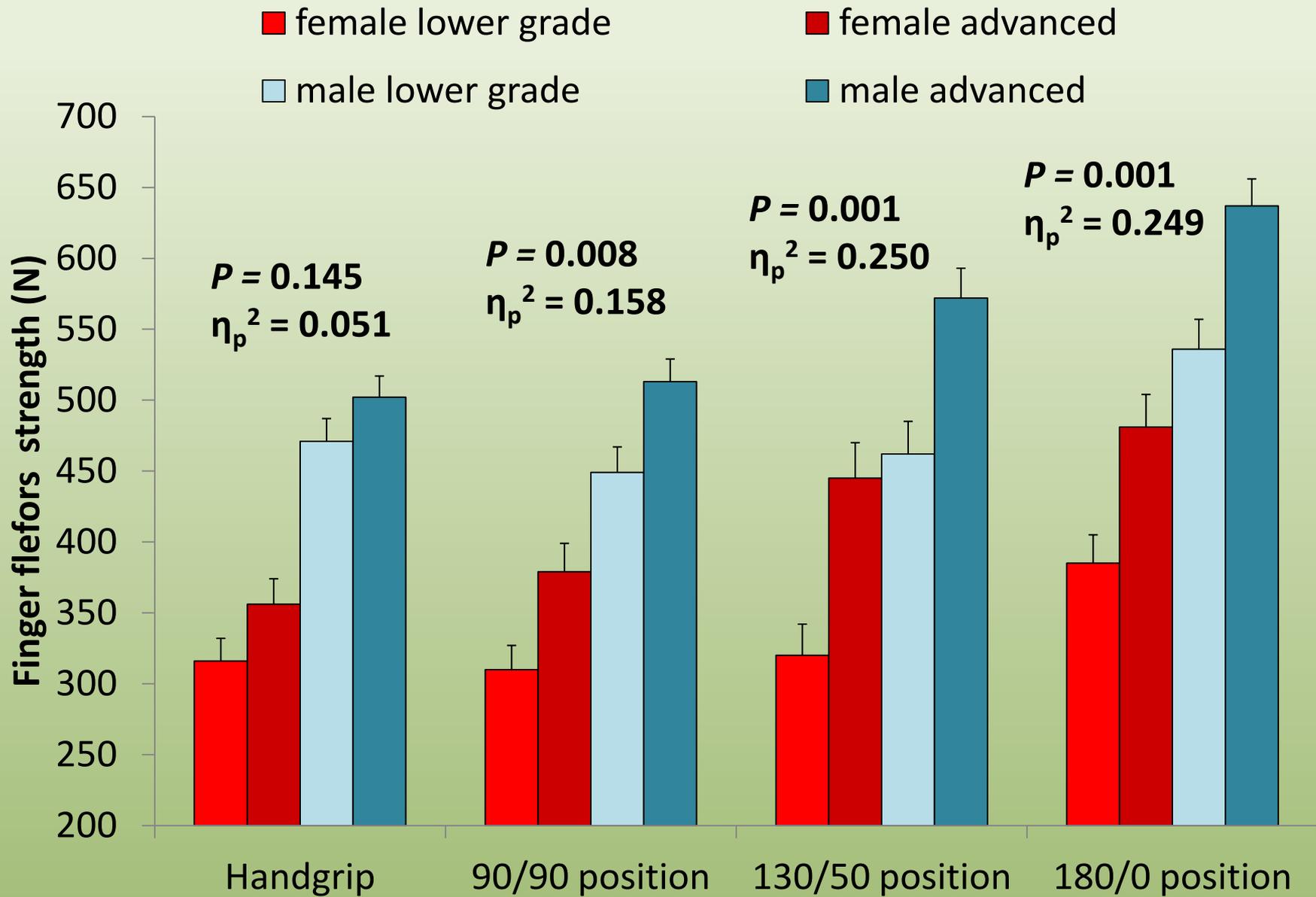
- The ICC was used to assess the intra-session reliability for all tests of the left and right hand.
- To assess the criterion related validity repeated analysis of covariance was used (4 x 2 x 2), with the arm position as a within subject factor, sex and climbing ability as between subject factors, and body mass as a covariate.

- Average values from all the test results of the left and right hands were analyzed.
- To control the effect of body mass on the strength results, the inclusion of body mass as a covariate was preferred, rather than standardizing the scores with regard to body mass.

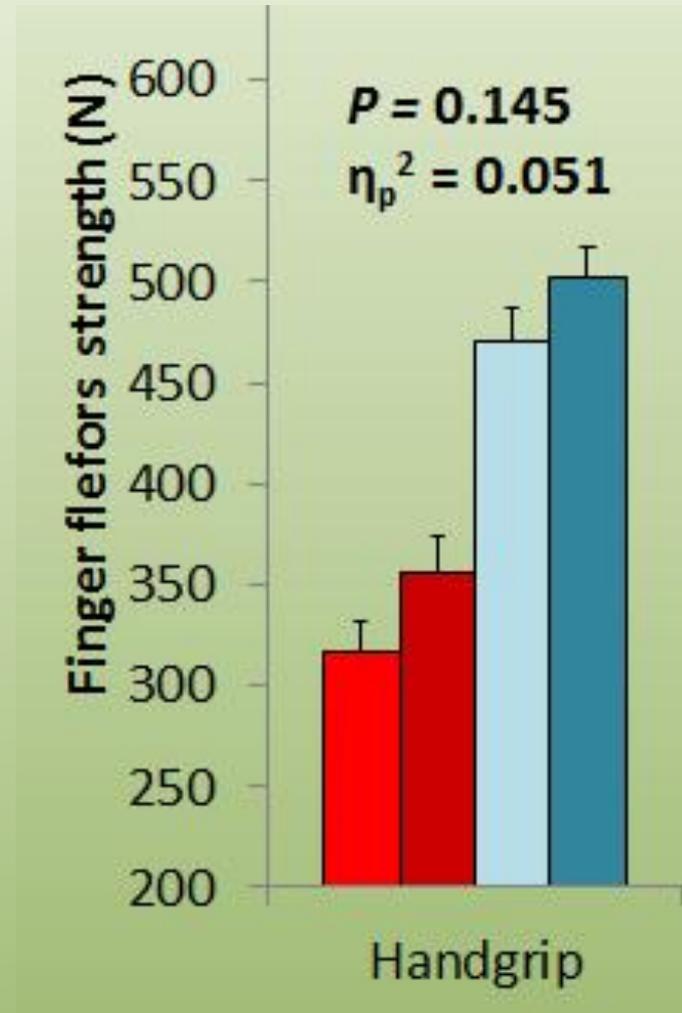
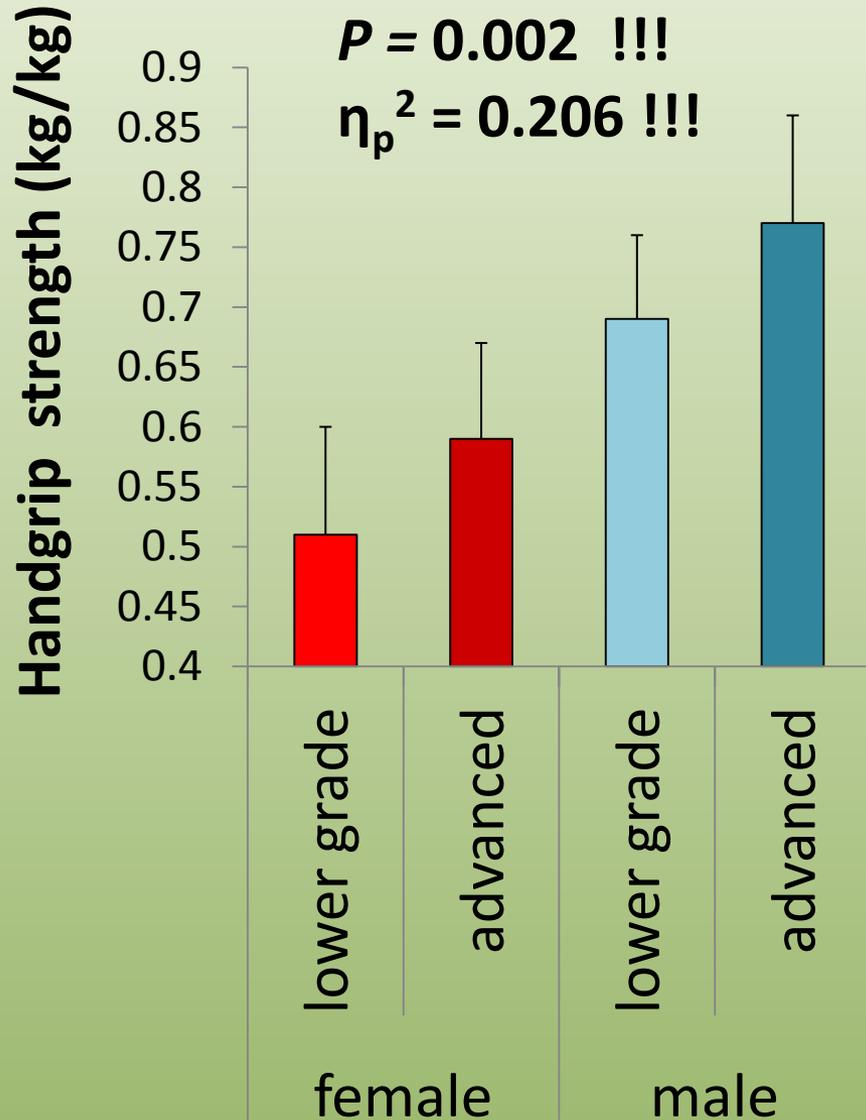
# Results

A high ICC was found for all positions:

- right hand (handgrip) 0.97; (90/90) 0.96; (130/50) 0.97; (180/0) 0.96;
- left hand (handgrip) 0.97; (90/90) 0.96; (130/50) 0.98; (180/0) 0.95.
- SEM ranging from 22-26 N



# Handgrip strength relatad to body

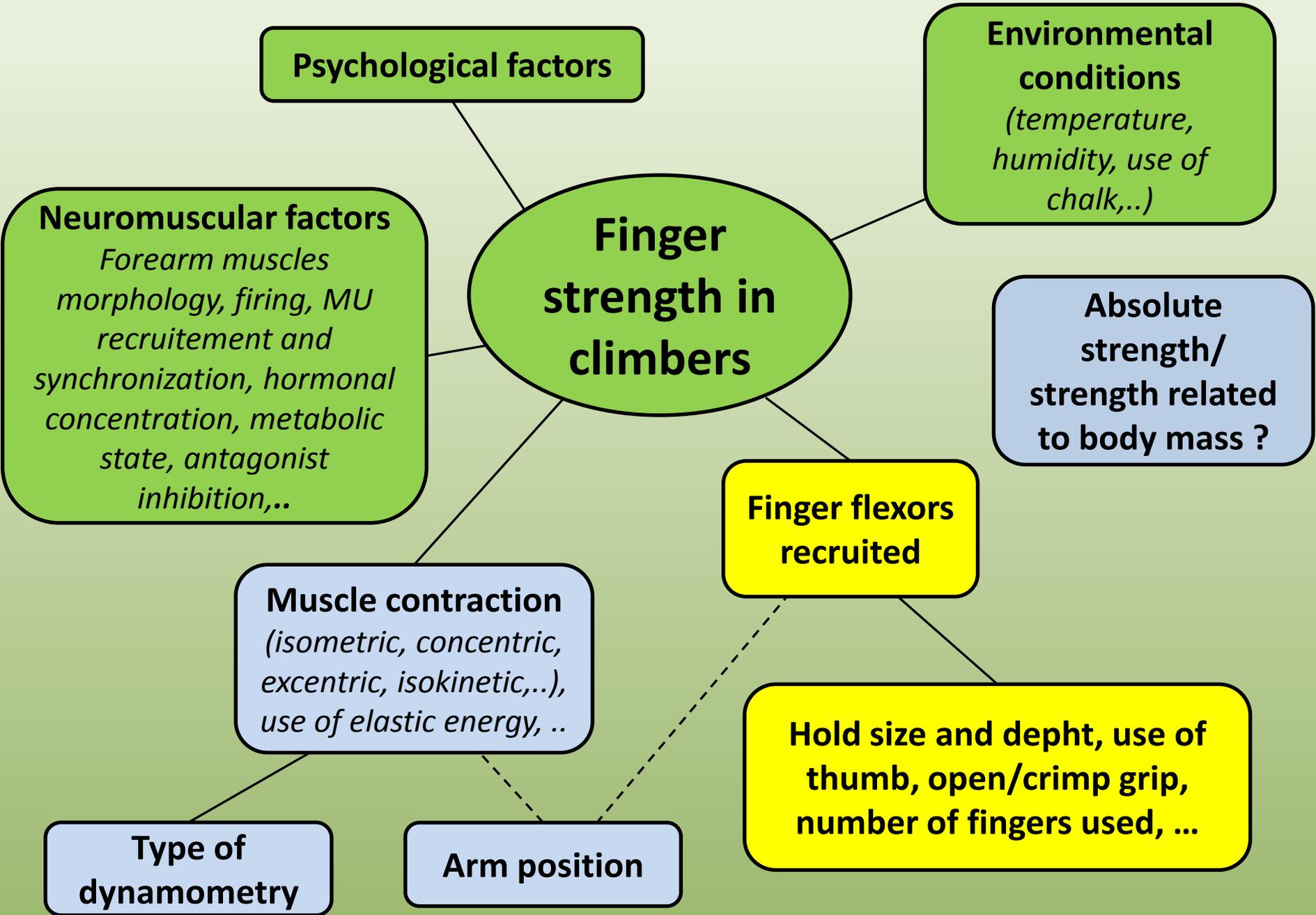


# Discussion

- Reasons of higher strength in different arm positions? (Watts et al., 2008)
- How to assess the effect of body mass on strength (ratio, linear regression, allometric scales?)
- Grouping design x correlation.
- Is the measurement valid also for top elite climbers?

# Conclusion

- The positions 180/0 and 130/50 were most suitable to assess finger flexor strength.
- The 90/90 position provided substantially less validity.
- The handgrip dynamometry had the lowest criterion validity from the proposed tests.
- The use of strength to body mass ratio might be problematic, as it increases the strength differences between ability groups with unequal body mass.



# **Finger flexors strength measurement using electronic scales in sport climbers**

Jiří Baláš, Jonáš Mrskoč, Michaela Panáčková,  
Nick Draper

# The aim of the study

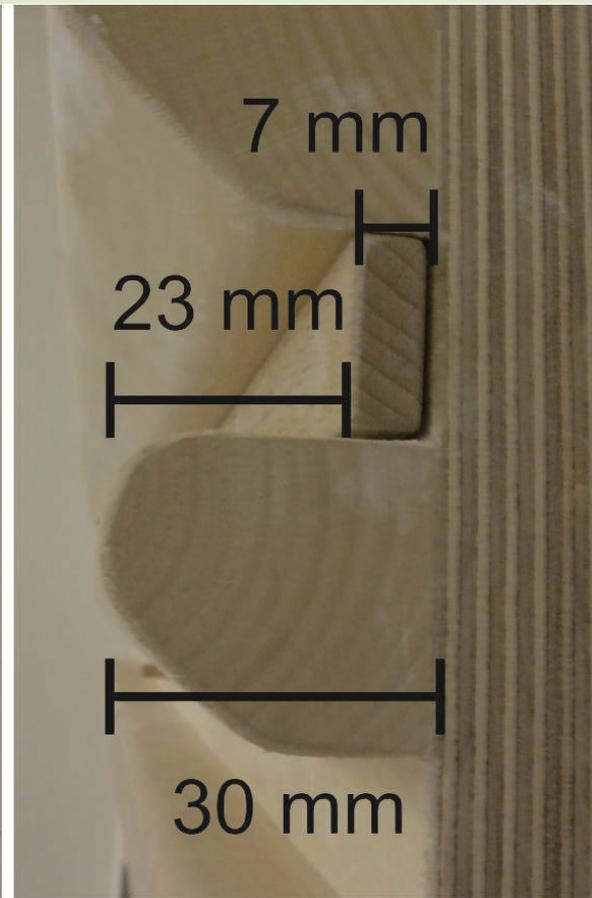
The aim of our study was to assess the validity and the reliability of four climbing grip positions during finger flexors strength measurement using electronic scales in sport climbers.

# Participants

- 55 climbers
- self-reported climbing abilities RP between 5 and 12- on the UIAA scale (4c - 9b+ French scale; 5.6 - 5.15c Yosemite decimal scale; 14 - 38 Ewbank scale)

Climbing ability group	Sex	Climbing ability RP (UIAA)	Age (years)	Body mass (kg)	Heigh (cm)
Lower grade	Male (N = 7)	IV to VI	25.9 ± 8.2	75.7 ± 8.5	176.6 ± 6.7
	Female (N = 8)	IV to VI	22.8 ± 2.9	58.9 ± 6.8	162.5 ± 4.4
Intermediate	Male (N = 10)	VI+ to VIII	25.8 ± 9.0	74.8 ± 4.8	178.1 ± 3.9
	Female (N = 7)	VI+ to VII+	29.5 ± 6.7	64.7 ± 10.7	168.7 ± 6.5
Advanced	Male (N = 10)	VIII+ to IX+/X-	24.1 ± 7.6	66.2 ± 8.3	173.9 ± 8.4
	Female (N = 5)	VIII- to IX	25.5 ± 4.1	55.2 ± 4.8	166.4 ± 5.7
Elite + high elite	Male (N = 5)	X- to XII-	24.0 ± 7.6	65.6 ± 4.9	178.0 ± 5.2
	Female (N = 2)	IX+ to X	16.9 ± 1.8	49.5 ± 2.1	165.0 ± 6.3

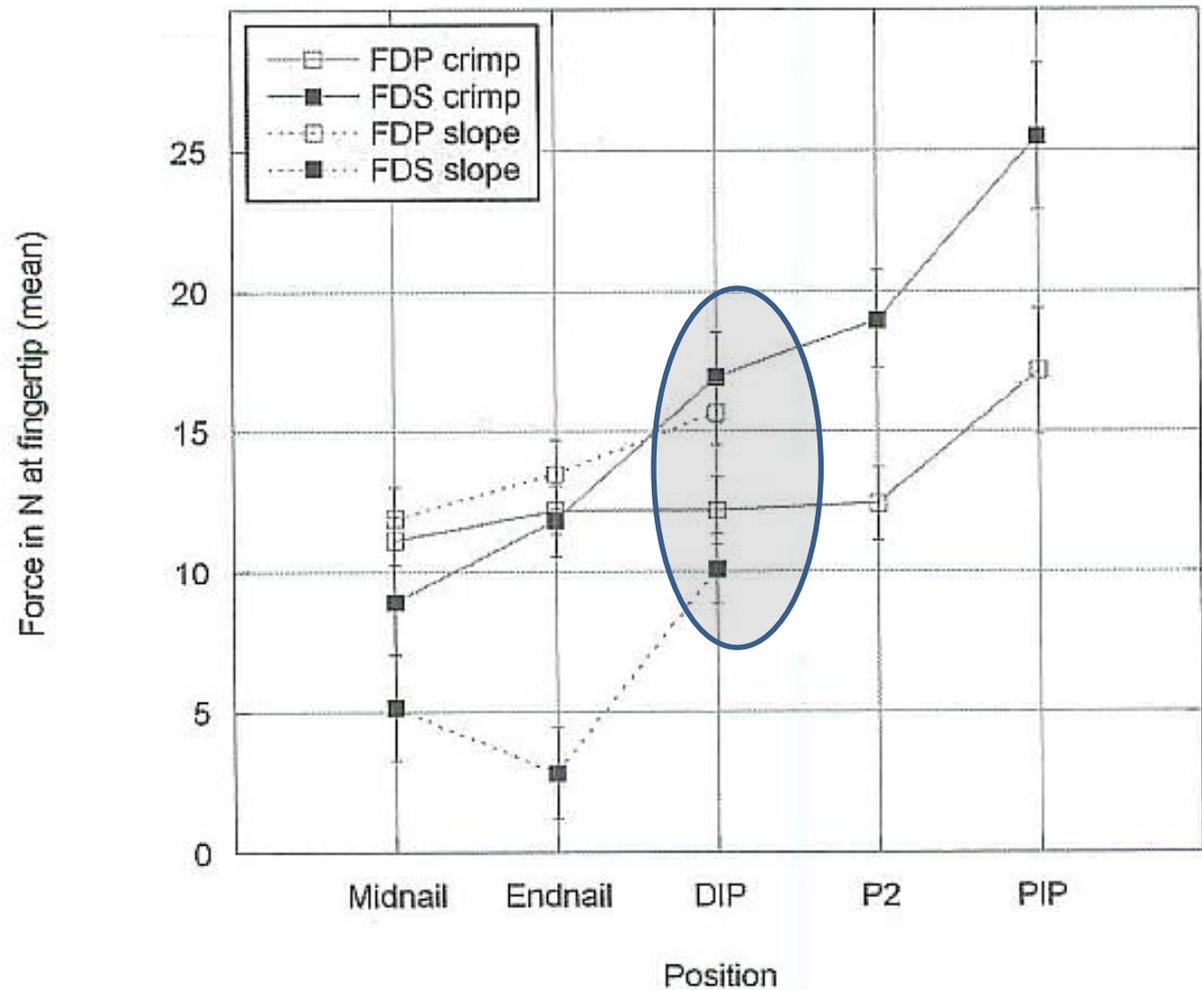
# Methods



# Kinetics of Crimp and Slope Grip in Rock Climbing

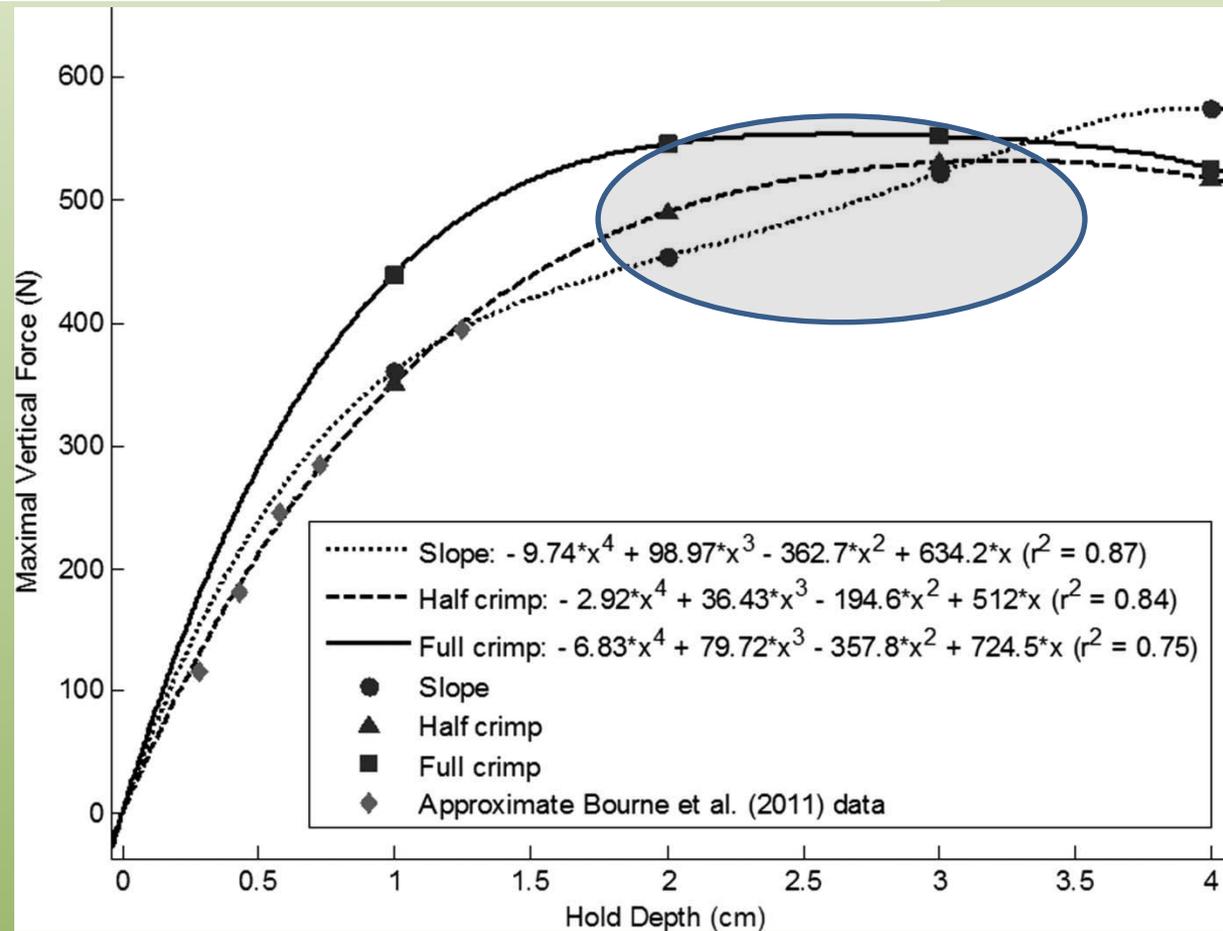
Andreas Schweizer and Robert Hudek

*Journal of Applied Biomechanics*, 2011, 27, 116-121  
© 2011 Human Kinetics, Inc.



## Effect of hold depth and grip technique on maximal finger forces in rock climbing

ARIF MITHAT AMCA<sup>1</sup>, LAURENT VIGOUROUX<sup>2</sup>, SERDAR ARITAN<sup>1</sup>, & ERIC BERTON<sup>2</sup>





# Reliability analysis

- The intra-session reliability or the consistency was analysed in all participants from 3 trials for the left and for the right hand.
- To assess the inter-session reliability, twelve climbers repeated the same measurement after 6-7 days. The mean scores from the first and from the second measurement were computed for the inter-session reliability.

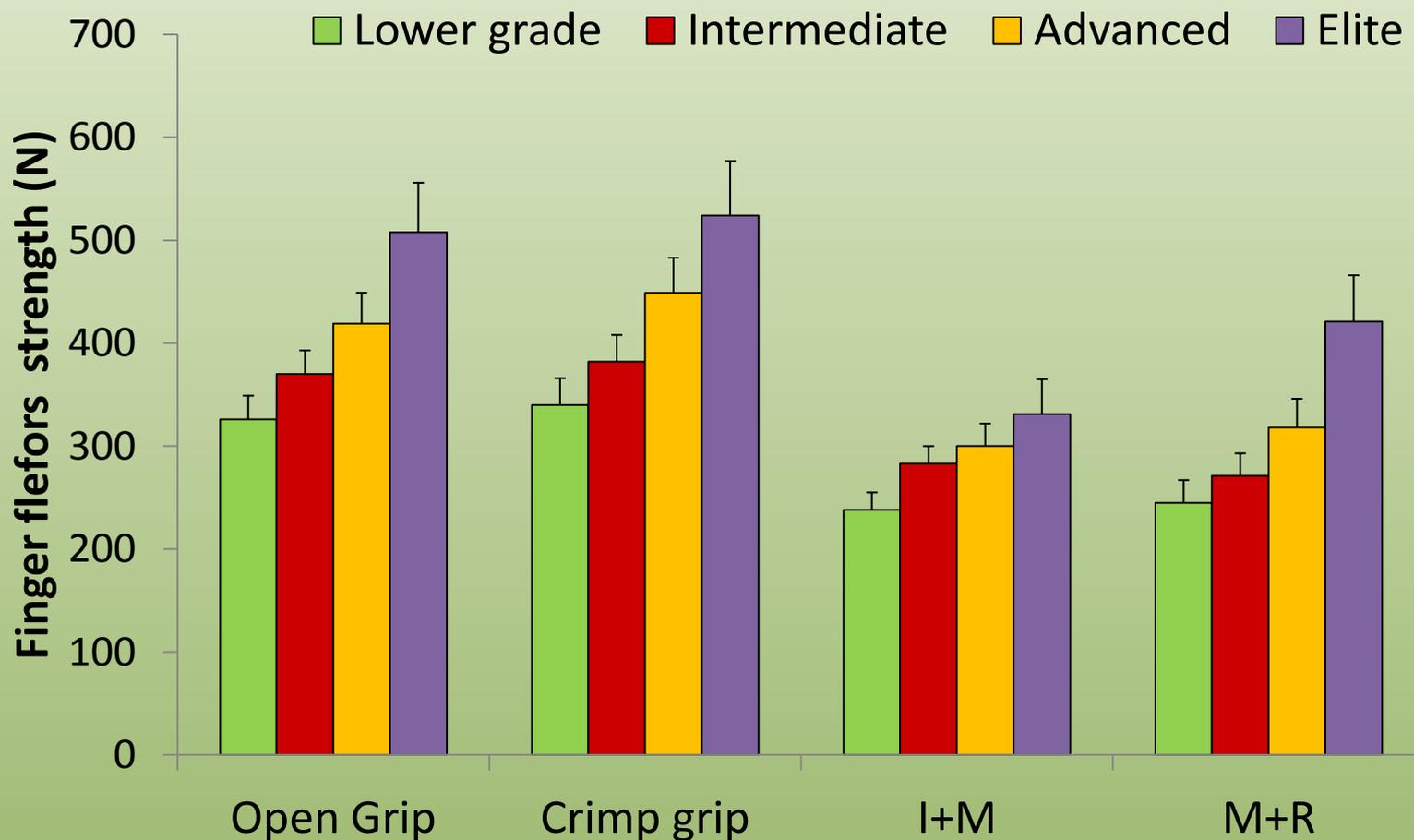
# Results - reliability

	Left hand			Right hand		
	Intra-session		Inter-session	Intra-session		Inter-session
	3 trials	2 trials	mean 3 trials	3 trials	2 trials	mean 3 trials
OG	0.94	0.93	0.90	0.93	0.93	0.94
CG	0.93	0.94	0.88	0.96	0.96	0.95
IM	0.95	0.93	0.88	0.91	0.88	0.91
MR	0.97	0.97	0.94	0.97	0.98	0.94

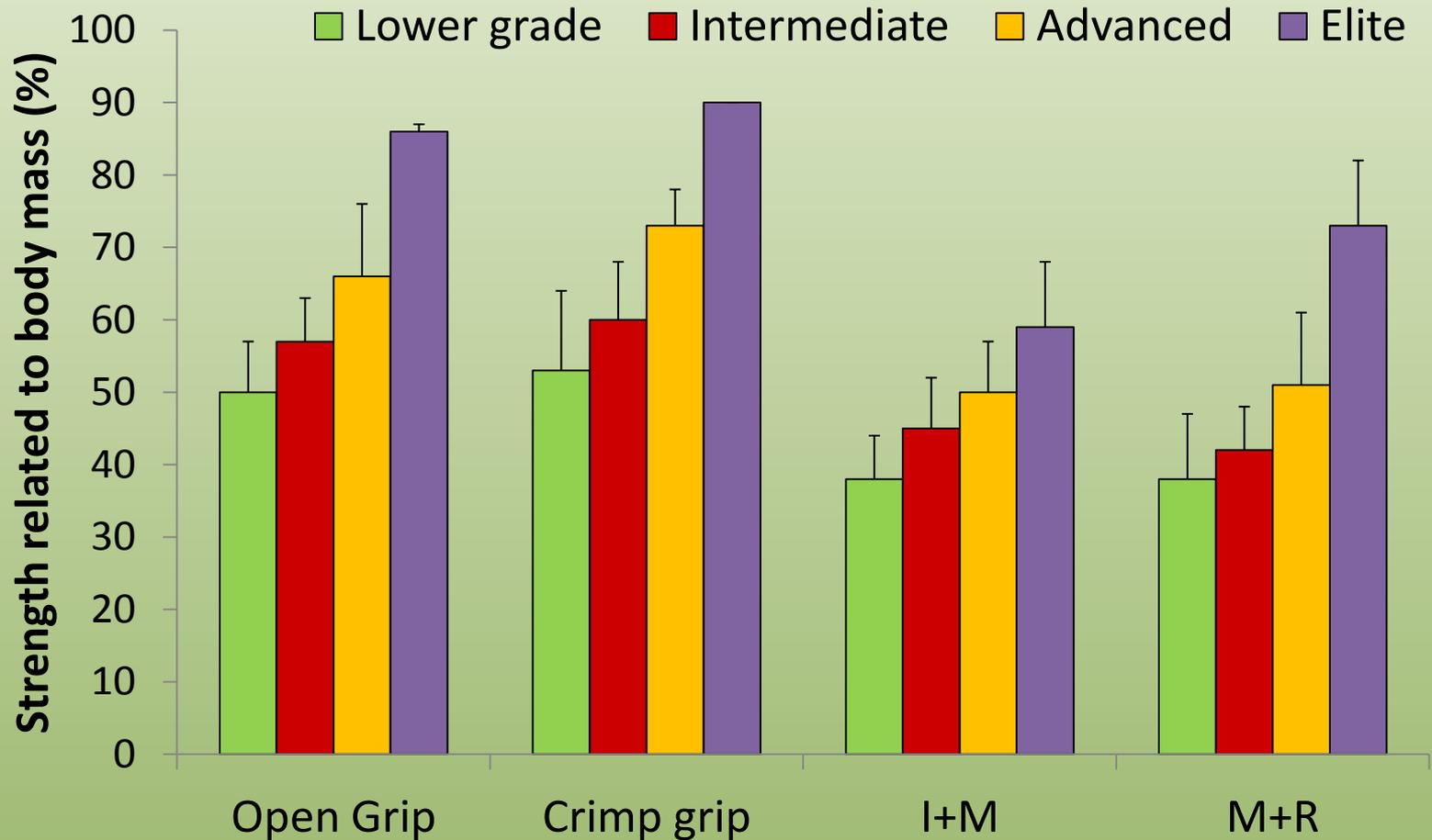
ANOVA results did not reveal a significant difference between 1-2, 2-3, 1-3 trials. **Two trials are sufficient, when testing maximal finger flexor strength.**

# Strength in females

## Effect of body mass corrected by ANCOVA

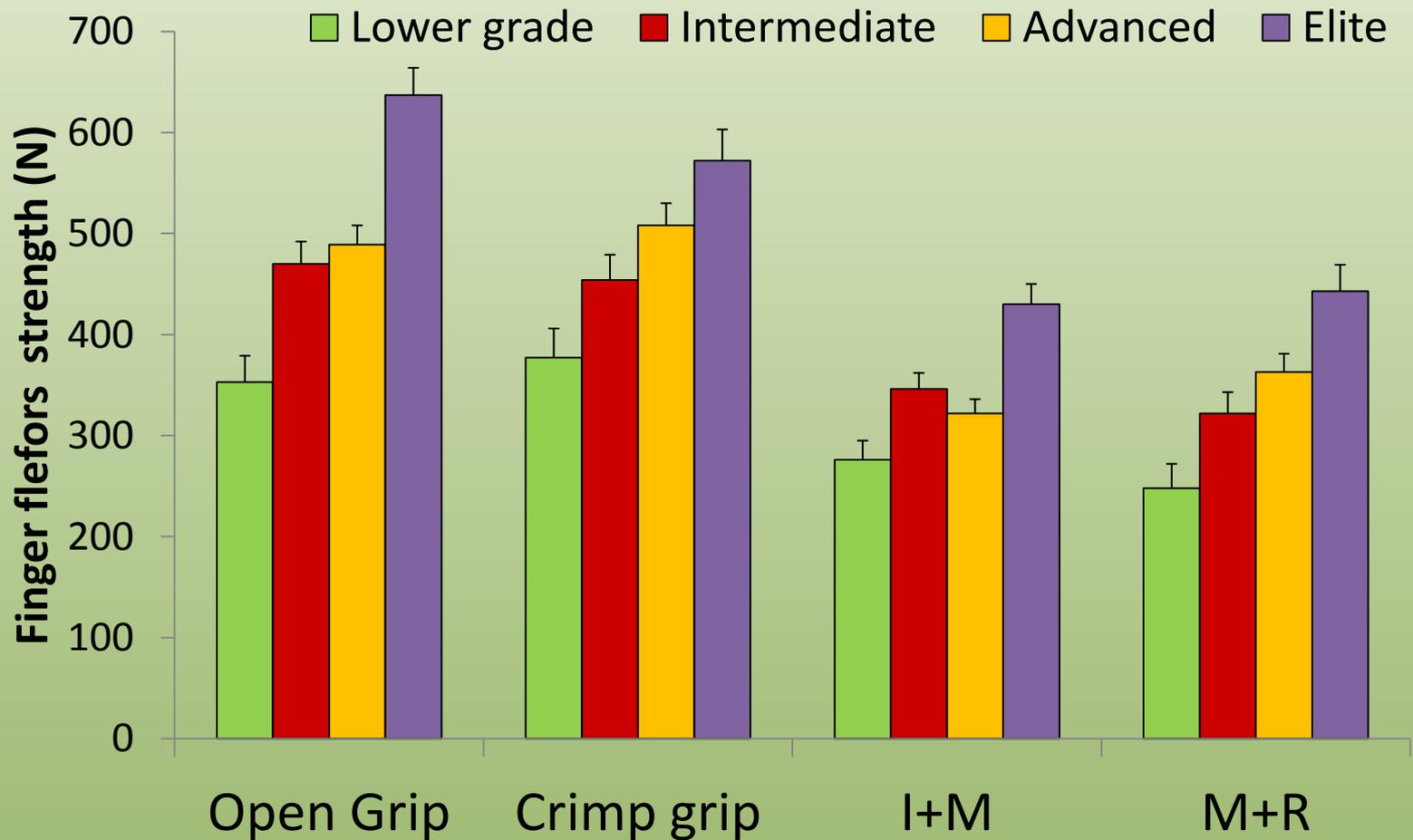


# Strength related to body mass in females

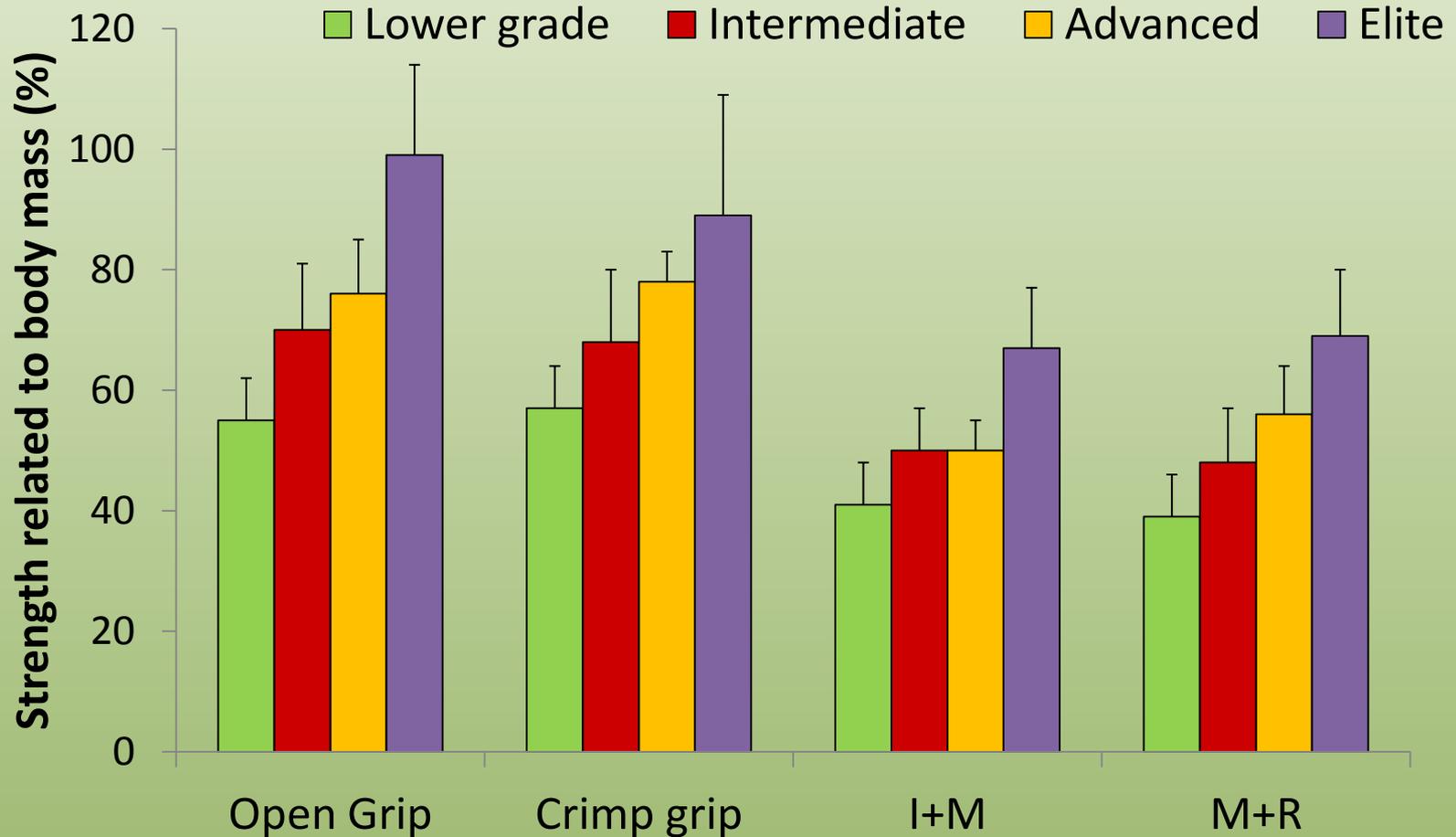


# Strength in males

## Effect of body mass corrected by ANCOVA



# Strength related to body mass in males



Bivariate (*in italic*) and partial correlations (**bold**) among climbing abilities (RP, OS) and finger strength

	RP	OS	OG	CG	IM	MR	Body mass
RP	1.000	<i>.968</i>	<i>.628</i>	<i>.625</i>	<i>.521</i>	<i>.636</i>	<i>-.131</i>
OS	<b>.968</b>	1.000	<i>.638</i>	<i>.648</i>	<i>.541</i>	<i>.647</i>	<i>-.121</i>
OG	<b>.806</b>	<b>.811</b>	1.000	<i>.908</i>	<i>.871</i>	<i>.847</i>	<i>.498</i>
CG	<b>.788</b>	<b>.808</b>	<b>.880</b>	1.000	<i>.823</i>	<i>.856</i>	<i>.476</i>
IM	<b>.677</b>	<b>.694</b>	<b>.830</b>	<b>.770</b>	1.000	<i>.860</i>	<i>.490</i>
MR	<b>.746</b>	<b>.753</b>	<b>.821</b>	<b>.831</b>	<b>.836</b>	1.000	<i>.375</i>

# Discussion

- The highest criterion validity was found for the 4-finger positions ( $R = 0.788 - 0.811$ ) to the RP or OS performance.
- Handgrip strength to OS performance
  - $R = 0.36$  in 16 elite climbers (España-Romero et al., 2009);
  - $R = 0.57$  handgrip strength + % fat in 39 World-Cup climbers (Watts et al., 1993)
  - $R = 0.55$  in 136 males;
  - $R = 0.75$  in 69 females (Baláš et al., 2012)

- Crimp x open grip; half crimp grip?
- The strongest position in intermediate and elite male climbers was OG followed by CG. This finding is in discrepancy with the Schweizer and Hudek (2011) who found that a crimp grip generated more flexion moment than an open grip independently on the size of the hold.

# Disadvantage of strength measurement on scales in standing position

- You cannot properly analyze rate of force development.
- You have to put additional weight on strong climbers.
- You have to carefully control the slow execution of strength measurement.

# Conclusion

- The use of a climbing fingers board and digital scales appears to represent a relatively inexpensive, straightforward, reliable and valid method to assess climbing-specific finger strength using different grip positions.
- The open grip and crimp grip were found most specific to the self-reported climbing performance.