EMG ACTIVITIES OF THE SHOULDER MUSCLES DURING A SIMULATED DOWNHILL COMPARED TO DYNAMIC SHOULDER EXERCISES

– A CROSS-SECTIONAL STUDY

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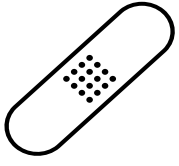
Background

Clavicular fractures and **glenohumeral dislocations** are the most common injuries in mountain biking (Goldstein et al., 2016)

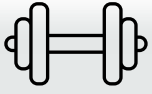


They can result in a **reduction of the previous level of sportive activity**

(Weber et al., 2019, De Carli et al., 2019)

Study Aim

- **Muscular activities** of the upper extremity muscles
- **Rehabilitation protocols** for mountain bikers (Ma et al., 2017)
- **Return to biking** criteria



EMG activity

shoulder exercises

Similar?

EMG activity

simulated downhill

Anterior deltoid Middle deltoid Posterior deltoid Pectoralis major

Methods

OVERVIEW

Cross-sectional

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Winterthur

- 18-50 years
- Recreational mountainbikers
- No ongoing injuries

12 participants

6 ♀ / 6 ♂

28.2 ± 6 years

173 ± 9.5 cm

Methods

MEASUREMENT PROTOCOL

Bear Hug

- 2, 3 & 4 kg
- 3 rep. à 6 sec.

Wall Push

- 3 rep. à 6 sec.

Bike Simulator

- 18 sec.

Maximum voluntary isometric contraction (MVIC) Tests

(Boettcher et al., 2008)

Methods

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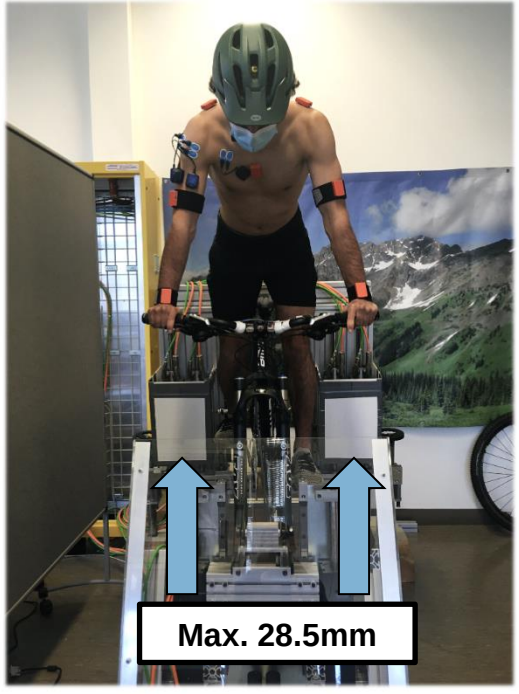
BIKE SIMULATOR




BMC

Methods

MEASUREMENTS

Surface Electromyography

Wireless superficial EMG Myon 320 Electromyography System
(myon AG, Kloten, Switzerland)

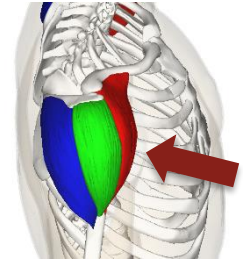
- Deltoid (anterior, middle, posterior)
- Pectoralis major

→ Sensor placement accordingly to SENIAM

Normalized EMG values (%MVIC)

- Peak activity = 95th percentile
- Average activity = median

Results



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ANTERIOR DELTOID

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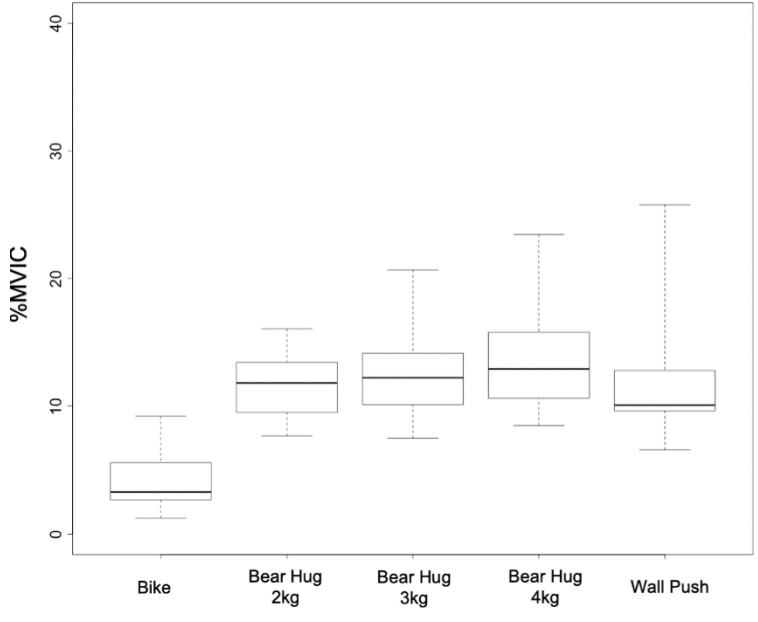

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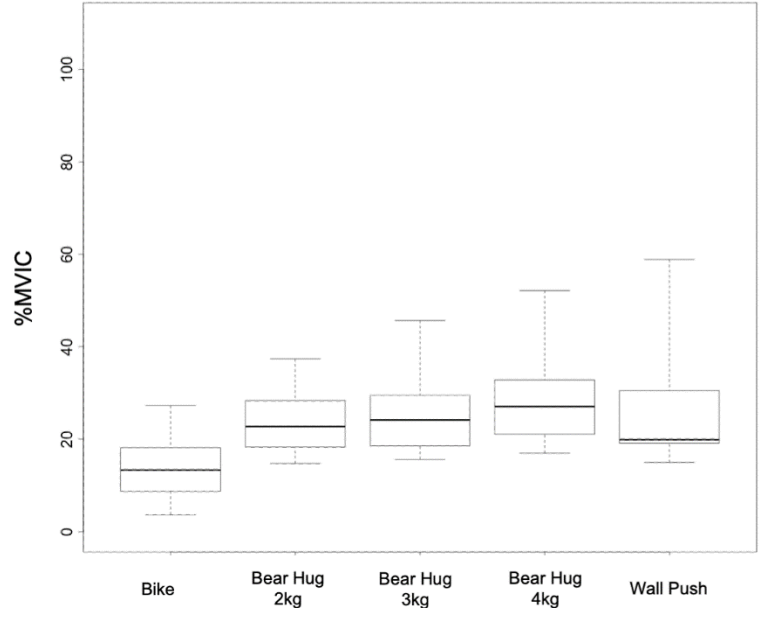
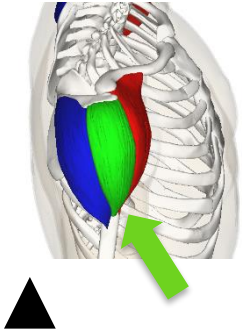


Results



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MIDDLE DELTOID

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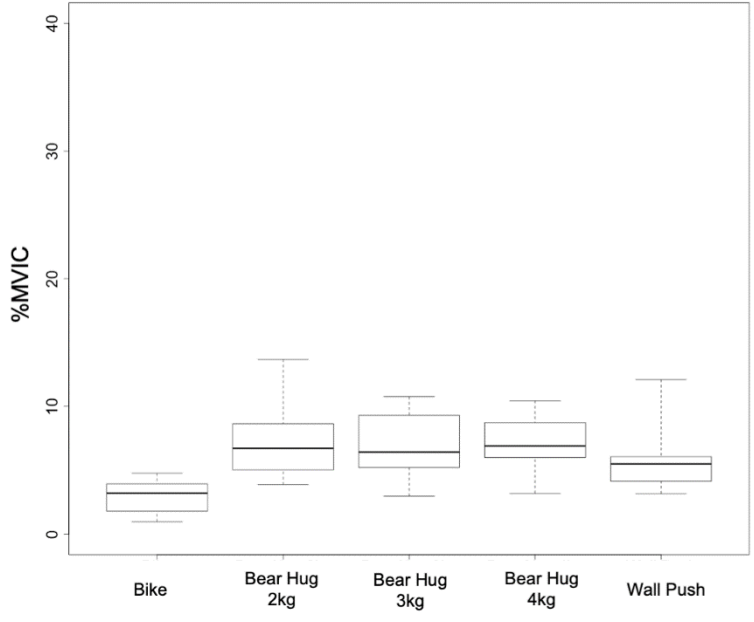

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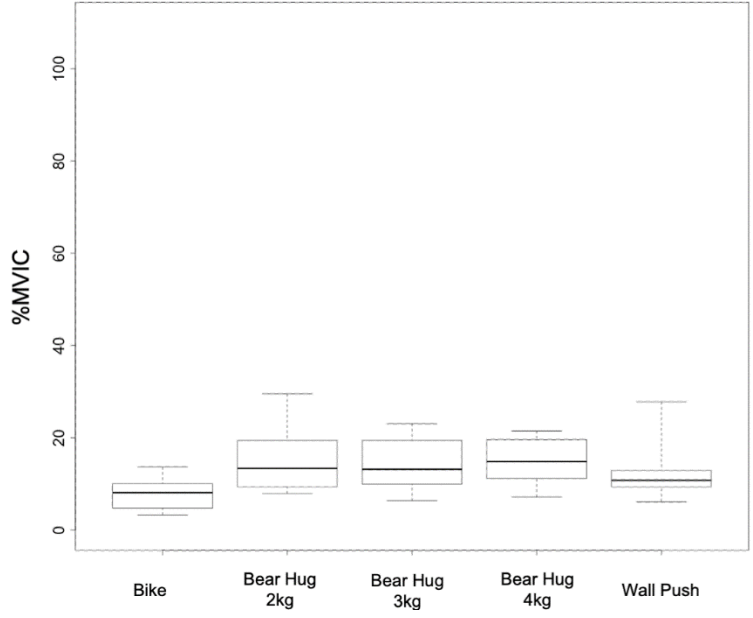
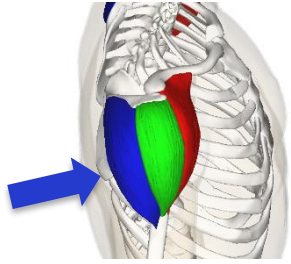


Results



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POSTERIOR DELTOID

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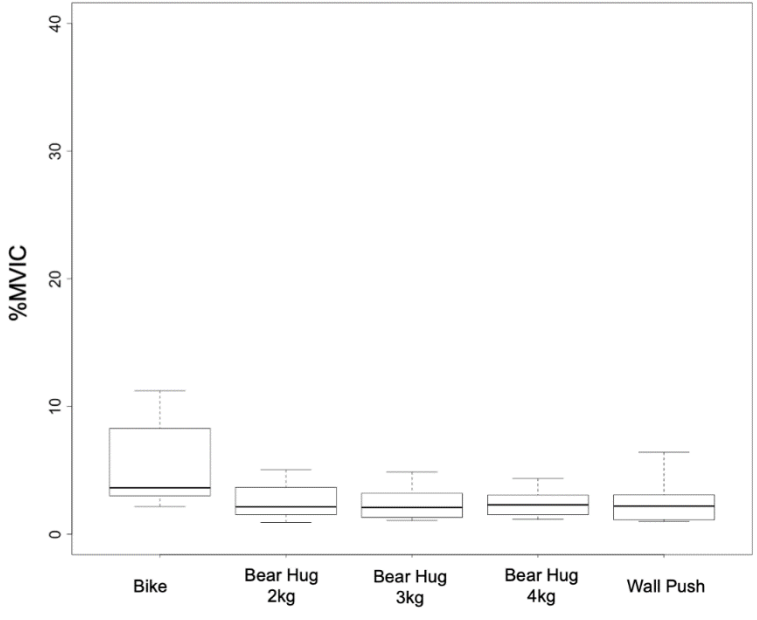

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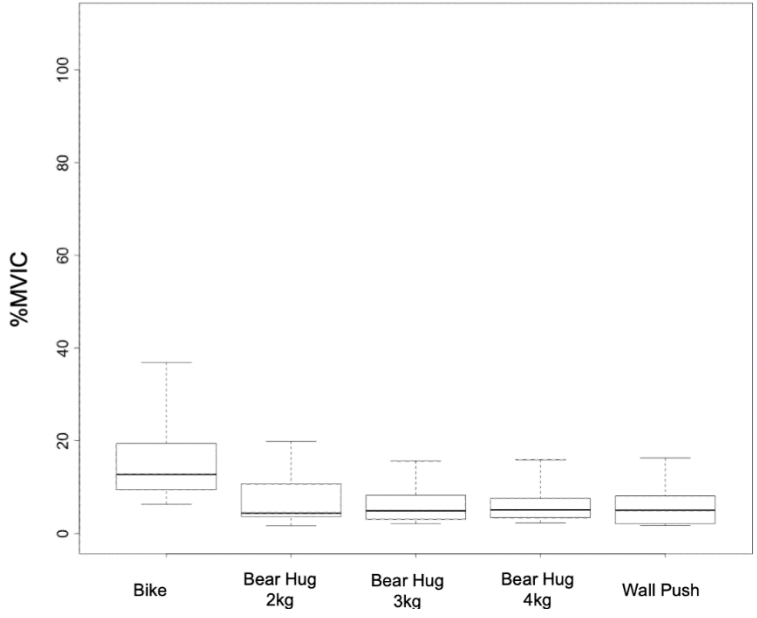
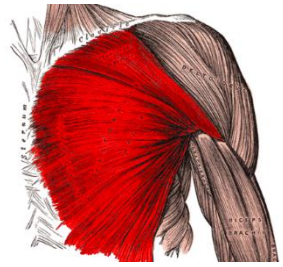


Results



PECTORALIS MAJOR

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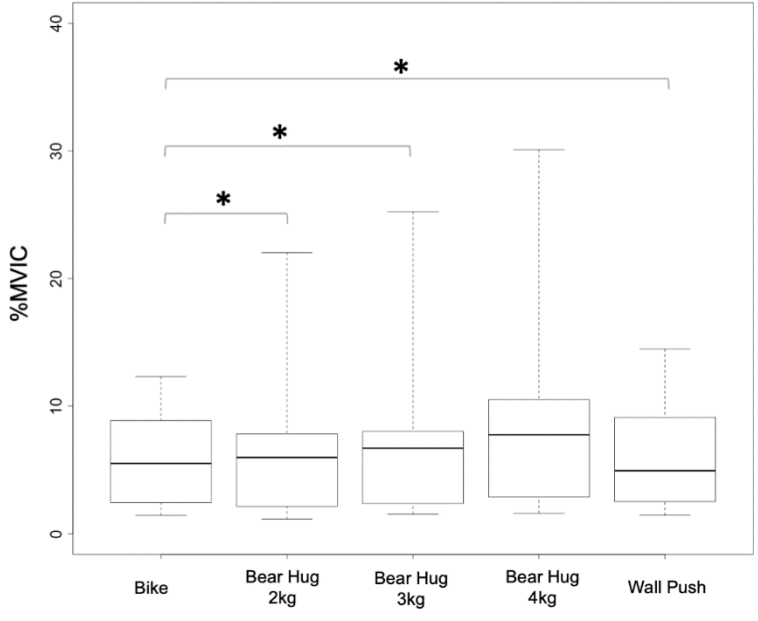

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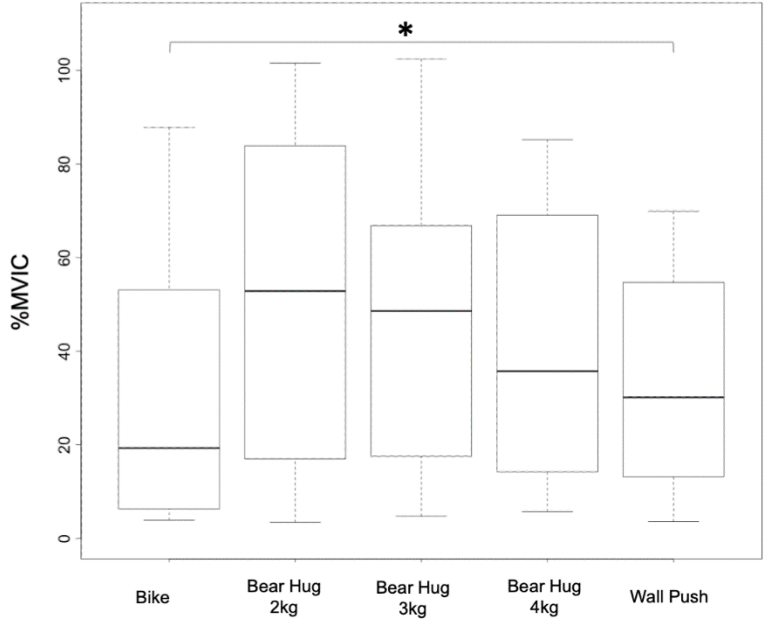
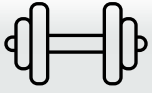


Discussion

KEY FINDINGS



EMG activity
shoulder exercises

Pectoralis major

EMG activity
simulated downhill

Bear Hug 2kg	⌀	
Bear Hug 3kg	⌀	
Wall Push	⌀	▲

Discussion

LIMITATIONS

Simulator can only simulate small bumps, but not lateral sways (Duc et al., 2008, Hurst et al., 2017)

!

Small bumps could not be anticipated visually

Conclusion

TAKE HOME MESSAGE

The **Bear Hug** and **Wall Push** might be used as a part of the rehabilitation process to prepare the **anterior and middle deltoid and the pectoralis major** for the return to biking on easy downhill trails.

! Results refer to a laboratory investigation without the influence of other factors than ground unevenness.

Conclusion

OUTLOOK

Joint loading and the influence of the rotator cuff have to be investigated further.

Field-testing is necessary to include all factors that go along with biking and to validate the laboratory setting.

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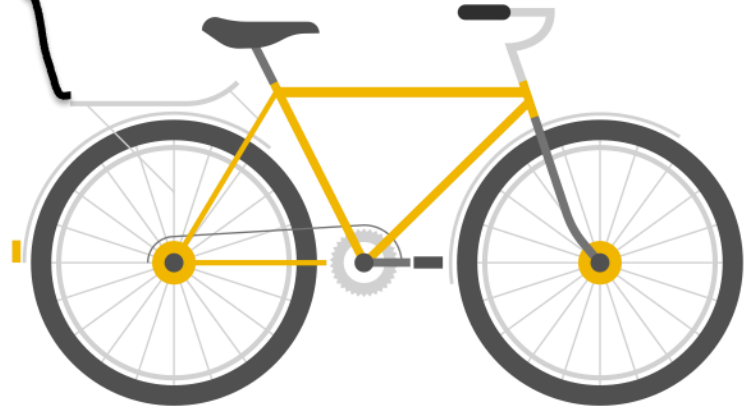
Thank you!



Methods

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DYNAMIC SHOULDER EXERCISES

Bear Hug

Wall Push

Methods

MVIC TESTS

- 90° scaption
- 90° shoulder internal rotation
- elbow extended
- belt around wrist
- isometric elevation

- 125° shoulder anteversion
- neutral rotation
- elbow extended
- belt around wrist
- isometric elevation

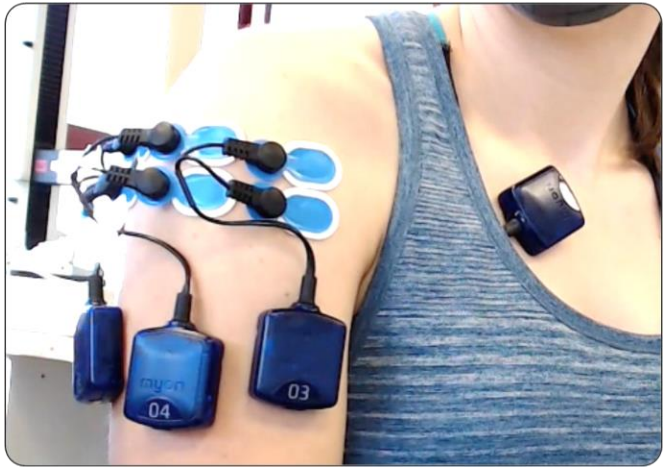
- 90° scaption
- 90° elbow flexion
- hands with neutral rotation on a table
- palms pressing down at the table

- 90° shoulder anteversion
- 25° elbow flexion
- palms pressing against each other

(Boettcher et al., 2008)

Methods

SENSOR PLACEMENT EMG



Methods

SENSOR PLACEMENT XSENS

Exemplary presentation of sensor placement

https://shop.xsens.com/SiteFiles/temp/2ea637d74819e0d96c7e5b1cb4ea2fb2-800x800.png

Methods

DATA PROCESSING

Surface Electromyography

- Sampling rate: 2000Hz
- A/D-converted (NI USB-6210, 16-Bit, 250 kS/s, National Instruments®, Austin, TX)
- Rectification
- Root Mean Square (20ms)
- Butterworth low pass (400Hz) and high pass (10Hz) filters of 2nd order

Shoulder Angle Measurement

- System calibration using “T-Pose”
- Euler-sequence XZY
- Conversion in MATLAB (v 9.6.0 (R2019a), The MathWorks Inc., Natick, MA)

Methods

STATISTICAL ANALYSIS

Non-parametric version if data was not normally distributed (Mara & Cribbie, 2012)

EMG activity shoulder exercises

Similar?

EMG activity simulated downhill

$H0_1 = \triangle > +0.8$ SD

$H0_2 = \triangle < -0.8$ SD

$H1 = -0.8$ SD $< \triangle < +0.8$ SD

Methods

STATISTICAL ANALYSIS

$$t_1 = \frac{\frac{1}{n}\sum_{i=1}^{n} pect.bike_i - \frac{1}{n}\sum_{i=1}^{n} pect.wp_i - 0.8SD}{\frac{S_{Diff}}{\sqrt{n-1}}}$$

$$t_2 = \frac{\frac{1}{n}\sum_{i=1}^{n} pect.bike_i - \frac{1}{n}\sum_{i=1}^{n} pect.wp_i - (-0.8SD)}{\frac{S_{Diff}}{\sqrt{n-1}}}$$

Methods

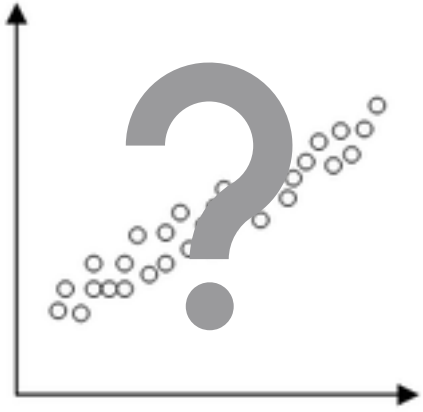
STATISTICAL ANALYSIS

$$z_1 = \frac{sr_1 - \left(\frac{N(N+1)}{4}\right)}{\sqrt{\frac{N(N+1)(2N+1)}{24}}}$$

$$z_2 = \frac{sr_2 - \left(\frac{N(N+1)}{4}\right)}{\sqrt{\frac{N(N+1)(2N+1)}{24}}}$$

Methods

STATISTICAL ANALYSIS



Correlation coefficient ‘r’

|r|	≤.29	low
	.3 to .49	medium
	≥.5	high

(Cohen, 1988)

Results

	Condition	ΔBike	90% CI	Raw Equivalence Bounds	p-value
Average			Anterior Deltoid		
	Bear Hug 2kg	-7.40	-8.93, -5.87	±2.36	1.000
	Bear Hug 3kg	-8.18	-10.05, -6.32	±2.88	1.000
	Bear Hug 4kg	-9.30	-11.32, -7.29	±3.11	1.000
	Wall Push	*-7.31*	*-8.92, -6.40*	*±4.05*	*.992*
Peak					
	Bear Hug 2kg	-9.46	-13.01, -5.90	±5.49	.965
	Bear Hug 3kg	-11.67	-16.04, -7.29	±6.75	.966
	Bear Hug 4kg	-14.34	-18.75, -9.92	±6.81	.995
	Wall Push	*-11.93*	*-16.25, -5.51*	*±9.99*	*.788*

Results

Average			Middle Deltoid		
	Bear Hug 2kg	-4.25	-5.59, -2.91	±2.07	.993
	Bear Hug 3kg	-3.98	-5.08, -2.88	±1.70	.998
	Bear Hug 4kg	-4.25	-5.15, -3.34	±1.40	1.000
	Wall Push	*-2.25*	*-4.89, -1.15*	*±2.04*	*.849*
Peak					
	Bear Hug 2kg	-7.00	-10.18, -3.83	±4.90	.870
	Bear Hug 3kg	-6.50	-9.04, -3.97	±3.91	.953
	Bear Hug 4kg	-7.10	-9.29, -4.90	±3.39	.994
	Wall Push	*-3.53*	*-7.16, 0.08*	*±5.01*	*.311*

Results

Average			Posterior Deltoid		
	Bear Hug 2kg	*1.54*	*0.76, 5.05*	*±2.37*	*.575*
	Bear Hug 3kg	*2.00*	*0.77, 5.02*	*±2.31*	*.715*
	Bear Hug 4kg	*1.83*	*0.51, 5.53*	*±2.43*	*.689*
	Wall Push	*1.78*	*1.06, 6.66*	*±3.00*	*.367*
Peak					
	Bear Hug 2kg	*6.00*	*1.50, 15.10*	*±8.62*	*.311*
	Bear Hug 3kg	*6.89*	*4.17, 14.94*	*±7.38*	*.605*
	Bear Hug 4kg	*7.37*	*3.97, 15.33*	*±7.47*	*.633*
	Wall Push	*6.11*	*4.39, 13.90*	*±8.47*	*.485*

Results

Average			Pectoralis major		
	Bear Hug 2kg	*1.02*	*-3.11, 3.47*	*±4.47*	*.017**
	Bear Hug 3kg	*0.85*	*-4.66, 3.09*	*±6.10*	*.021**
	Bear Hug 4kg	*-0.09*	*-7.94, 1.83*	*±6.52*	*.117*
	Wall Push	-0.01	-2.61, 2.57	±3.99	.009*
Peak					
	Bear Hug 2kg	*-3.09*	*-62.31, 5.60*	*±27.50*	*.367*
	Bear Hug 3kg	*-1.86*	*-72.63, 6.68*	*±31.93*	*.212*
	Bear Hug 4kg	*-2.93*	*-71.65, 6.07*	*±33.57*	*.117*
	Wall Push	*-4.22*	*-12.01, 7.21*	*±11.05*	*.032**

Results

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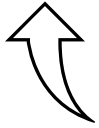
CORRELATION

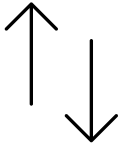
Muscle	Average sEMG (%MVIC) (min/max)	r	p-value	95%CI
Anterior Deltoid	3.29 (1.24-9.22)	-.049	.886	-.606, .540
Middle Deltoid	3.21 (0.98-4.78)	.098	.761	-.504, .636
Posterior Deltoid	3.63 (2.17-11.24)	.084	.795	-.568, .730
Pectoralis Major	5.52 (1.45-12.32)	.203	.528	-.420, .696

Discussion

CHOICE OF DYNAMIC SHOULDER EXERCISES



„Free-moving“ character of Bear Hug vs. weightbearing during a bike ride



Concentric work during the exercises but not on the bike

Higher EMG activities during concentric work (Decker et al., 2003)

Literature

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