HIIT-harjoittelun vaikutukset suorituskykyyn kamppailu-urheilijoilla – case 10 päivän jakso miesjudokoilla

Master's Thesis in Sport Coaching and Fitness Faculty of Sport and Health Sciences

University of Jyväskylä

Jaana Jokinen

Introduction

JUDO has high-intensity intermittent efforts but also technique and tactics influence on competitive performance

High physiological demands, a lot of training and competitions and weight-loss procedures, it is difficult to optimize training periods between competitions

HIIT block training is an efficient way to develop physical performance

shorter training periods: focus on developing 1-2 chosen physical abilities.

The purpose of this study: examine the effect of HIIT according to block periodization on physical performance levels in male judo athletes.

In addition, how other judo performance levels can be maintained during a mesocycle.

Block periodization

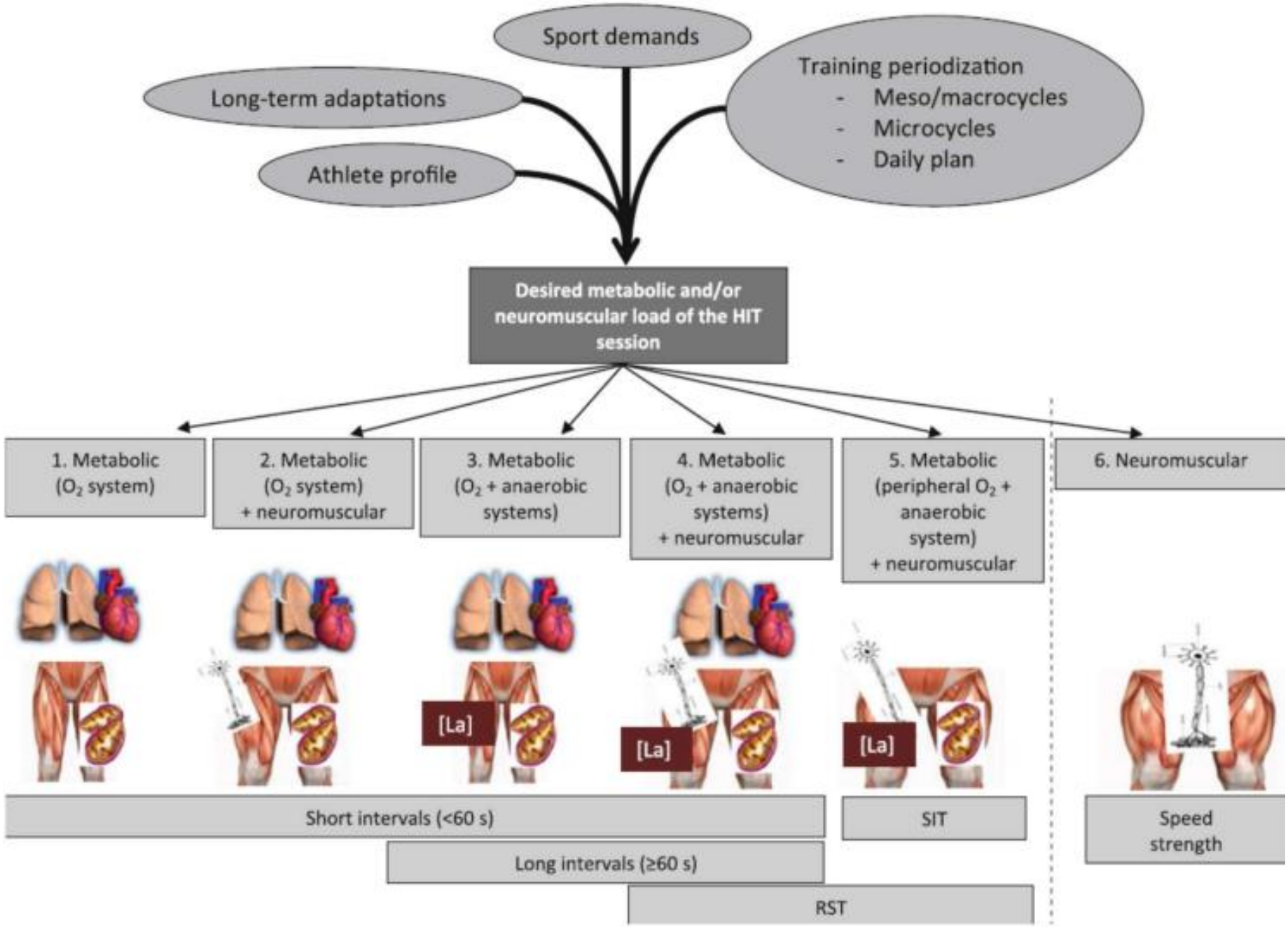
- Accumulation – muscular strength, basic aerobic endurance and general coordination; high volume and reduced (medium) intensity of workload for 2-6 weeks
- Transmutation - sport-specific abilities like special (aerobic-anaerobic or glycolytic) endurance, strength endurance and individual technical and tactical skills during competition-like training; 2-4 weeks
- Realization - tapering to gradually reduce training volume aiming to facilitate the recovery processes and maximize performance for competition; 8-15 days
- Competition

Motor ability	Residual Duration days	Physiological background
Aerobic endurance	30 +/-5	Increased amount pf aerobic enzymes. Number of mitochondria. Muscle capillaries. Hemoglobin capacity. Glycogen storage and higher rate of fat metabolism.
Maximal strength	30 +/-5	Improvement of neural mechanism and muscle hypertrophy due mainly to muscle fiber enlargement.
Anaerobic glycolytic endurance	18 +/-4	Increased number of anaerobic enzymes. Buffering capacity and glycogen storage and higher possibility of lactate accumulation.
Strength endurance	15 +/-5	Muscle hypertrophy mainly in slow-twitch fibres, improved aerobic-anaerobic enzymes. Better local blood circulation and lactic acid tolerance.
Maximal speed (alactic)	5 +/-3	Improved neuromuscular interactions and phosphocreatine storage.

Issurin 2008

High-intensity interval training (HIIT)

- repeated short (15-45 s) to long (2-4 min) bouts with recovery periods
- “all -out” sprints with extra intense work
  - repeated-sprint training (RST) several supramaximal sprints 3-10 s with less than 60 s recovery periods
  - sprint interval training (SIT) with 30-45 s “all-out” efforts interspersed with 2–4 min inactive recovery
    (also referred as speed endurance training)



Buchheit & Laursen 2013

Methods

- Subjects
  - Nine healthy male judo athletes (mean ±SD: 21.6 ±4.5 years; height 1.77 ±0.05 m and body mass 77.6 ±9.6 kg)
  - compete at least at the Nordic level participated voluntary to this study
  - All athletes had over 5 years of judo training experience and they were familiar with high-intensity interval training protocols

Experimental design - Training program for 10 days HIIT cycle

microcycle		**day -2**	**day -1**	**day 1**	**day 2**	**day 3**	**day 4**	**day 5**
1st w	AM	*pre-test strength	*pre-test endurance	judo speed	strength	judo technic	speed/ strength	HIIT
	PM			HIIT[1)]	HIIT	rest	HIIT	rest
2nd w		**day 6**	**day 7**	**day 8**	**day 9**	**day 10**	**day 0**	**day +1**
	AM	active rest	judo speed	strength	active rest	judo/ strength	rest	rest
	PM		HIIT	HIIT		HIIT[2)]		
3rd w		**day +2**	**day +3**					
	AM	#post-test strength	#post-test endurance					

AM morning, PM evening. 1) Start of training program. 2) End of training program. *Pre-tests were 1-2 days before training program started. #Post-tests were done two days after training program had ended.

Training program - HIIT training protocols

HIIT session	Week 1	Week 2
1	4 sets of fight 4 min / 6 min	3 sets (8 x work 30 s/ rest 30 s)/ rest 8 min
2	4 sets (2x work 2 min/ rest 4 min)/ rest 8 min	3 sets (8 x work 20 s/ rest 30 s)/ rest 8 min
3	4 sets of fight 4 min / 6 min	4 sets of fight 4 min / 6 min
4	7+7 sets (work 1 min/ rest 1 min) / rest 10 min	-

4x(2x2 min/5 min/)10 min: one bout of circuit training for 2 min followed by a rest of 5 min. Then again work 2 min, then rest 10 min. Altogether 4 sets of 2 x 2 min.

- High intensity training volume altogether 90 min.

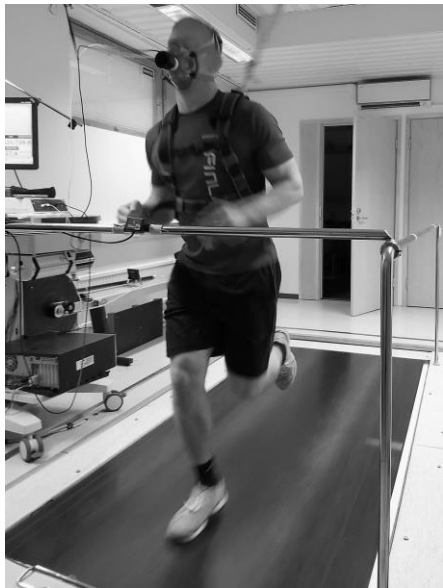
Measurements

8.00	10.00	11.00	12.00
A	B	C	D

- 1st test day (3 hr/person)
  - A) Anthropometry (weight, height, body composition, skinfold thicknesses)
  - B) Muscle power measurements (CMJ, SJ, box squat, bench press)
  - C) Maximum isometric force (leg press and bench press)
  - D) Anaerobic performance (30-s Wingate)

- 2nd test day (1,5-2 hr/person)
  - The incremental exercise test (VO2max)

- Control measurement during intervention
  - In all HIIT sessions HR ja session-RPE and in 3 HIIT sessions also La
  - During the first (day 1) and the last (day 10) HIIT sessions
    - CMJ and power output of the bench press



RESULTS

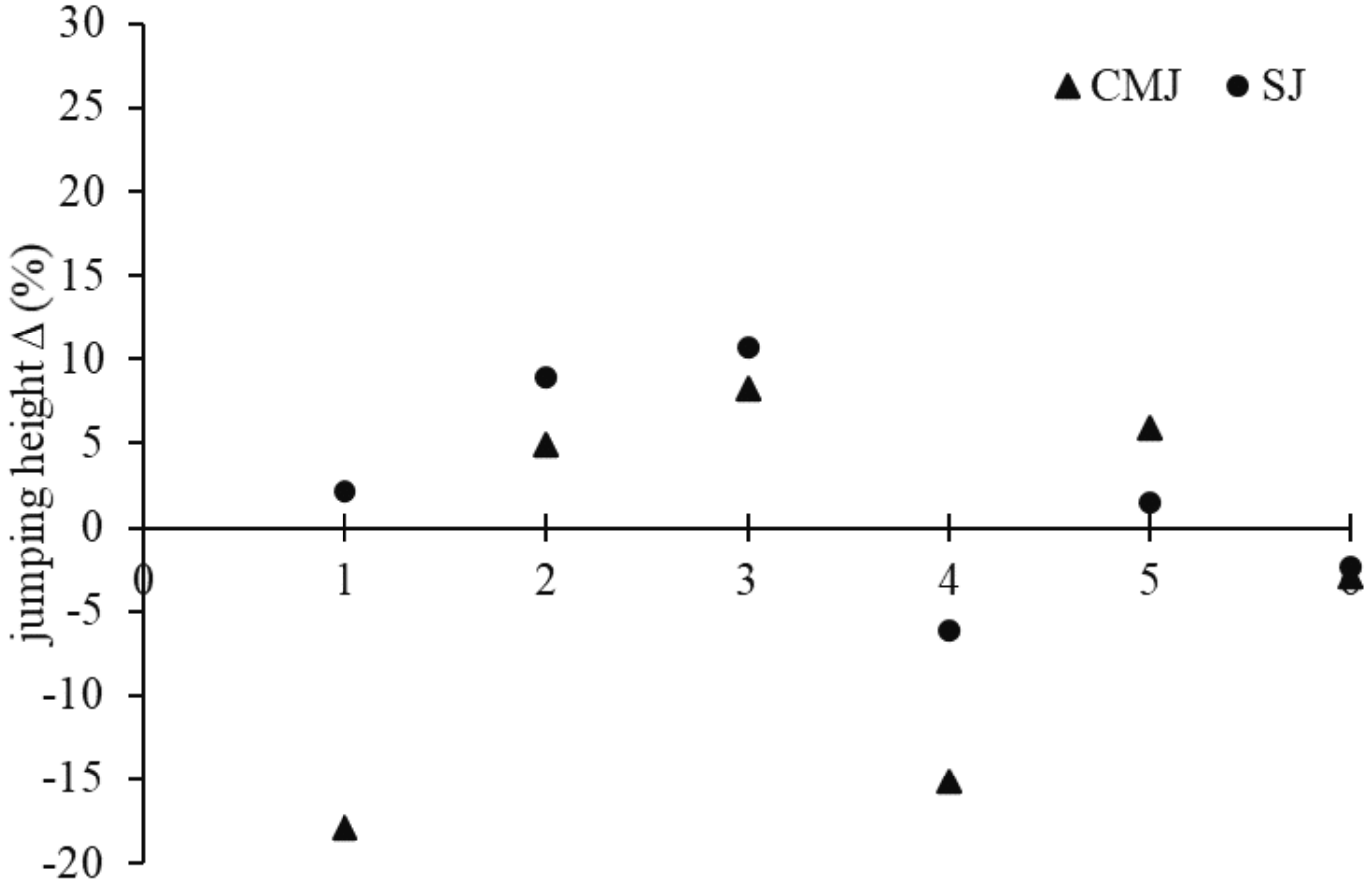
Neuromuscular system

- No significant changes in jumps
- Muscle power improved but the differences between pre- and post-test were not significant ($p>0.05$)
- Maximum isometric strength levels remained almost same
  - Isometric leg press had small decrease
  - Isometric bench press had small increase
- Relative maximum bench press correlated significantly between pretest and Δ% ($r=0.761$, p 0.047)

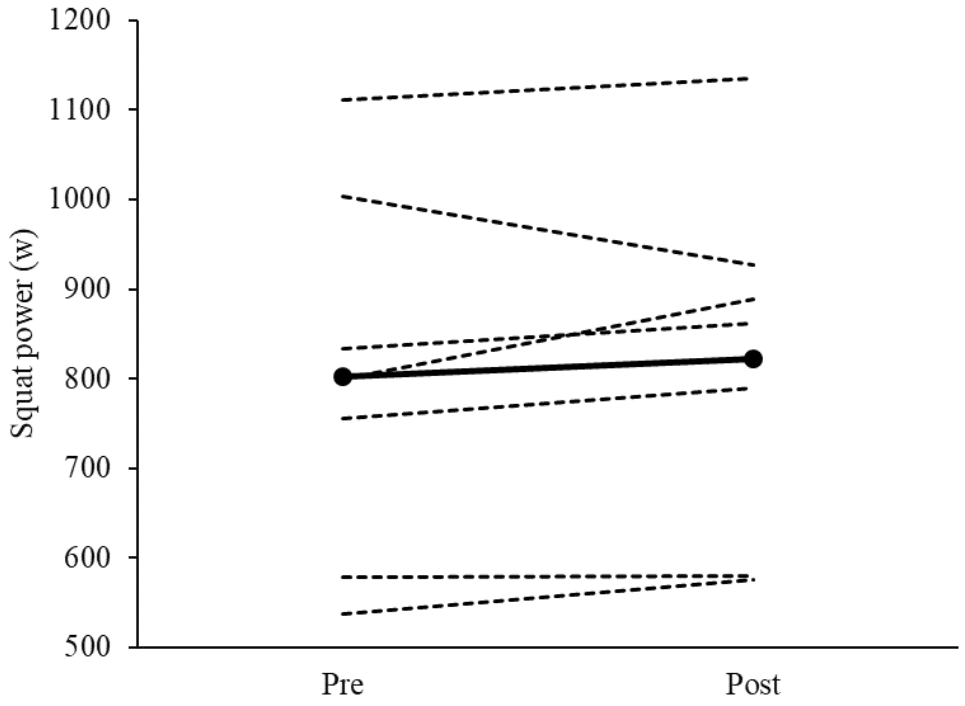
Measurements	before	3 days after	*P*	ES	% of change
Muscle power					
CMJ (cm) /	42.2 ± 4.6	41.5 ± 7.9	.63	0.2	-2.8 ± 11.3
Squat jump (cm)	42.5 ± 5.9	43.6 ± 7.4	.34	-0.4	2.4 ± 6.4
Squat (W) / 97.9 ± 15.2 kg	802 ± 208	823 ± 199	.33	-0.4	2.5 ± 5.9
bench press (W) / 56.1 ± 9.0 kg	553 ± 99	570 ± 122	.27	-0.5	3.1 ± 6.9
Maximum isometric strength					
Leg press (kg)	343 ± 86	339 ± 91	.68	0.2	-1.2 ± 8.2
RLP (kg/kg)	4.5 ± 1.1	4.4 ± 1.1	.41	0.3	-2.3 ± 8.6
Bench press (kg)	169 ± 16	171 ± 13	.66	-0.2	1.0 ± 5.2
RBP (kg/kg)	2.2	7.0	.92	0.0	-0.2 ± 4.8

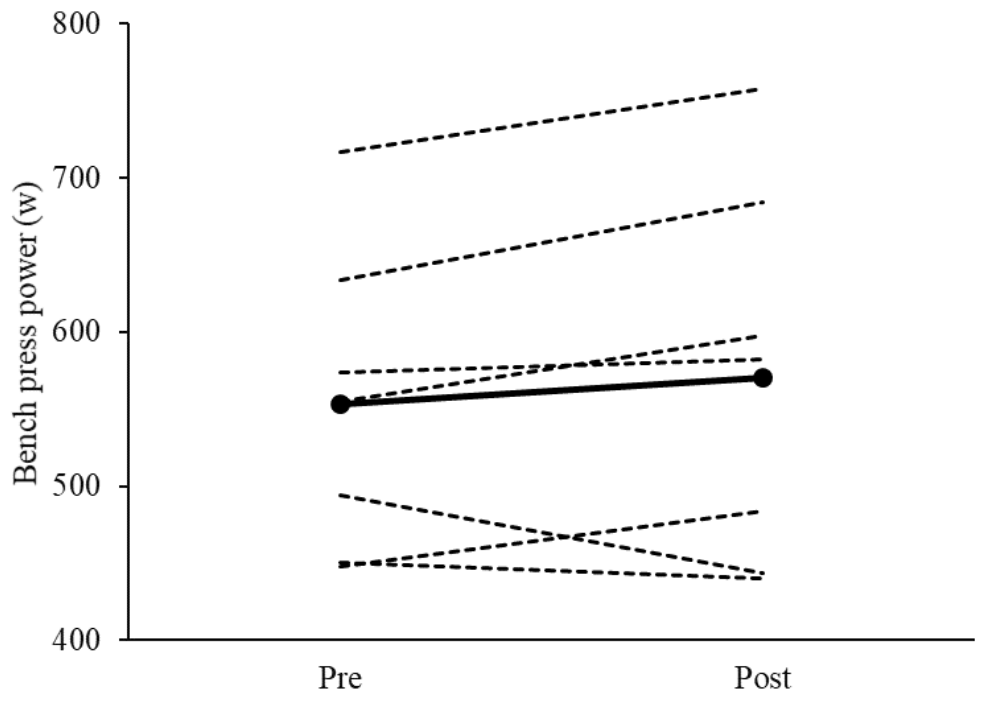
Table. Changes in strength performance obtained during the pre- and post-test. Values are presented as mean (±SD). Back squat (60% 1 RM) [W]; bench press (50% 1 RM); RLP = relative leg press; RBP = relative bench press

Individual changes (%) for counter movement jump (CMJ) and squat jump (SJ)

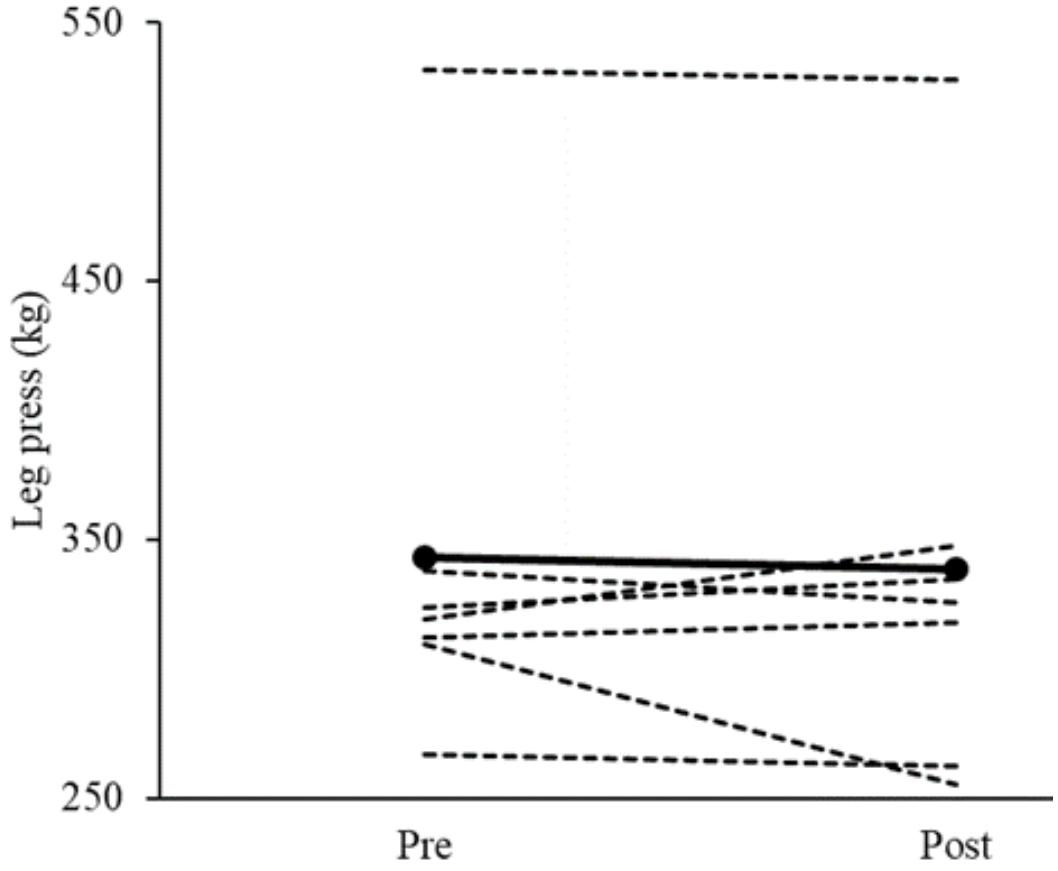


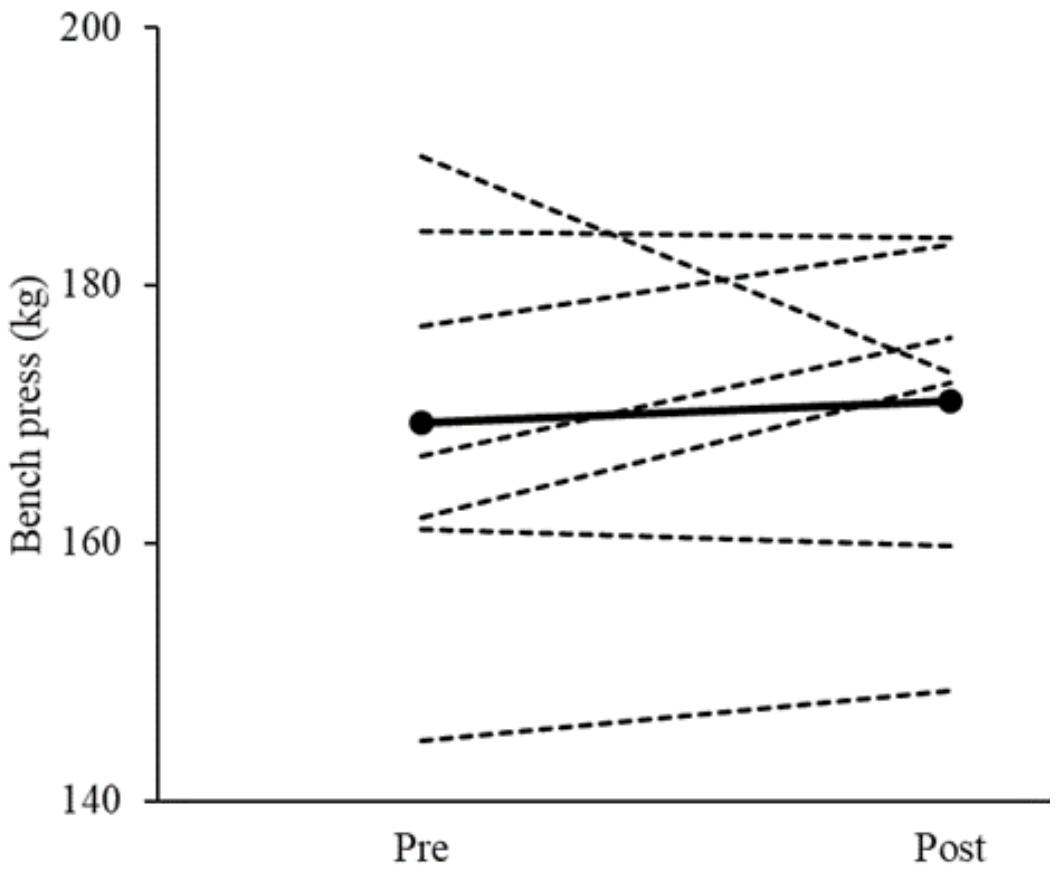
Individual muscle power (kg) changes in box back squat and bench press



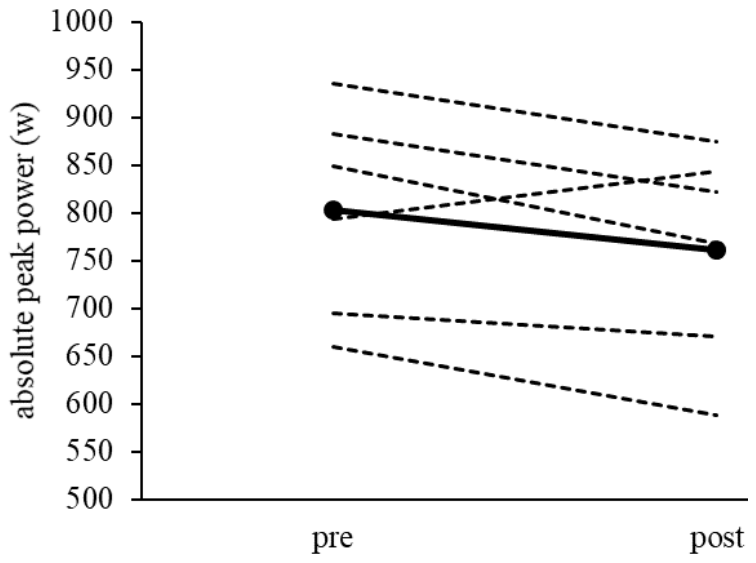


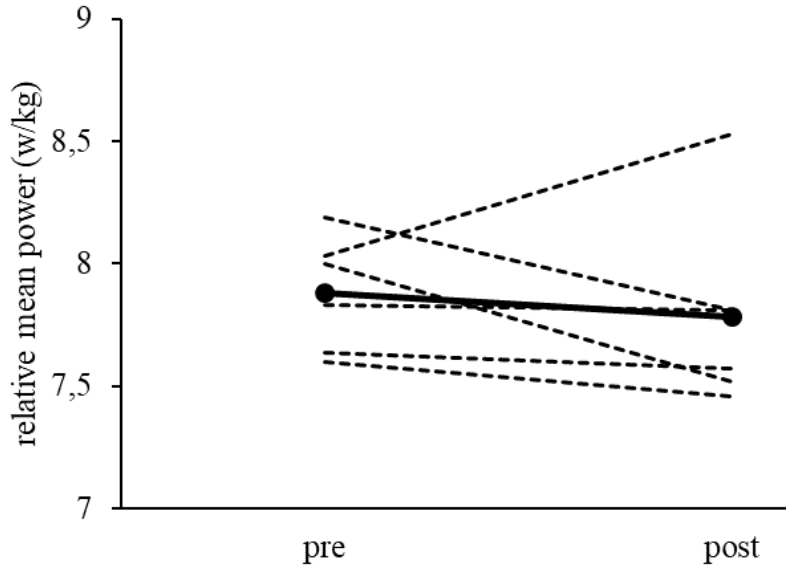
Individual maximum isometric strength changes in leg press and bench press



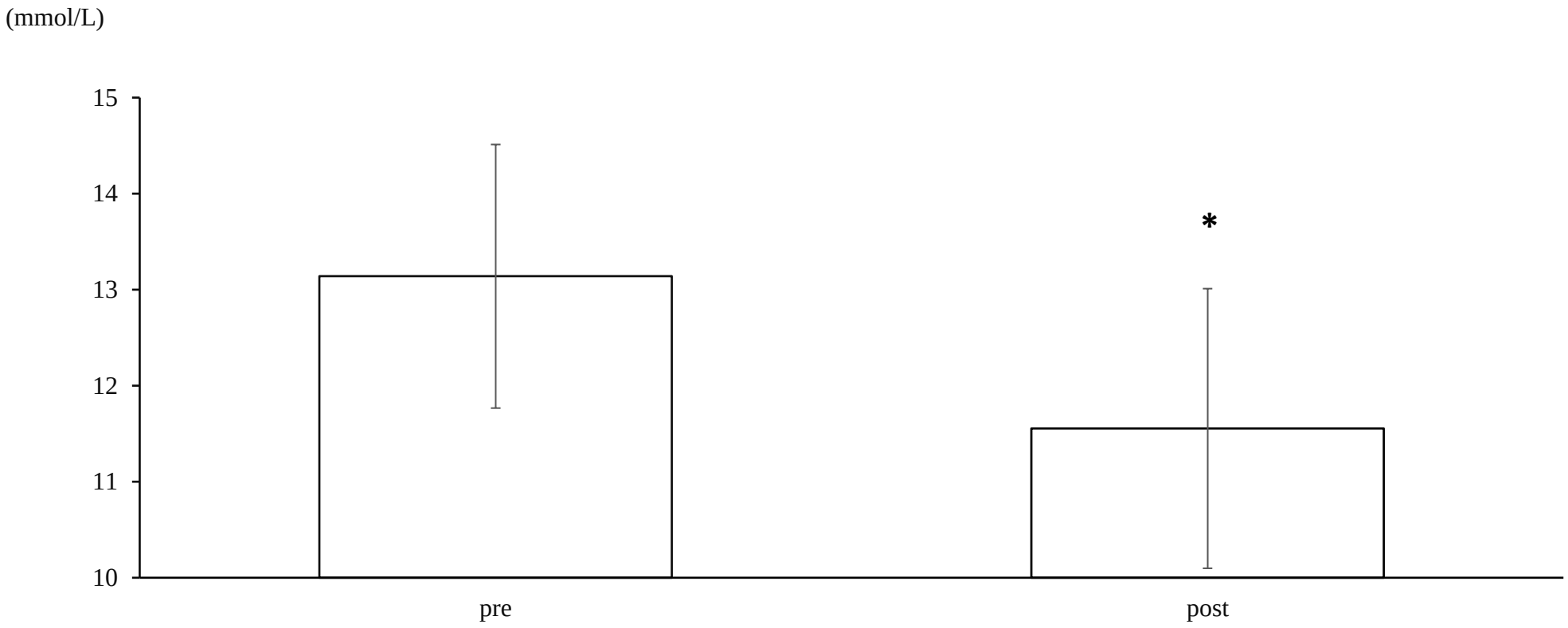


Wingate's individual changes in absolute peak power and mean power





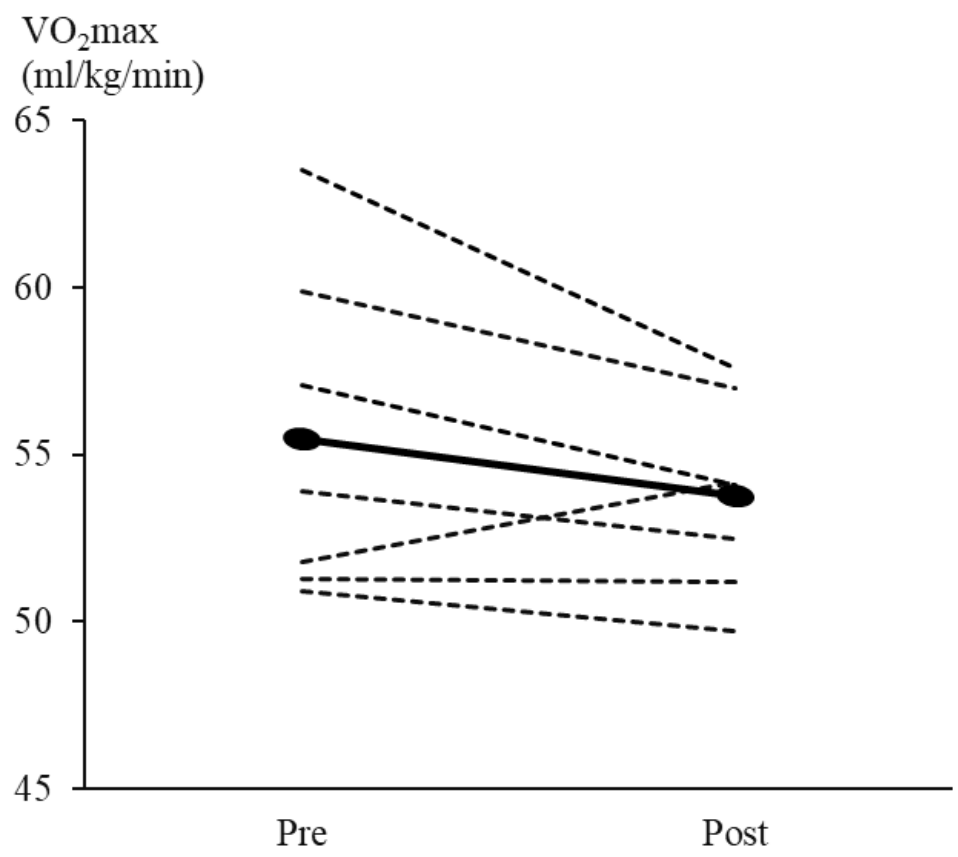
La changes 4 min after the Wingate test

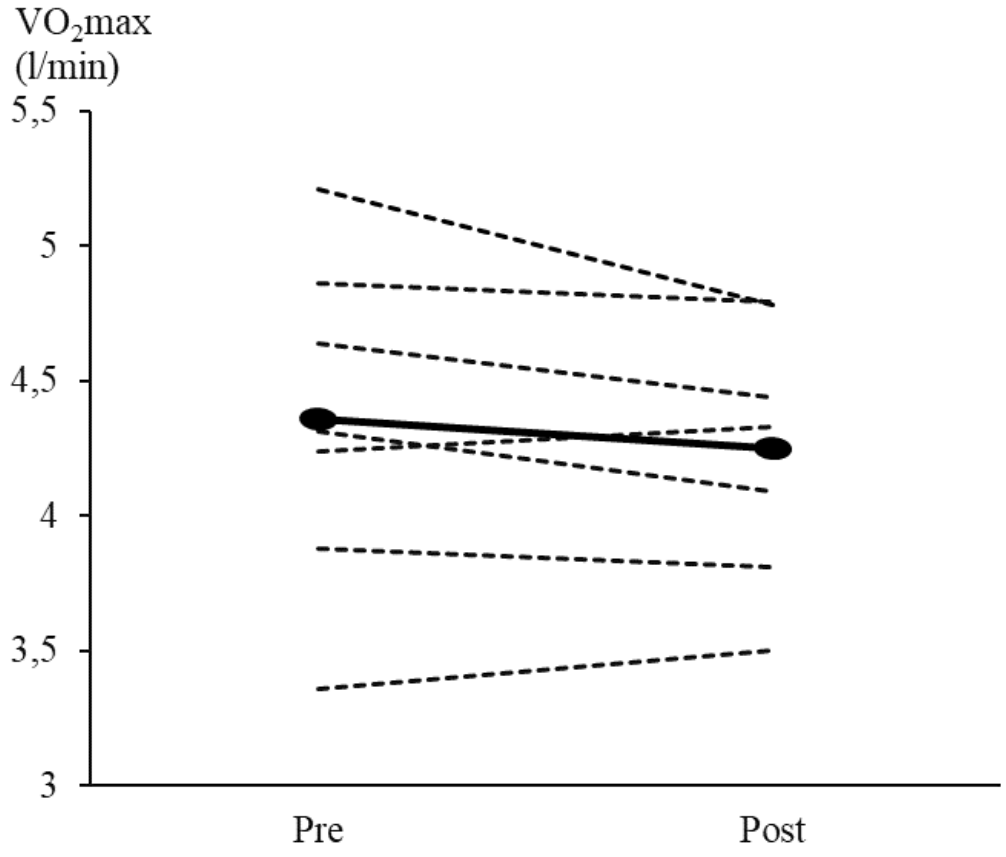


Values are presented as mean ± SD.
*p ≤ 0.05 indicates significant difference between pre- and post-test.

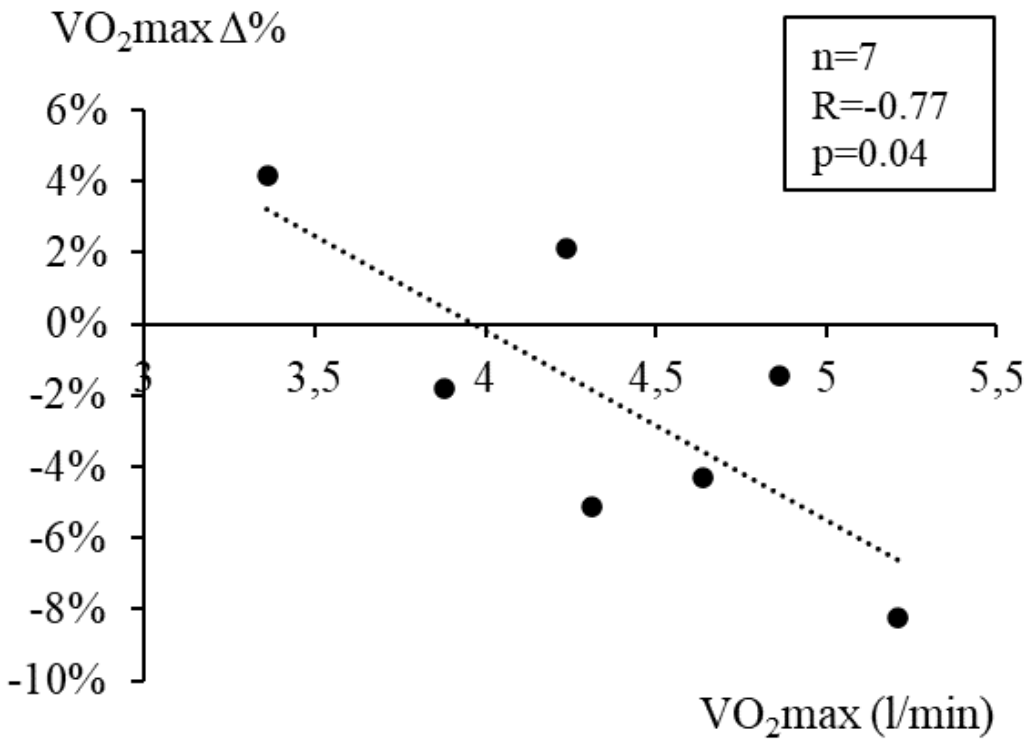
Aerobic profile

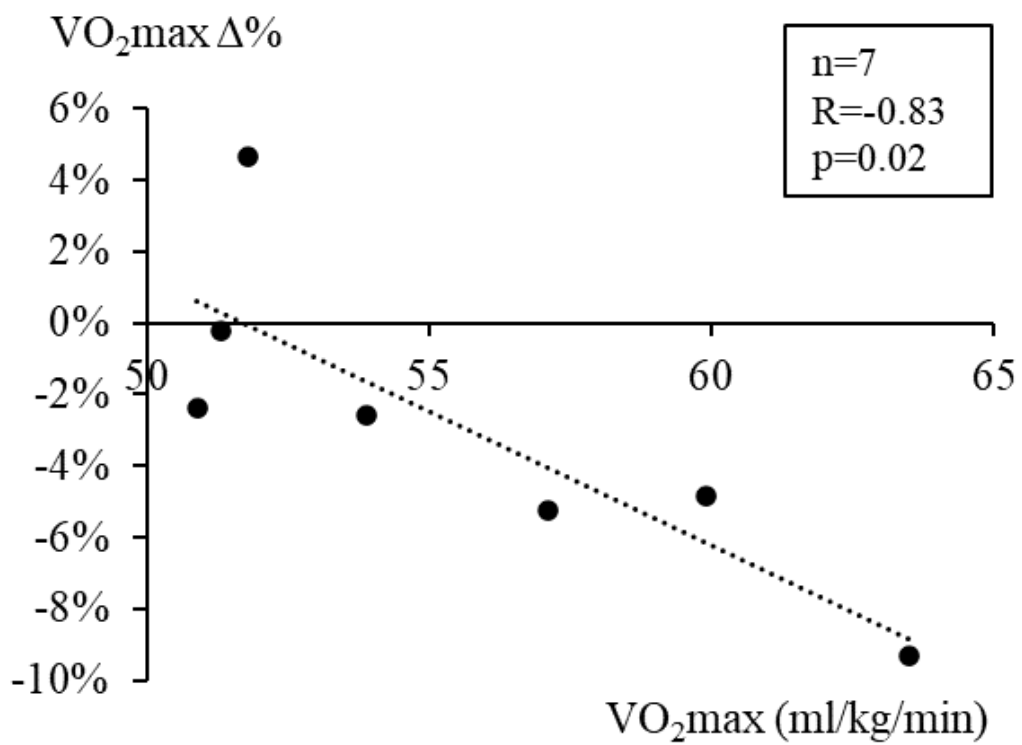
Individual data points for relative VO_2max (ml/kg/min) and absolute VO_{2max} (l/min)





Correlations between relative and absolute VO2max pre and pre-post changes





Acute changes in bench press power

<u>Performance levels decreased:</u>

- no significant decrease during first (day 1) and last (day 10) HIIT sessions
- comparing pre-test (rest) values to intervention's post-test a significant difference between last HIIT session's pre and intervention's post value (505 ± 108 vs. 570 ± 122 W)
  - obvious when athletes were tired in the end of intervention

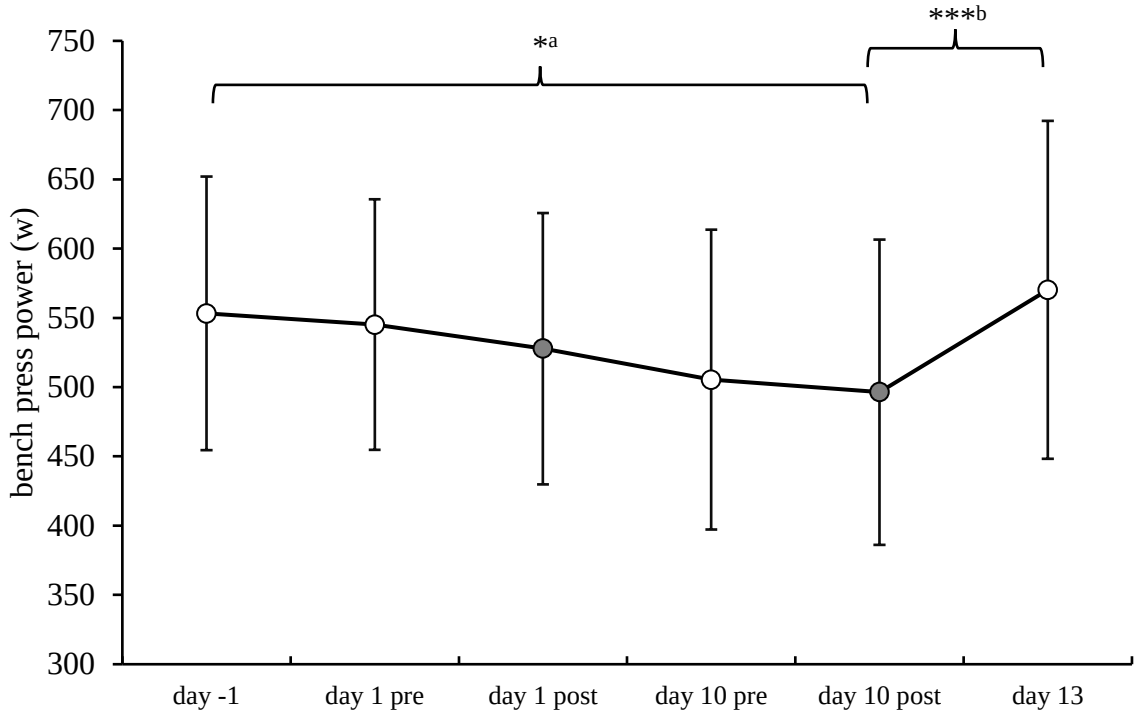


Figure. Acute changes in muscle power in bench press.
Values are presented as mean ± SD.
White balls are pre values and grey post values after training.
* $p<0.05$, *** $p<0.001$.
a = Difference between intervention's pre and Hi7 post-test,
b = difference between Hi7 post-test and intervention's post-test.

Acute La changes during intervention

Performance levels decreased:

- Lactate level straight after first 4 min interval round significantly decreased between day 1 and day 10 sessions (-24.2 ± 13.6%, p=0.01)
- Also lactate level direct after third 4 min interval round significantly decreased during training period between day 1 and day 4 (26.3 ± 9.3%, p=0.0005)
- It seems that training had been very loading and athletes were not able to perform as high La levels as day 1 comparing to day 4 and 10

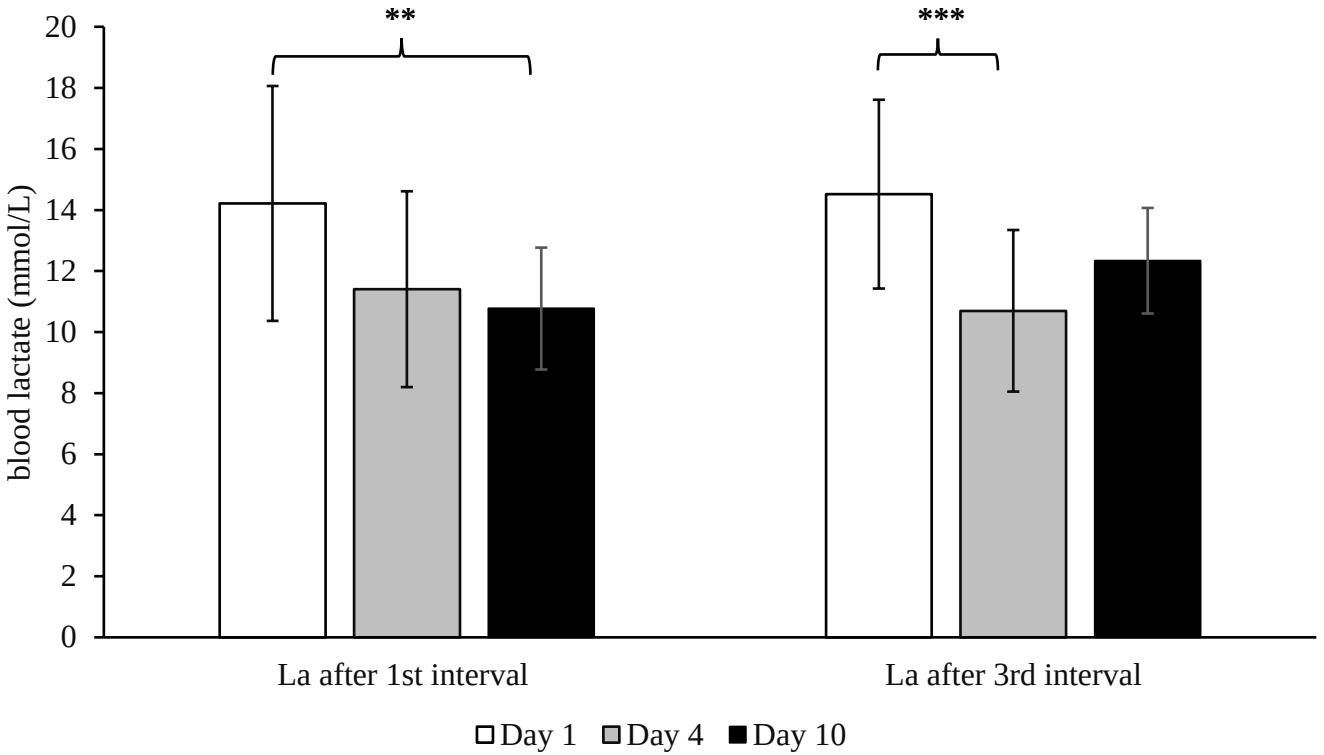


FIGURE. Acute blood lactate changes during HIIT-trainings.
Values are presented as mean ± SD.
La sample after first 4 min interval. La sample after third 4 min interval.
**Significant difference compared to previous session (*p*<0.01). *** p<0.001.

Discussion I

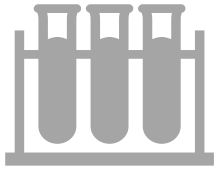
→ implemented as such a short-term 10-day intervention including seven HIIT sessions NOT significantly improved the physical performance

Neuromuscular system stayed same (small increase in muscle power +2.4 - 3.1%)

Anaerobic: no improvement (relative mean power -2.1%) and peak La decreased

Aerobic performance: Max HR decreased

- Subjects with good VO2max in the pretest, weakened their VO2max during the intervention



Were test subjects overstressed right after intervention in post-tests because performance decreased significantly in many variables?

Why?

Didn't recover from training phase OR not enough training minutes at zone 3 (HR > 87 %Hrmax).

No answer because there were no measurements after post-tests.

Acute changes

No significant decrease during first and last HIIT sessions in acute bench press

- However Bonitch-Góngora (2007): an increase in the maximum arm power in bench press after judo matches which was based on the significant increase in movement velocity for upper body.

Training very loading and athletes were not able to perform as high La levels as day 1 comparing to day 4 and 10.

Discussion II

- Limitations
  - The study did not use a control group performing regular training in the period
    - However, the study was performed under a real training programme
    - Still a comparison of different training programmes between low intensity vs. HIIT would have been needed
  - Now subjects seem to been overstressed right after the intervention in the post because most of the physical performance levels weakened OR post was too close after the training period
    - Fernandez-Fernandez et al. (2015) had in a 17-day intervention post after 5 d of HIIT. Wahl et al. (2014) had in a 13 d HIIT post 6d and 24 d after post. Breil et al. (2010) had 7 days rest before the post in a 11-day HIIT
    - In a real-life content, the present HIIT block would have ended two weeks before a competition
  - There might not have been enough training minutes at zone 3 (total 97.5 min)
    - Fernandez-Fernandez et al. (2015) with 195 HIIT min, Wahl et al. (2014) 192 min, Breil et al. 2010 240 min
- Conclusions: a 10-day short-term interval training mesocycle (i.e., 7 HIIT sessions, intervals ranging from 20 to 240 s, intensity >87%HRmax) performed as simulated judo matches did not improve physical performance in the present male judo athletes
  - Findings opposite previous studies. However, also longer interventions (4-12 weeks)
- Practical applications: A judo athlete have lot of competitions during a year. As maintaining technical skills is important to a successful judo performance, simulated judo matches is an important way for improving an athlete's aerobic and anaerobic performance while still maintaining other important judo components
  - Only simulated judo matches do not present an appropriate exercise stimulus for individual athletes because of their backgrounds

QUESTIONS?

THANK YOU.