Deutsche Sporthochschule Köln
German Sport University Cologne

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@steffen_held

Deutscher Ruderverband
DRV

Ausdauer & Krafttraining:
Ein Blick über den Tellerrand

*Trainer*innen Kongress, Hannover, 20—22.01.2023*

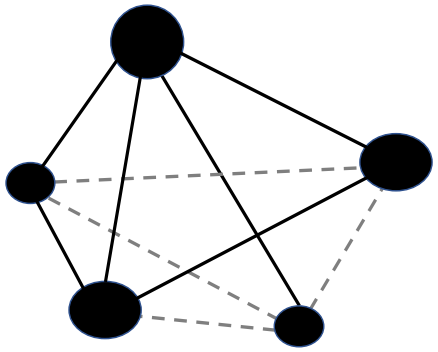
I **performance enhancement in rowing: a NMA**

II **velocity-based resistance training (VBT) in rowing**

III **blood flow restriction training (BFR) in rowing**

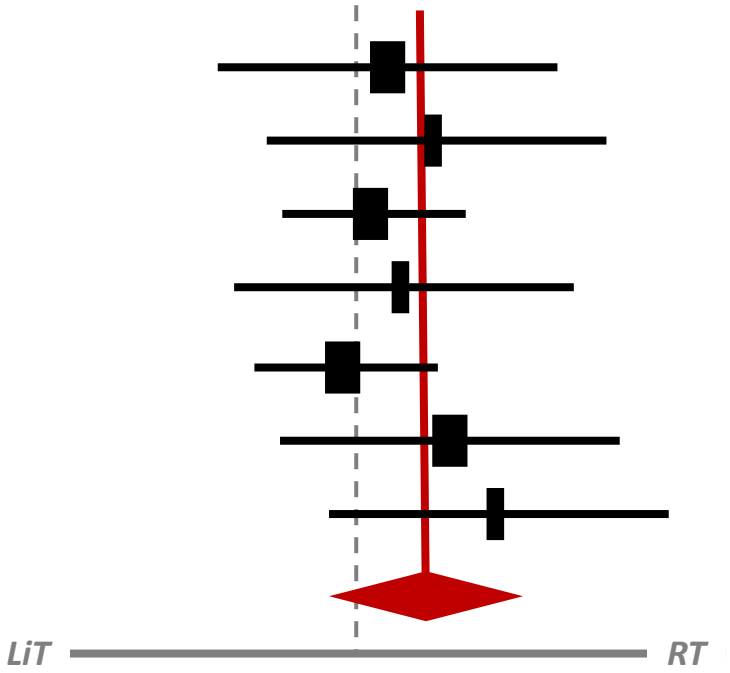
IV **current trends in high intensity training (HiT)**

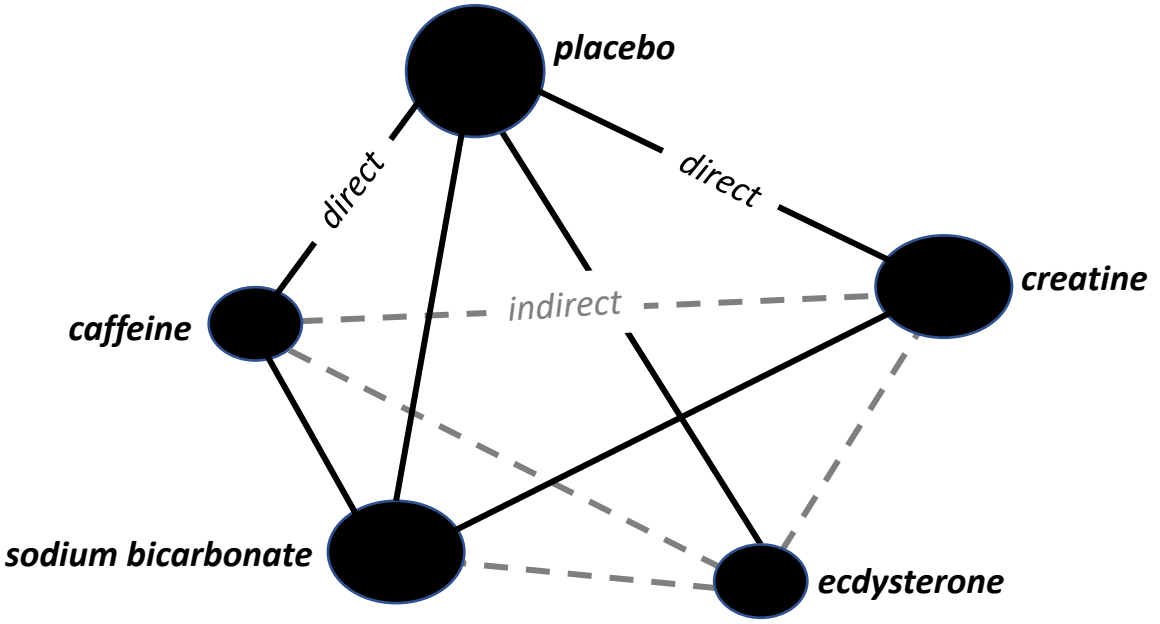
Sports Medicine

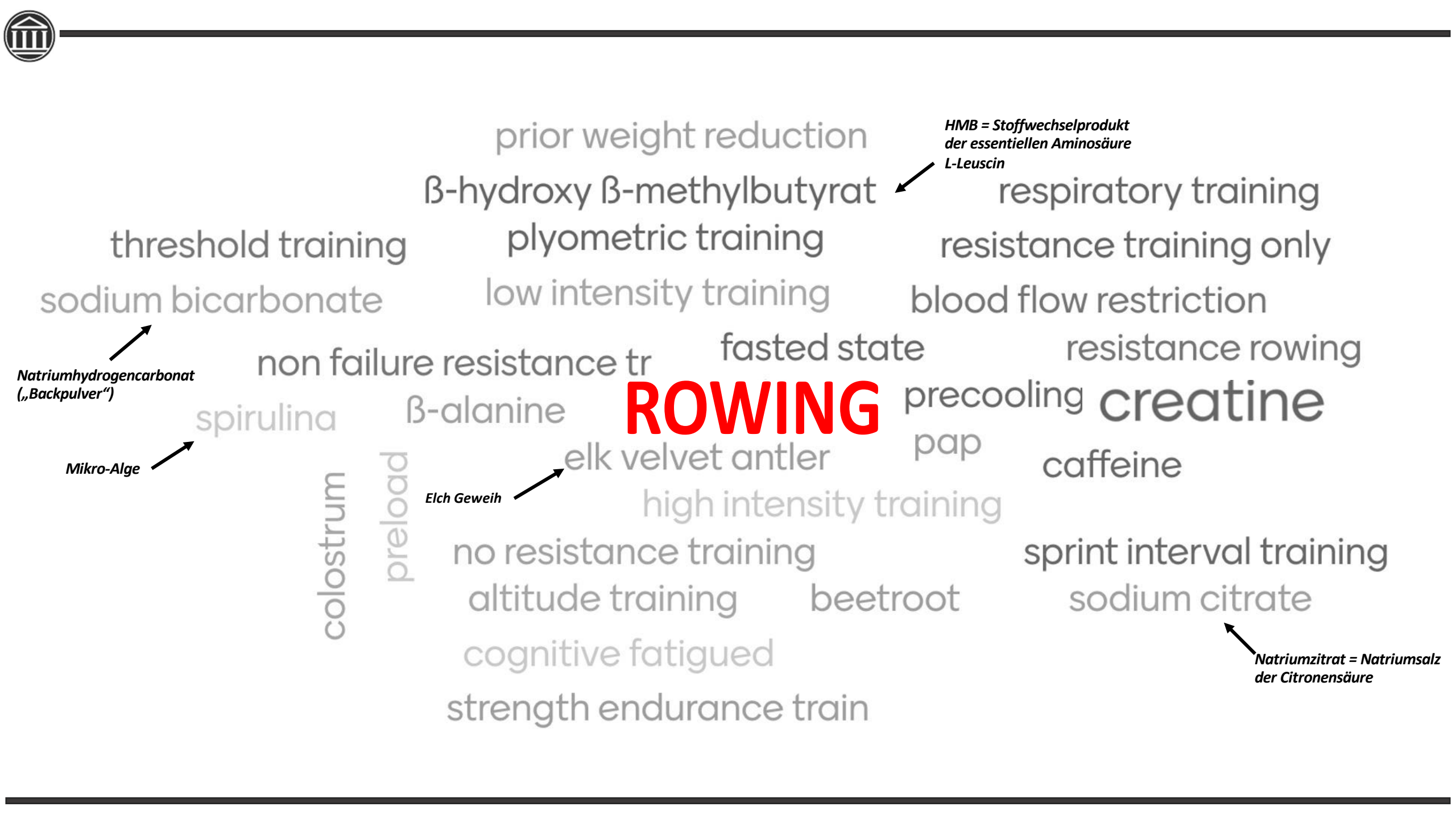


Acute and chronic performance enhancement in rowing – A network meta-analytical approach on the effects of nutrition and training

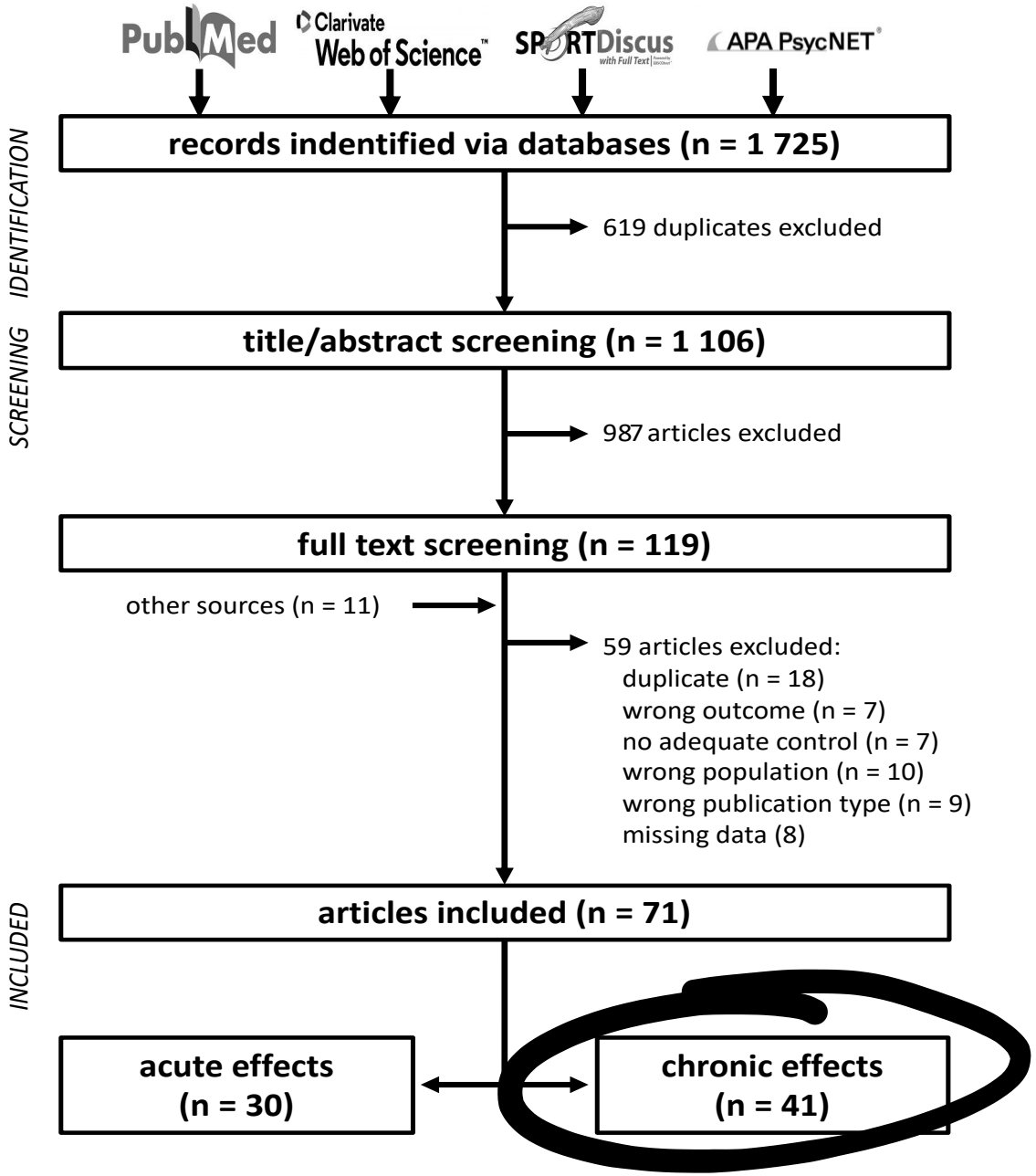
Held, Rappelt & Donath (2023)


LiT
RT


placebo
direct
direct
creatine
caffeine
indirect
sodium bicarbonate
ecdysterone


prior weight reduction
HMB = Stoffwechselprodukt der essentiellen Aminosäure L-Leuscin
ß-hydroxy ß-methylbutyrat
respiratory training
threshold training
plyometric training
resistance training only
sodium bicarbonate
low intensity training
blood flow restriction
Natriumhydrogencarbonat („Backpulver“)
fasted state
resistance rowing
non failure resistance tr
ROWING
precooling
creatine
spirulina
ß-alanine
Mikro-Alge
pap
elk velvet antler
caffeine
Elch Geweih
high intensity training
colostrum
preload
no resistance training
sprint interval training
altitude training
beetroot
sodium citrate
cognitive fatigued
Natriumzitrat = Natriumsalz der Citronensäure
strength endurance train

screening



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Search #2	#1 AND (“VO2peak" OR "VO2max" OR "maximal oxygen uptake" OR "maximal oxygen consumption" OR "aerobic capacity" OR "threshold" OR "time trial" OR "time to exhaustion" OR "one repetition maximum" OR "1RM" OR "1 repetition maximum" OR "MVC" OR "maximal voluntary contraction" OR "rowing performance“)
Search #3	#2 NOT (“patient“ OR “patients“)

(Held et al., 2023)

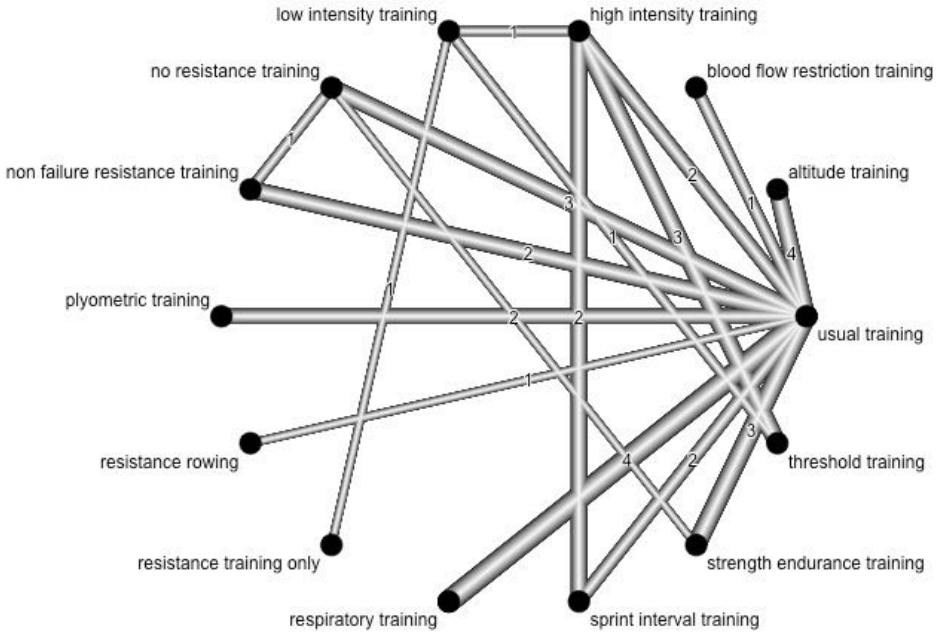
chronic effects

chronic effects - nutrition

I^2 = 0.0% (95CI: 0.0 to 79.2%)
Q_{total} = 0.5 (p = 0.97)
$Q_{within\ designs}$ = 0.4 (p = 0.84)
$Q_{between\ designs}$ = 0.2 (p = 0.92)

chronic effects - exercise

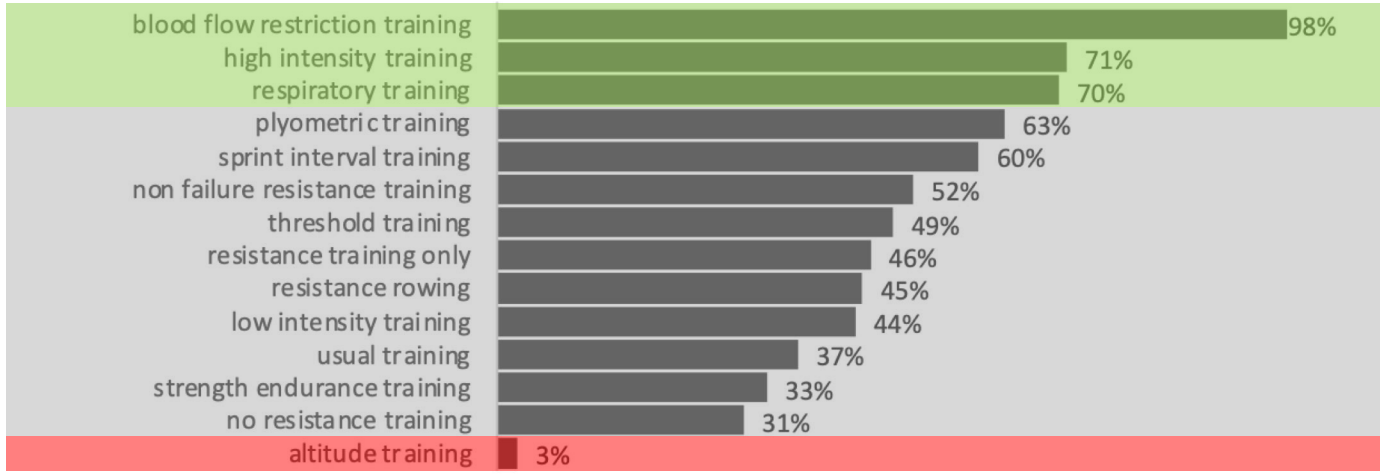
I^2 = 0.1% (95CI: 0.0 to 48.0%)
Q_{total} = 19.0 (p = 0.46)
$Q_{within\ designs}$ = 13.8 (p = 0.40)
$Q_{between\ designs}$ = 5.3 (p = 0.51)



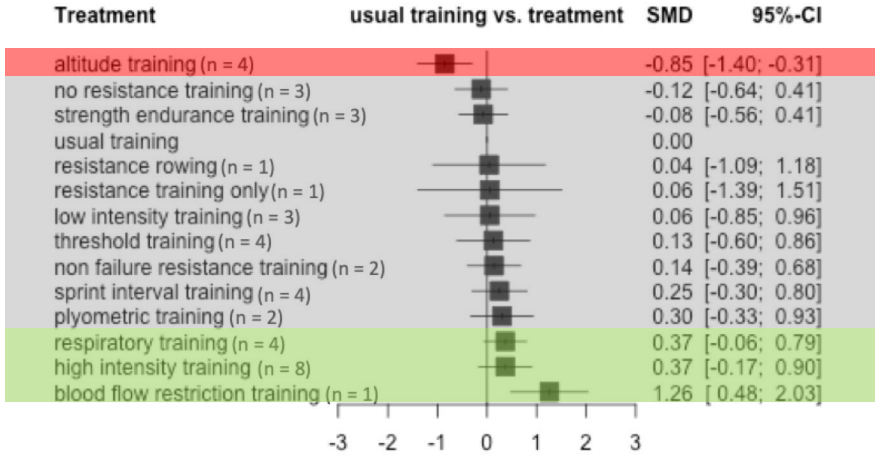
(Held et al., 2023)

chronic effects

chronic effects - exercise



chronic effects - exercise

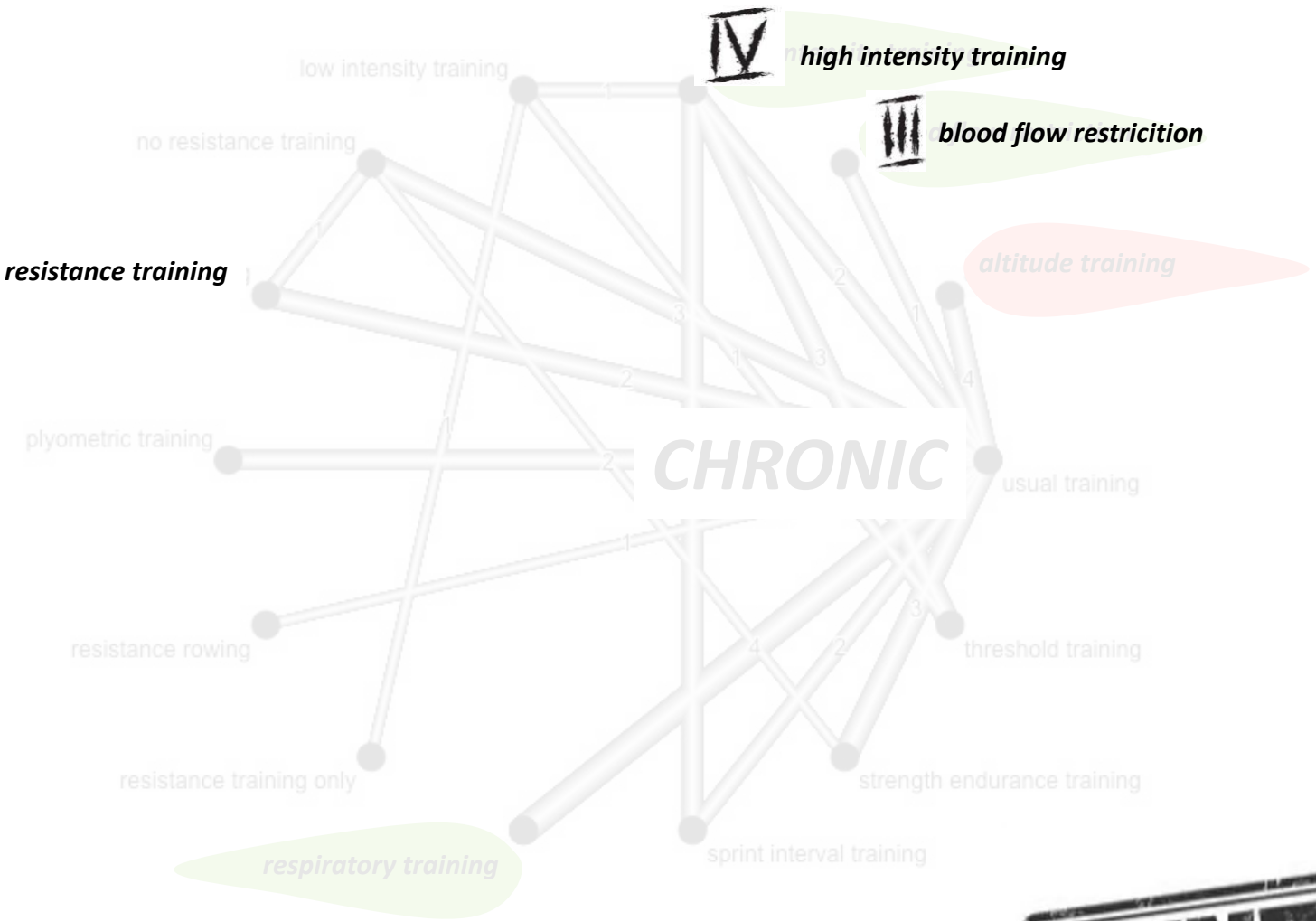


(Held et al., 2023)

IV *high intensity training*

III *blood flow restricition*

II *non failure resistance training*



NEXT STEP

VBT

IN ROWING?

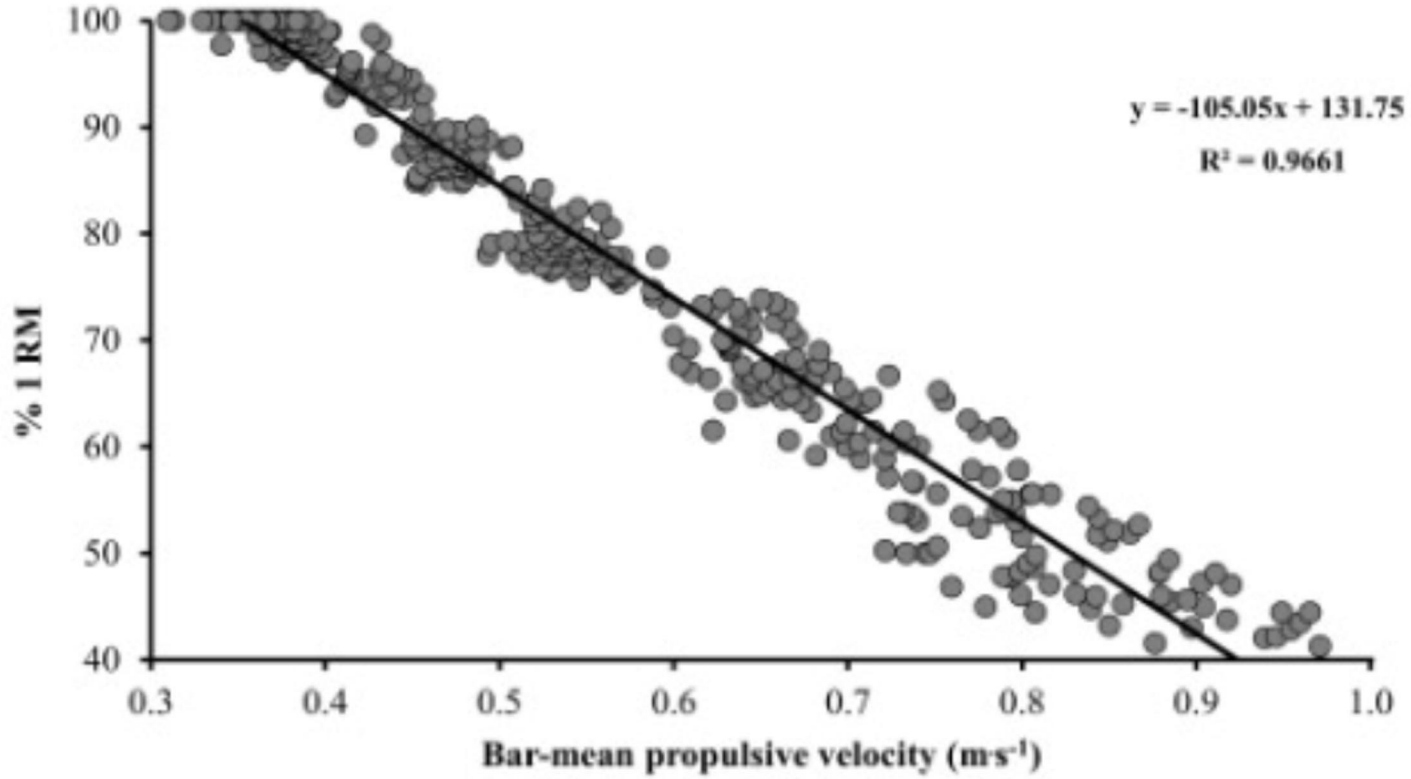
1RM estimation

International Journal of Sports Physiology and Performance, 2016, 11, 697-700
http://dx.doi.org/10.1123/ijspp.2015-0316

Human Kinetics
BRIEF REPORT

Using Bar Velocity to Predict Maximum Dynamic Strength in the Half-Squat Exercise

Irineu Loturco, Lucas A. Pereira, Cesar C. Cal Abad, Saulo Gil, Katia Kitamura, Ronaldo Kobal, and Fábio Y. Nakamura



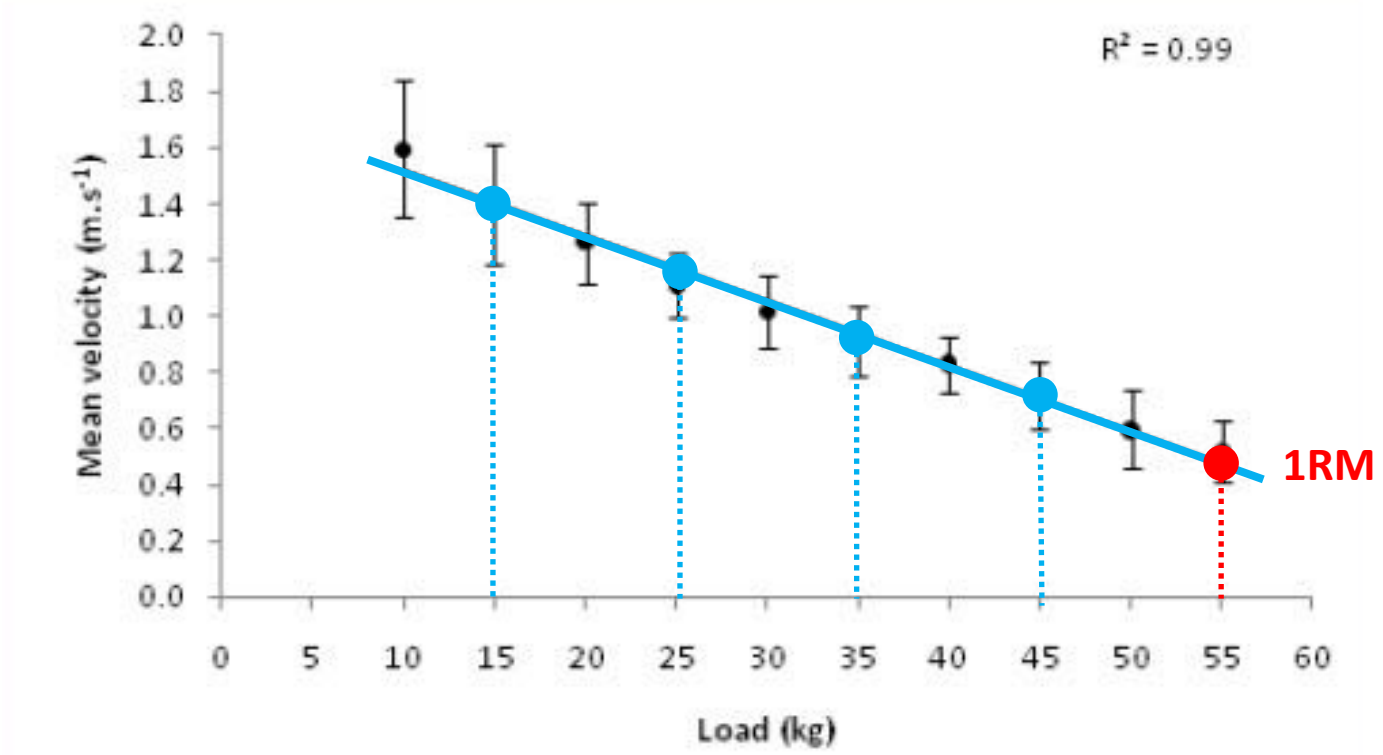
1RM estimation

Journal of Sports Science & Medicine
Home | Editorial Board | Submission | Statistics

J Sports Sci Med. 2010 Sep; 9(3): 459–463.
Published online 2010 Sep 1.
PMCID: PMC3761713
PMID: 24149641

Validity of a Commercial Linear Encoder to Estimate Bench Press 1 RM from the Force-Velocity Relationship

Laurent Bosquet,[1,2,3]* Jeremy Porta-Benache,[1,*] and Jérôme Blais[2,*]



Strength and Conditioning Journal

Outline
Images

Velocity-Based Training: From Theory to Application

Weakley, Jonathon PhD[1,2]; Mann, Bryan PhD[3]; Banyard, Harry PhD[4]; McLaren, Shaun PhD[2,5]; Scott, Tannath PhD[2,6]; Garcia-Ramos, Amador PhD[7,8]

Author Information

Strength and Conditioning Journal: April 2021 - Volume 43 - Issue 2 - p 31-49
doi: 10.1519/SSC.0000000000000560

Exercise	Study
Bench press	González-Badillo and Sánchez-Medina[a] (32) Sánchez-Medina[a] et al. (75) García-Ramos[a] et al. (27) Helms et al. (38)

Sample	1RM MV (mean ± SD)	V1RM
120 young healthy males	0.16 ± 0.04 m/s	0.17 m/s
75 athletes	0.17 ± 0.04 m/s	
30 healthy males	0.17 ± 0.03 m/s	
15 powerlifters	0.10 ± 0.04 m/s	
Squat	Conceição[a] et al. (13) Sánchez-Medina and[a] González-Badillo (74) Banyard et al. (6) Helms et al. (38)	
15 male athletes	0.32 ± 0.04 m/s	0.30 m/s
80 strength-trained males	0.32 ± 0.03 m/s	
17 strength-trained males	0.24 ± 0.06 m/s	
15 powerlifters	0.23 ± 0.05 m/s	

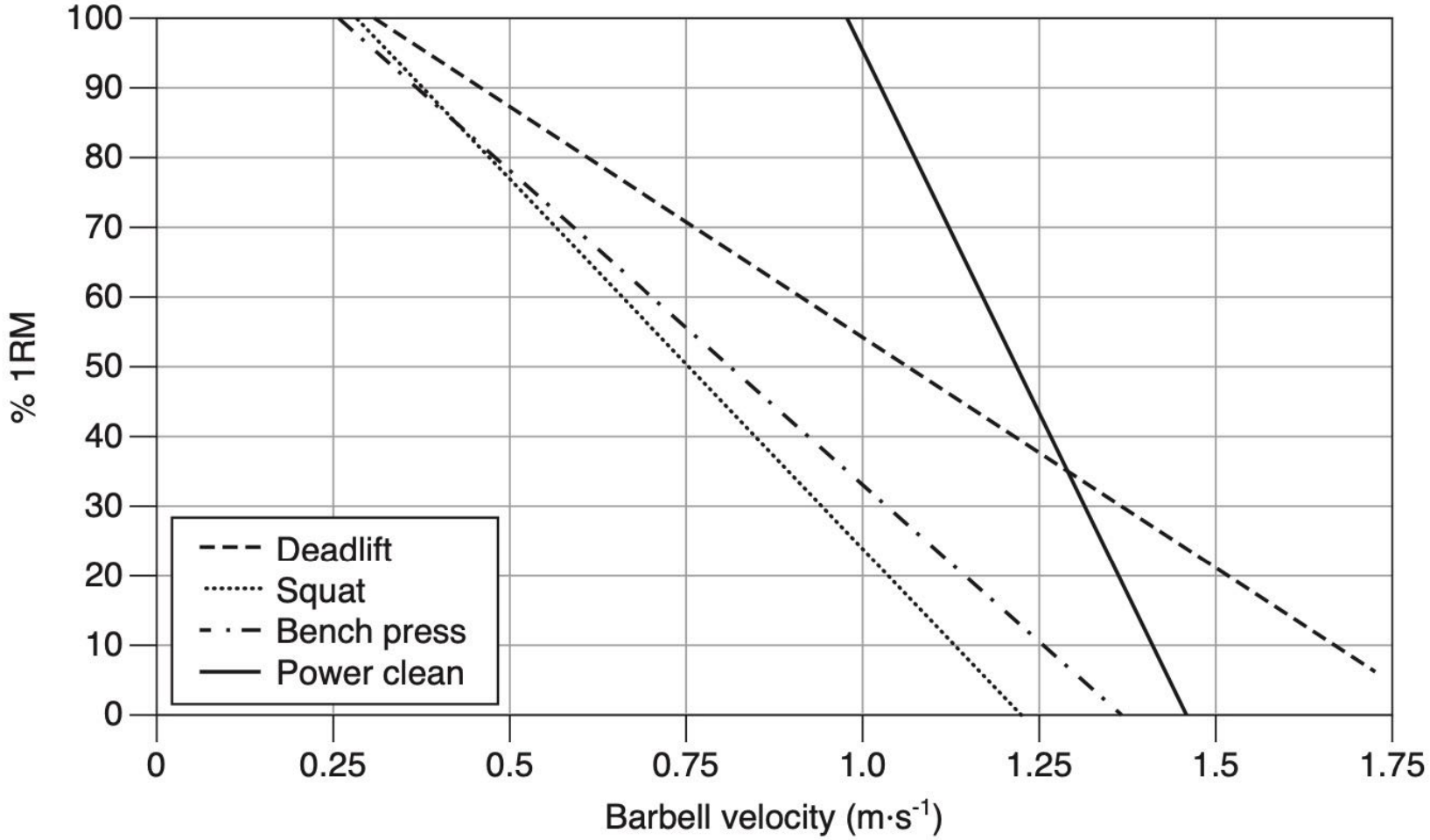
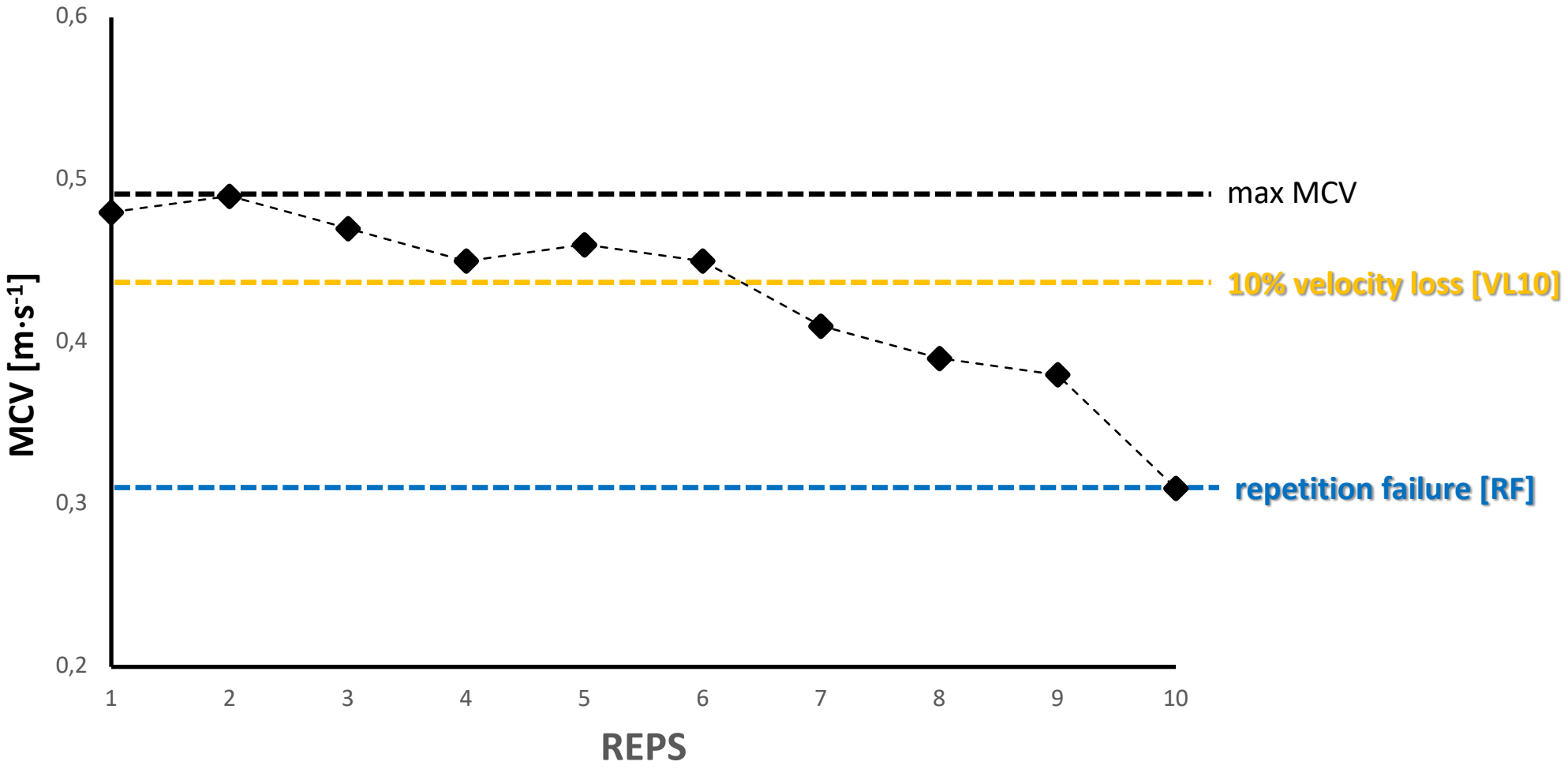


FIGURE 7.22 Examples of load–velocity curves for four exercises showing how extension of the regression line to 100% 1RM values can provide an estimate of 1RM strength. Note also how some exercises have a different load–velocity relationship (e.g., power clean).

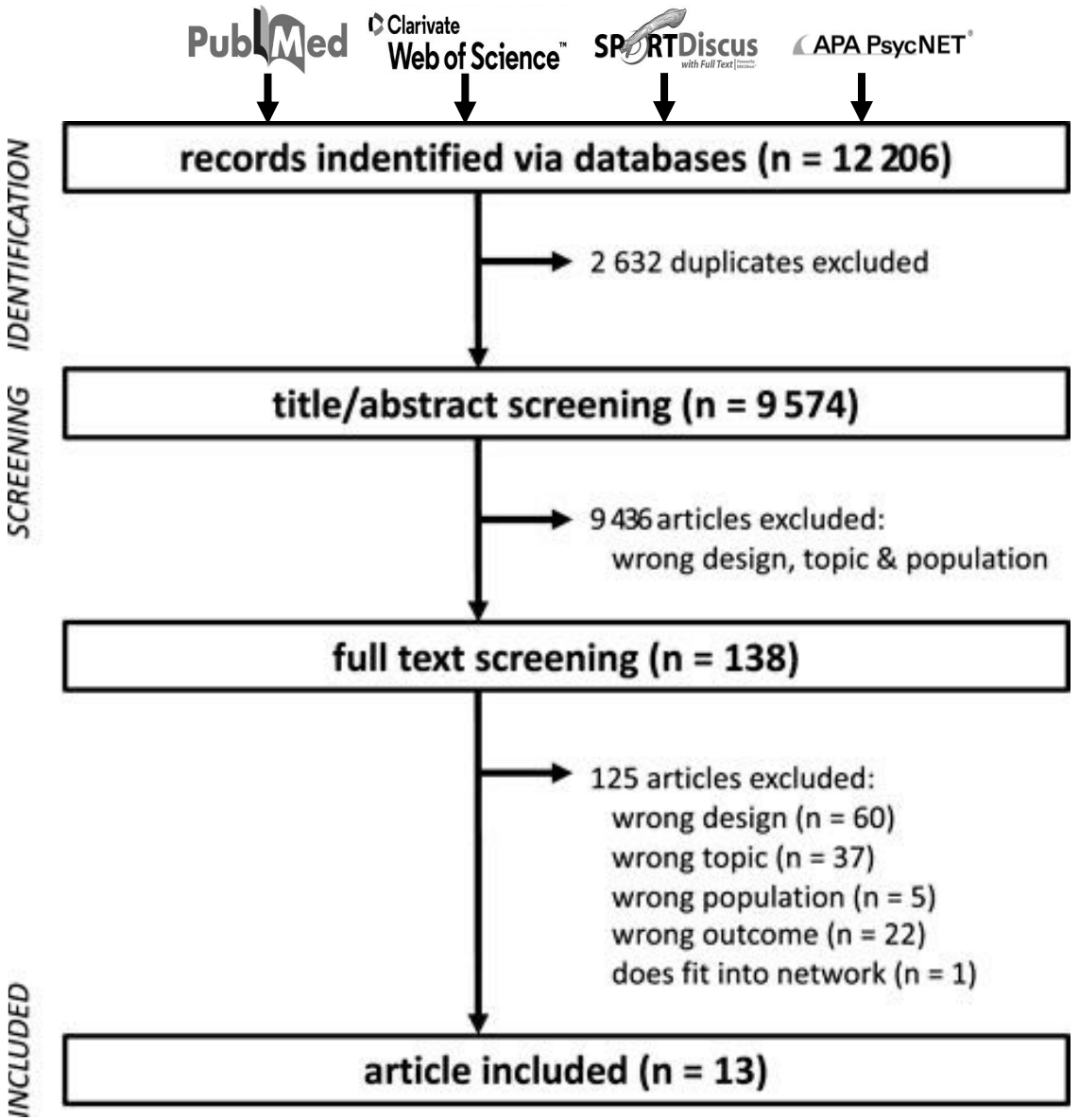
Adapted by permission from B. Mann, *Developing Explosive Athletes: Use of Velocity Based Training in Training Athletes*, 3rd ed. (Muskegon, MI: Ultimate Athlete Concepts, 2016), 48.

velocity loss



(Held et al., 2021)

VBT – Network Meta-Analysis



Search level	Search terms with Boolean operators
Search #1	"velocity based training" OR "velocity based" OR "vbt" OR "concentric velocity" OR "mean concentric velocity" OR "movement velocity" OR "barbell velocity" OR "velocity loss" OR "power based training"
Search #2	#2 AND ("1 repetition maximum" OR "1RM" OR "one repetition maximum" OR "MVC" OR "muscle strength" OR "muscular strength" OR "hypertrophy" OR "muscle hypertrophy" OR "muscular hypertrophy" OR "muscle fibre" OR "muscle fiber" OR "muscle thickness" OR "CSA" OR "cross-sectional area" OR "muscle size" OR "girth" OR "torque" OR "rate of torque development" OR "RTD" OR "rate of force development" OR "RFD" OR "strength development rate" OR "SDR" OR "jump" OR "drop jump" OR "depth jump" OR "DJ" OR "counter movement jump" OR "CMJ" OR "vertical jump")

> Front Physiol. 2022 Aug 10;13:926972.
doi: 10.3389/fphys.2022.926972. eCollection 2022.

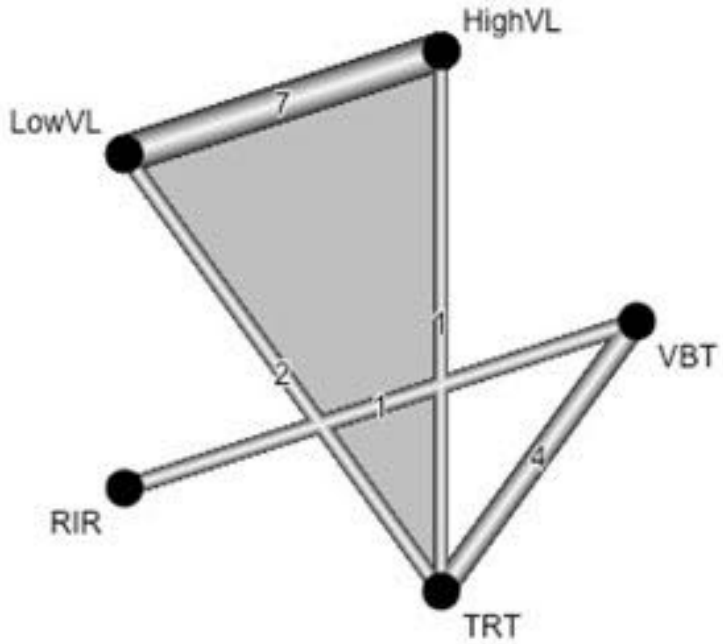
The effectiveness of traditional vs. velocity-based strength training on explosive and maximal strength performance: A network meta-analysis

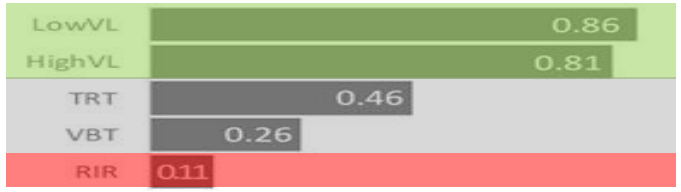
Steffen Held [1], Kevin Speer [1], Ludwig Rappelt [1], Pamela Wicker [2], Lars Donath [1]

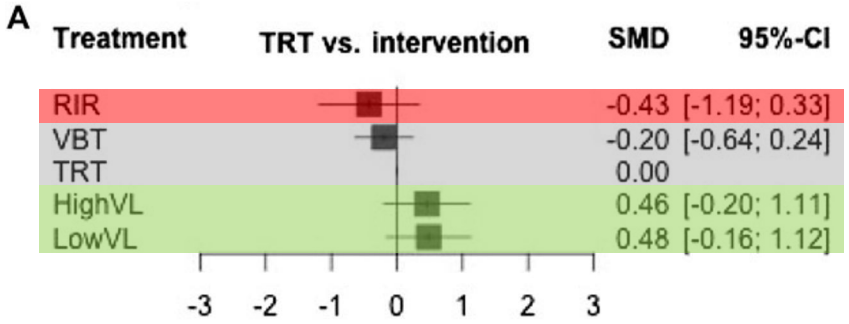
(Held et al., 2022)

A strength network

I^2 = 0.0% (95CI: 0.0 to 60.2%)
Q_{total} = 3.0 (p = 0.98)
$Q_{within\ designs}$ = 2.7 (p = 0.95)
$Q_{between\ designs}$ = 0.3 (p = 0.87)



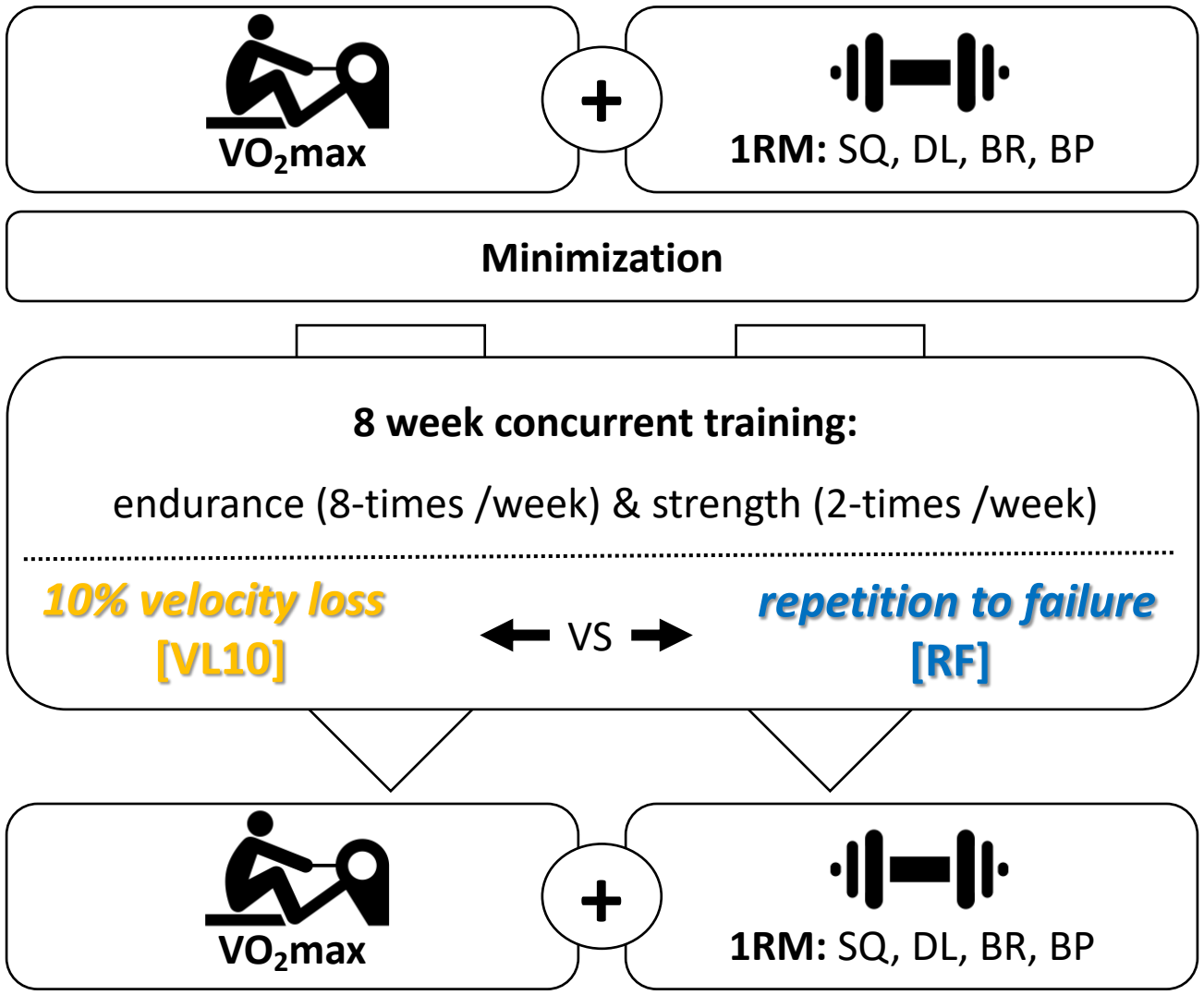




(Held et al., 2022)

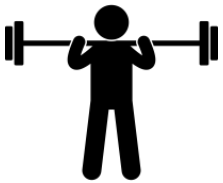
Effects of VL10 vs. RF on performance surrogates in rowing?

randomized controlled trial: 21 sub-elite rowers



VO_2max, $Strength_{Total}$, Age, Height, Weight, Gender

4 sets
80% 1RM
2-3 min rest



clean,
SQ, DL
BR, BP

VL10 ← VS → **RF**

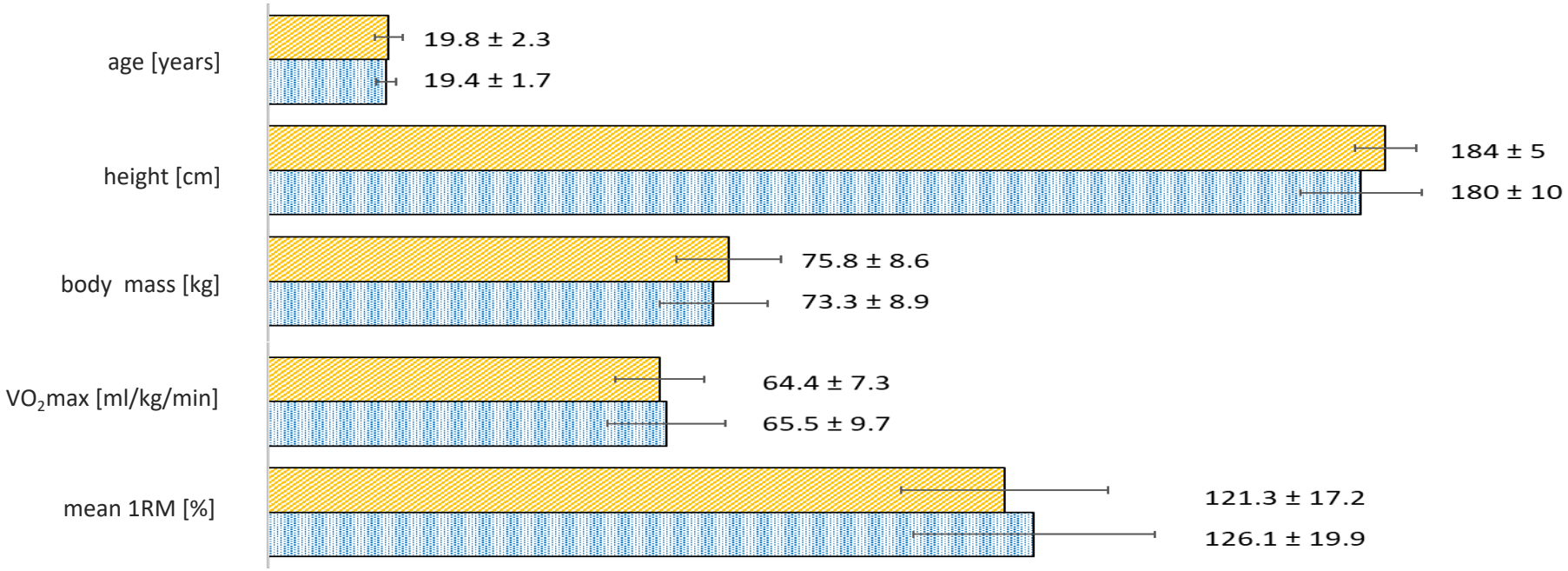
Daily Short Recovery and Stress Scale
(Nässi et al., 2017)

SE < 0.01 $m \cdot s^{-1}$
CV < 1.8%
ICC > 0.999
(Martínez-Cava et al., 2020)

(Held et al., 2021)

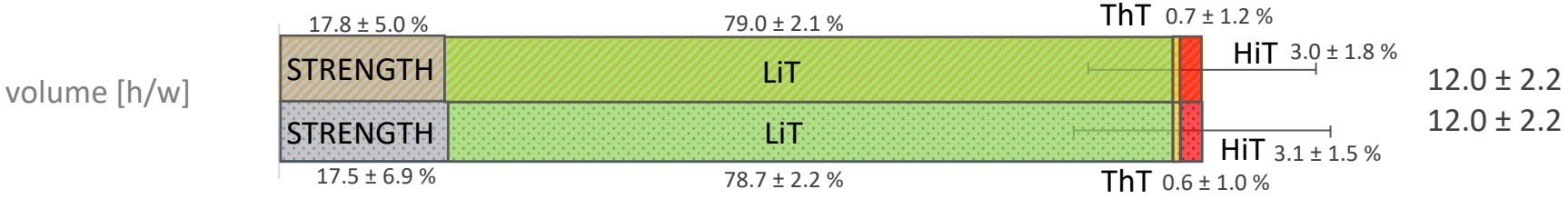
similar baseline

($p > 0.468$, $\eta_p^2 < 0.03$, SMD < 0.34)



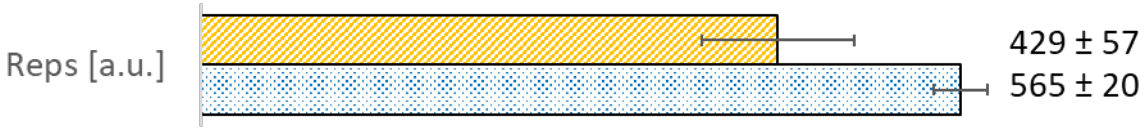
similar training data

($p > 0.461$, $\eta_p^2 < 0.03$, SMD < 0.34)



less reps for VL10

($p < 0.001$, $\eta_p^2 = 0.75$, SMD = 3.45)



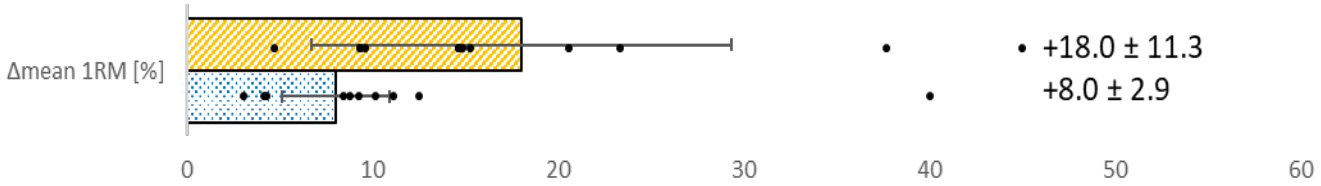
(Held et al., 2021)

similar VO_2max gains

(group × time rANOVA: $p > 0.51$, $\eta_p^2 < 0.03$)
(post-hoc: $p > 0.53$, SMD < 0.48)

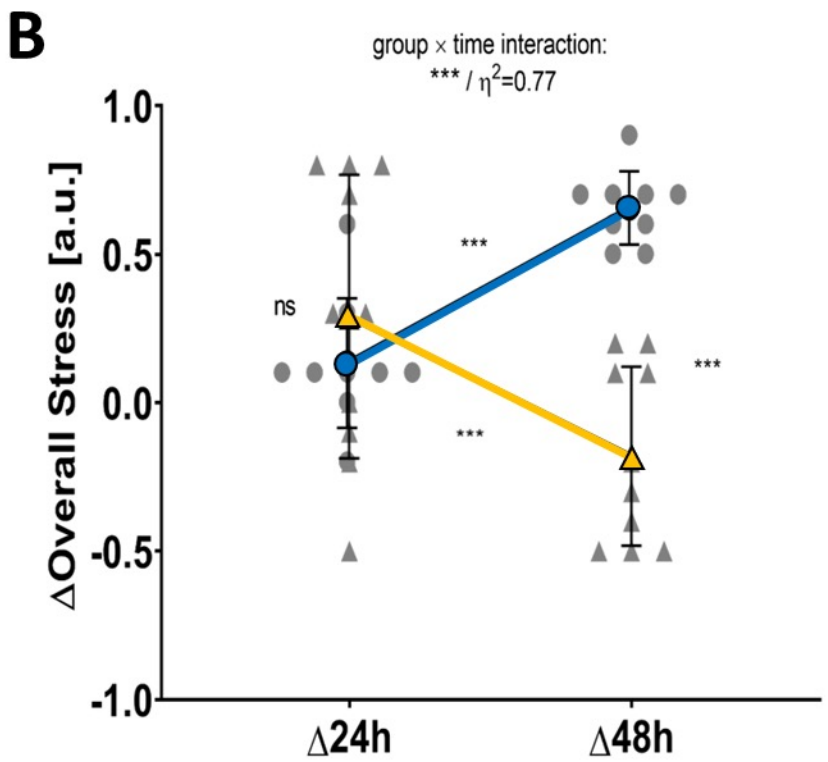
higher 1RM gains in VL10

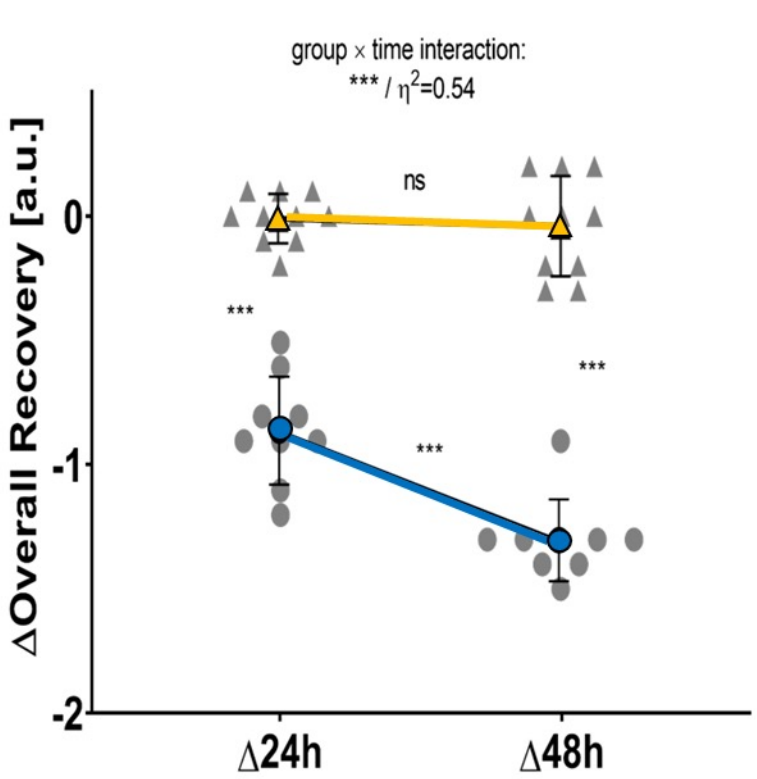
(group × time rANOVA: $p < 0.031$, $\eta_p^2 < 0.22$)
(post-hoc: $p > 0.010$, SMD > 0.68)



(Held et al., 2021)

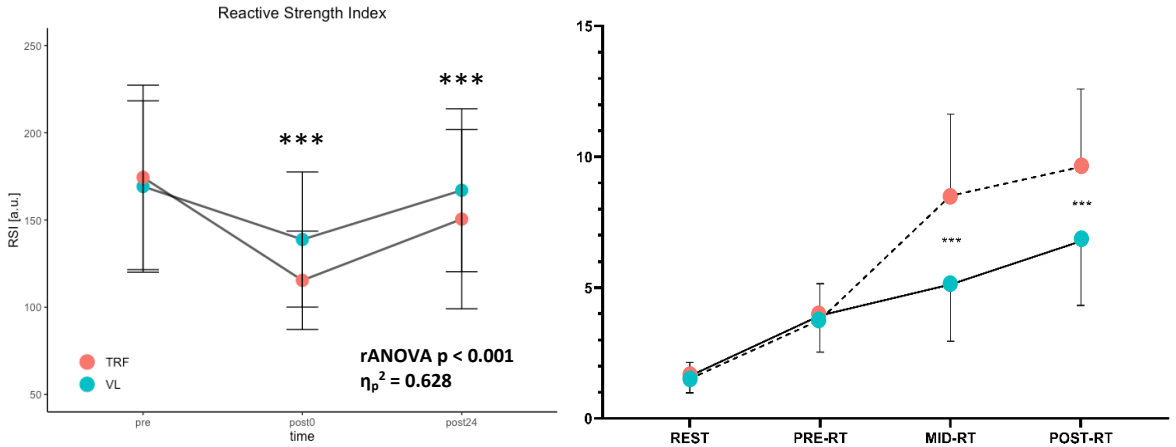
lower stress & less need of recovery in VL10

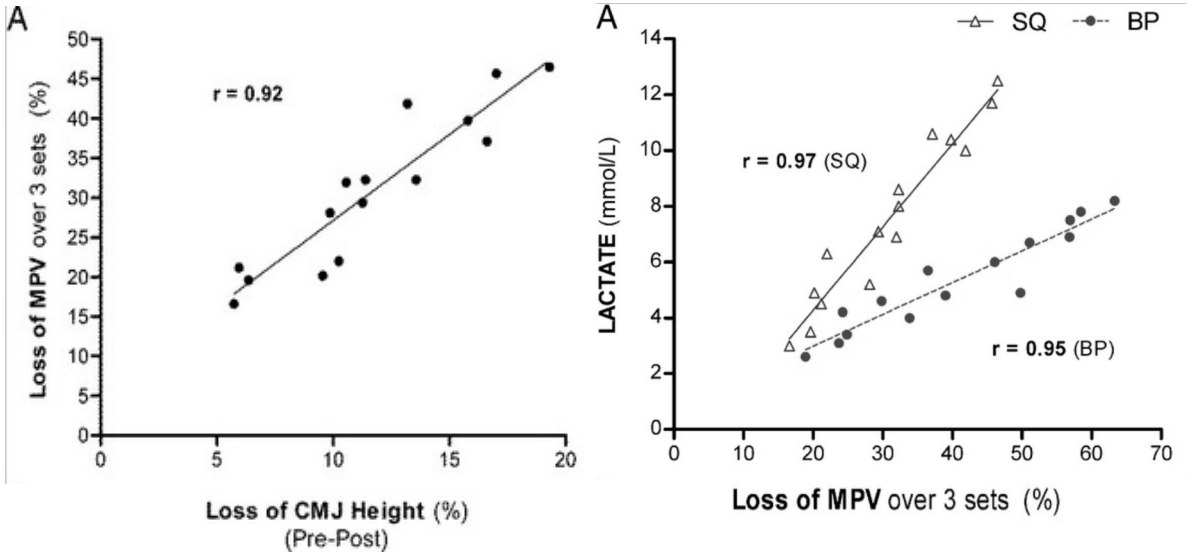




(Held et al., 2021)

VBT - acute





> Int J Sports Med. 2022 Dec 2.
doi: 10.1055/a-1897-5694. Online ahead of print.

Jump and Sprint Performance Directly and 24 h After Velocity- vs. Failure-based Training

Steffen Held [1], Ludwig Rappelt [1], Jan-Philip Deutsch [1], Lars Donath [1]

> Med Sci Sports Exerc. 2011 Sep;43(9):1725-34.
doi: 10.1249/MSS.0b013e318213f880.

Velocity loss as an indicator of neuromuscular fatigue during resistance training

Luis Sánchez-Medina [1], Juan José González-Badillo

(Held et al., 2022)

Improved Strength and Recovery After Velocity-Based Training: A Randomized Controlled Trial

in International Journal of Sports Physiology and Performance

Steffen Held, Anne Hecksteden, Tim Meyer, and Lars Donath

View Less —

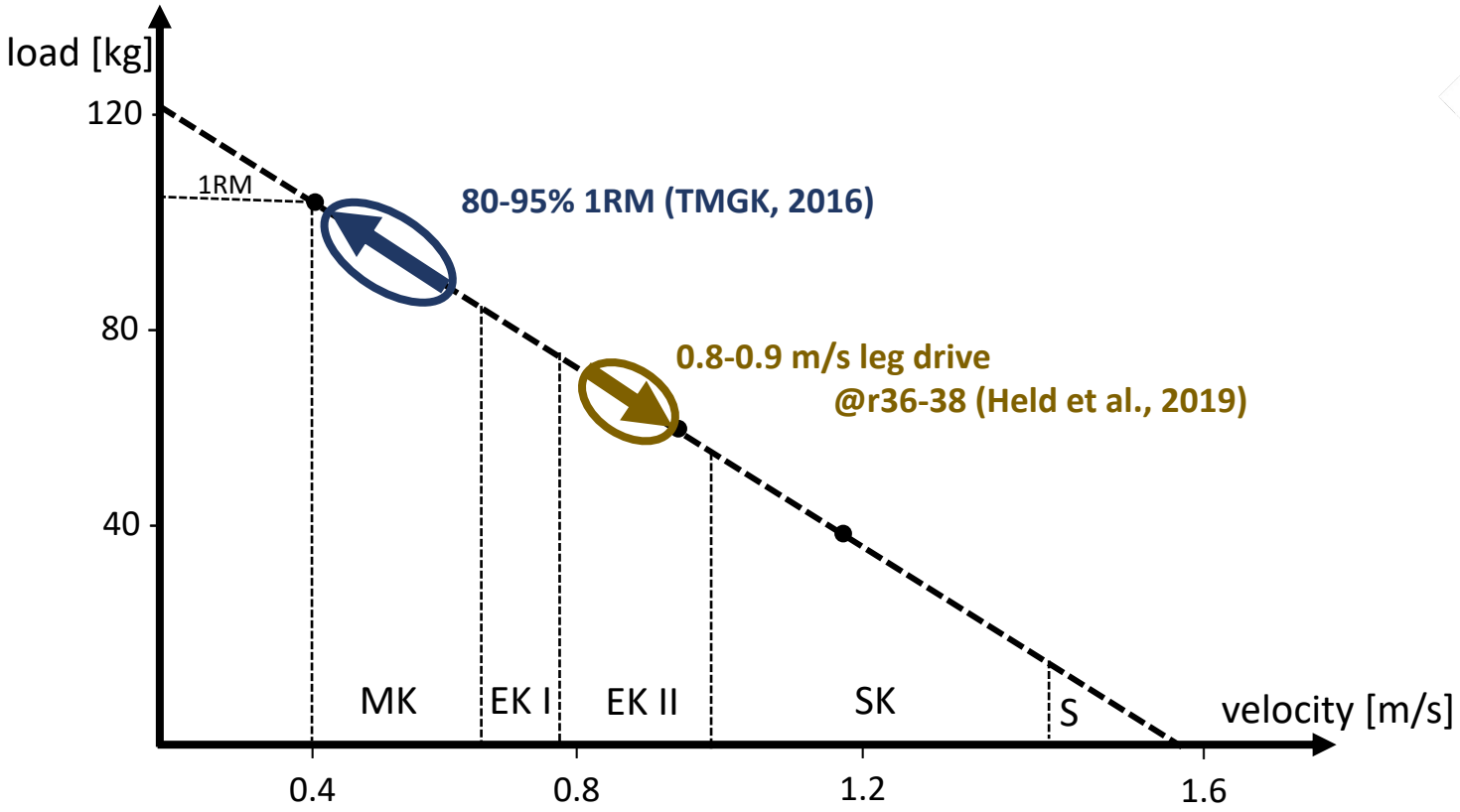
DOI: https://doi.org/10.1123/ijspp.2020-0451

Keywords: stress; rowing; mean concentric velocity; endurance; power at V˙O2max

In Print: Ahead of Print 2020 **Pages:** 1–9

Rowing-specific velocity based resistance training – BISp Service 2023

Donath & Held, DSHS Köln

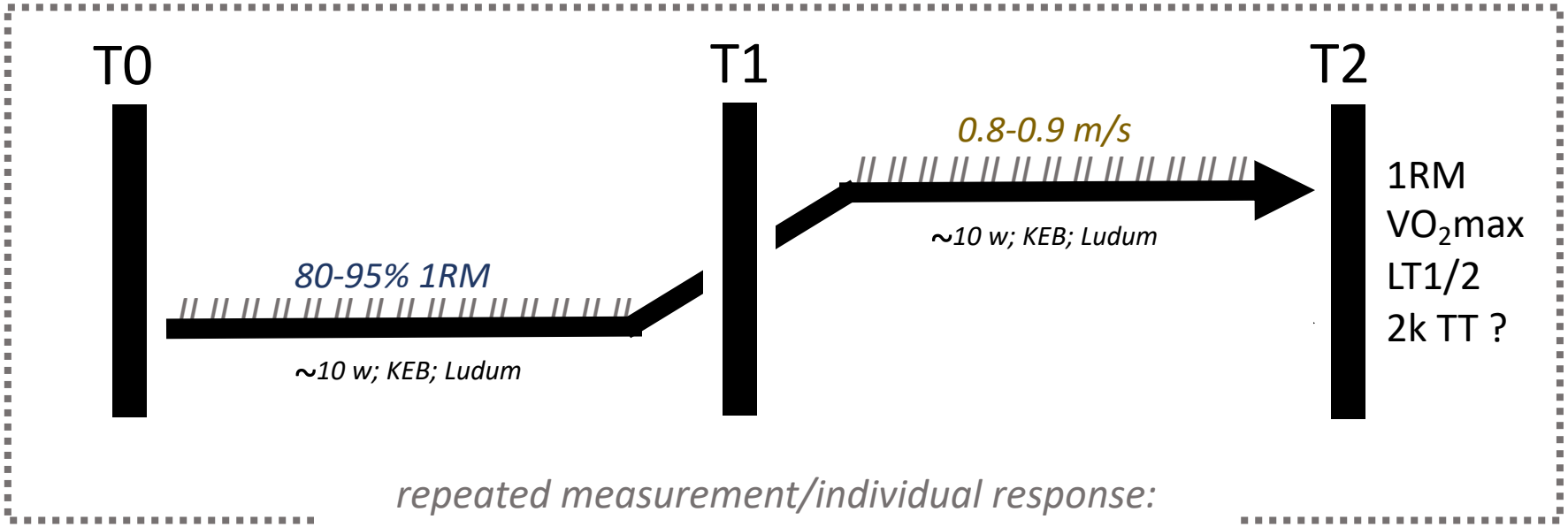


Effects of resistance training @0.8-0.9m/s vs. @80-95%1RM ?

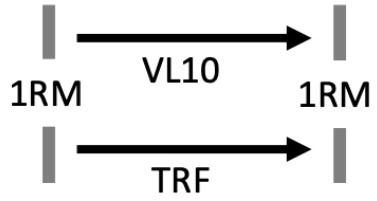
adapted from Dunst et al., 2021

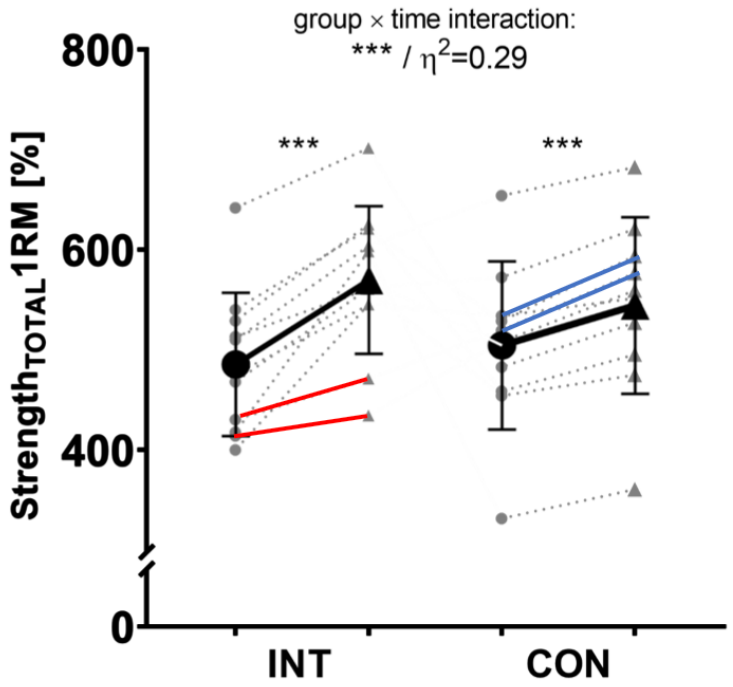
Effects of resistance training @0.8-0.9m/s vs. @80-95%1RM ?

***Participants**: 15-20 elite athletes*

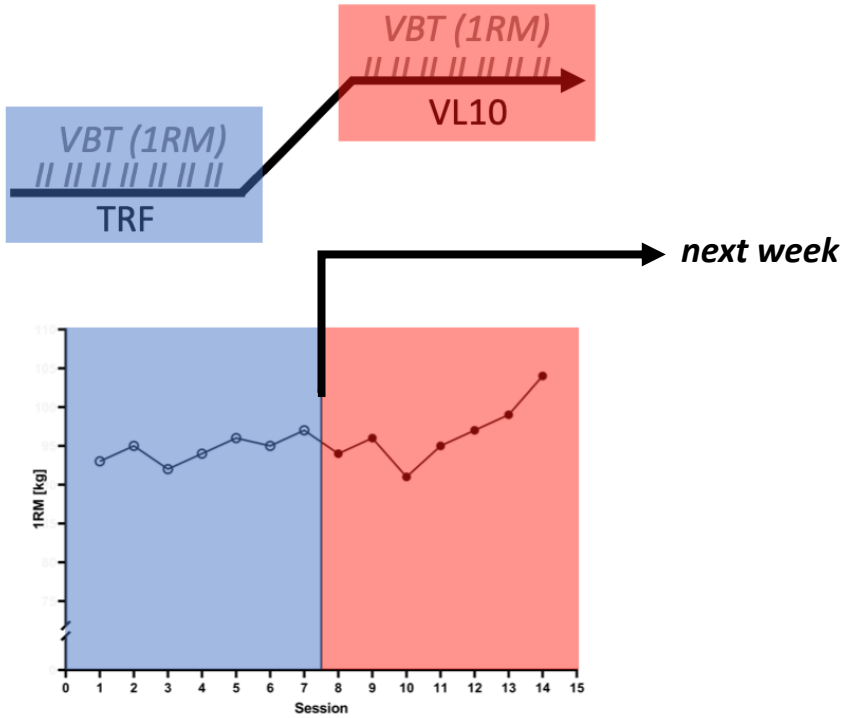


results 2023 ?!



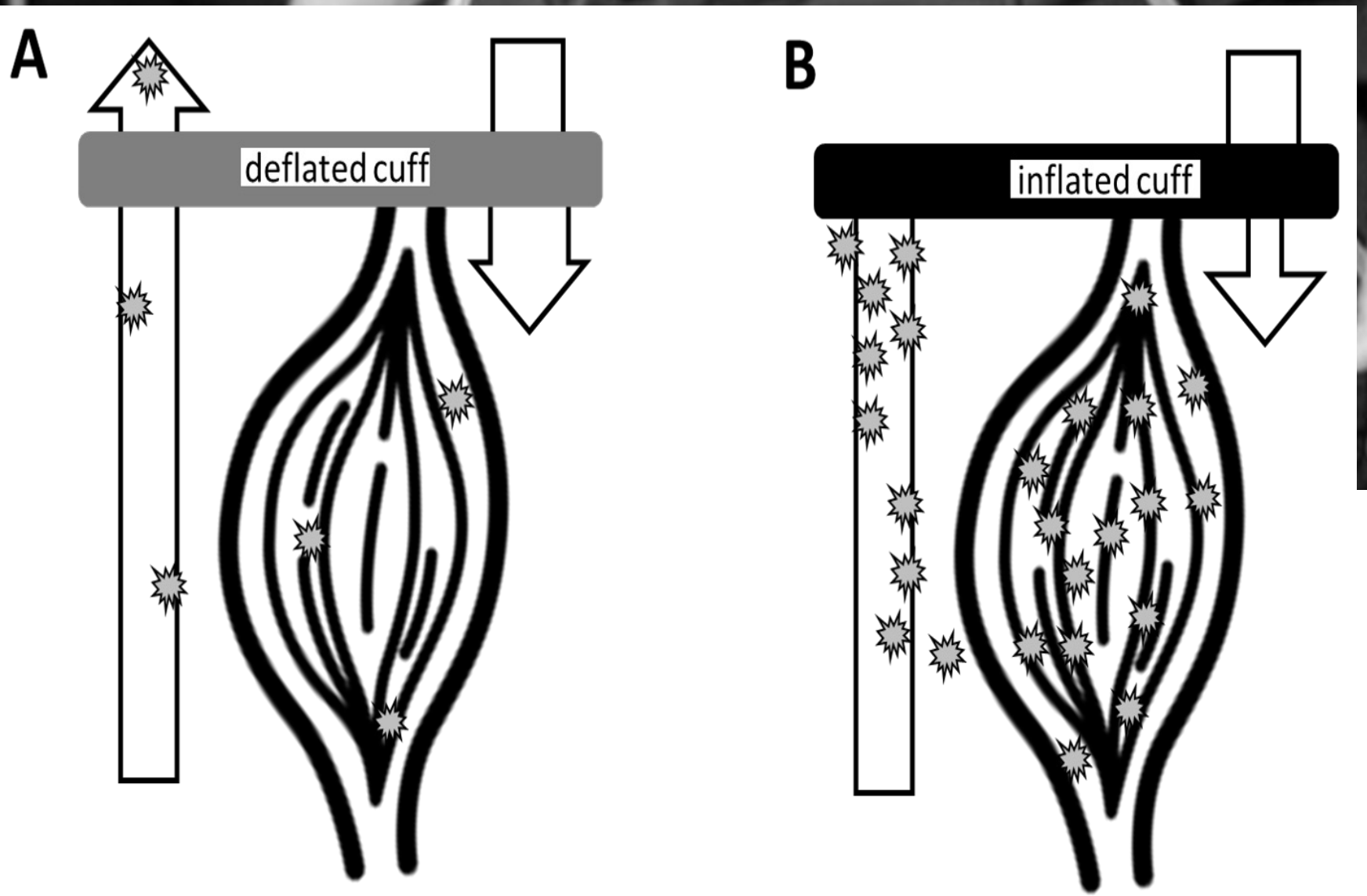


Inform.- prior



BFR IN ROWING?

restricted venous return & reduced aterial flow



Techniques in Orthopaedics®

Translational and Surgical Techniques

Mechanisms of Blood Flow Restriction

The New Testament

Jessee, Matthew B. MSc; Mattocks, Kevin T. MSc; Buckner, Samuel L. MSc; Dankel, Scott J. MSc; Mouser, J. Grant MSc; Abe, Takashi PhD; Loenneke, Jeremy P. PhD

Techniques in Orthopaedics: June 2018 - Volume 33 - Issue 2 - p 72–79

Scand J Med Sci Sports 2011
doi: 10.1111/j.1600-0838.2010.01290.x

SCANDINAVIAN JOURNAL OF
MEDICINE & SCIENCE
IN SPORTS

Review

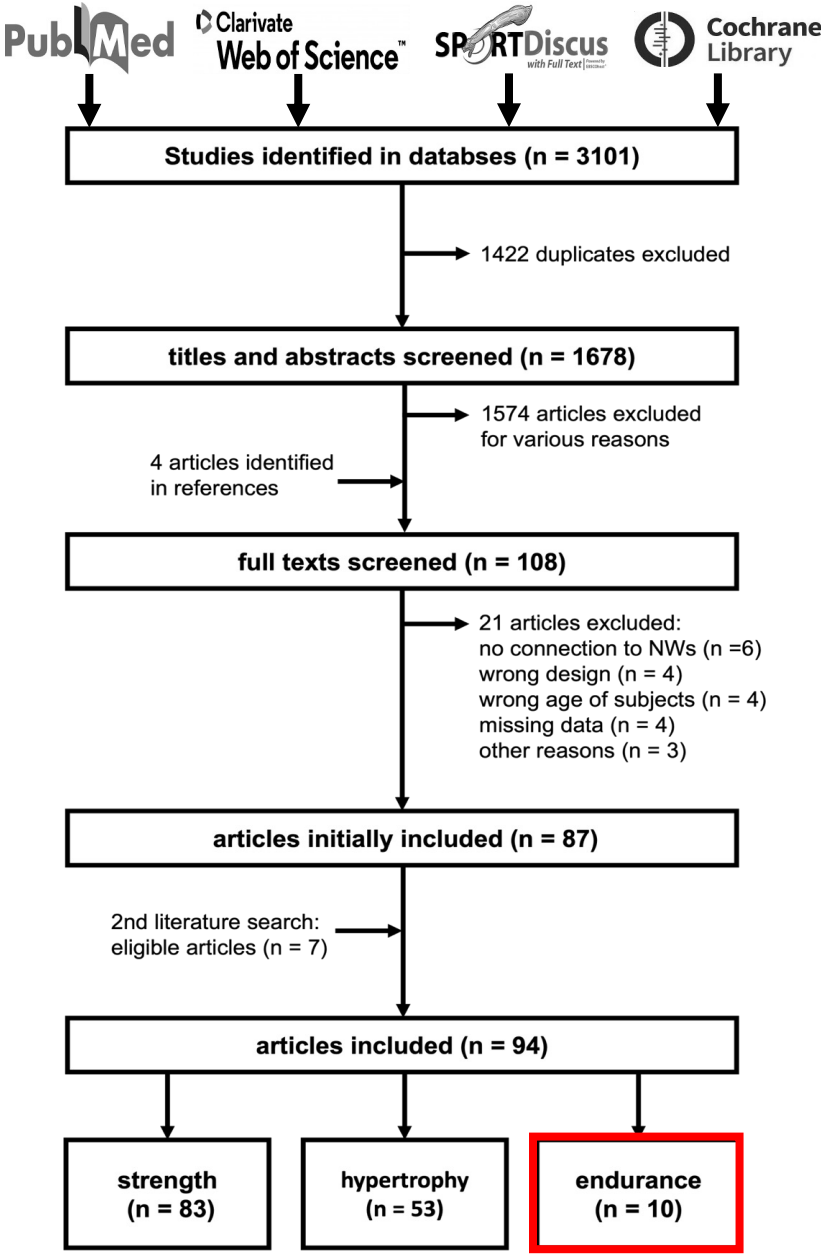
Potential safety issues with blood flow restriction training

J. P. Loenneke[1], J. M. Wilson[2], G. J. Wilson[3], T. J. Pujol[4], M. G. Bemben[1]

The focal point of previous literature was establishing the efficacy of blood flow restriction training with respect to muscular strength, muscular hypertrophy, and muscular endurance. After mounting evidence supporting the efficacy of low-intensity blood flow restriction training, research has shifted to the overall safety of this training modality. The aim of this review was to summarize the research on the overall safety of blood flow restriction training, focusing on the cardiovascular system (central and peripheral), muscle damage, oxidative stress, and nerve conduction velocity responses compared with those observed with regular exercise. Although still sparse, **the blood flow restriction training research thus far is promising with respect to safety outcomes. Individuals respond similarly to blood flow restriction training and to regular exercise;** however, longer term studies are required to better understand the chronic effects of low-intensity blood flow restriction training and possible safety issues.

***Kontraindikatoren**: offene Frakturen, akute Verletzungen an den Extremitäten, Krebserkrankungen, Schwangerschaft, Thrombose, Dialyse-Anwendungen, schwerer Bluthochdruck, gerinnungsfördernde Medikamente.*

Search level	Search terms with Boolean operators
Search #1	(“BFR” OR “blood flow restriction” OR “blood flow restriction training” OR “blood flow occlusion” OR “kaatsu training” OR “kaatsu” OR “occluded blood flow” OR “restricted blood flow” OR “vascular occlusion” OR “vascular restriction”)
Search #2	#1 AND (“VO_2peak“ OR “VO_2max” OR “maximal oxygen*” OR “aerobic capacity” OR “endurance” OR “threshold” OR “time trial” OR “time to exhaustion” OR “strength*” OR “torque” OR “peak torque” OR “one repetition maximum” OR “1RM” OR “1 repetition maximum” OR “MVC” OR “maximal voluntary contraction” OR “muscle thickness” OR “CSA” OR “cross sectional area” OR “muscle size” OR “muscle mass” OR “hypertrophy”)

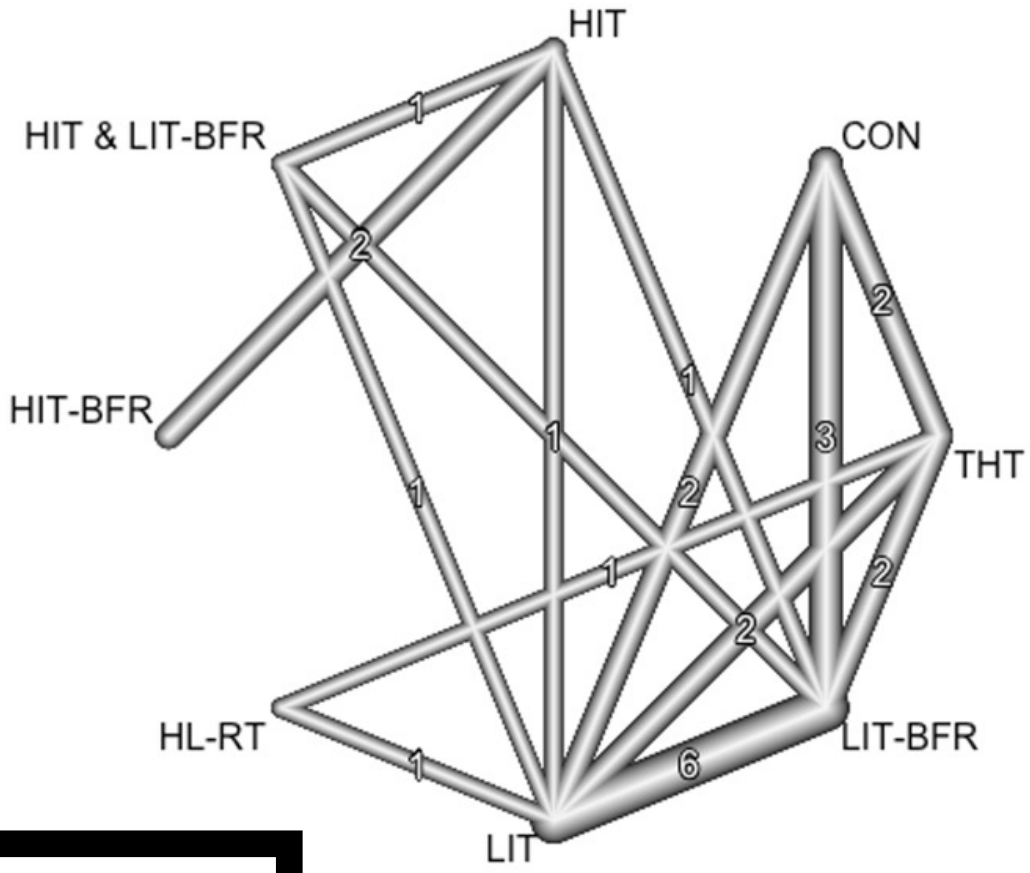


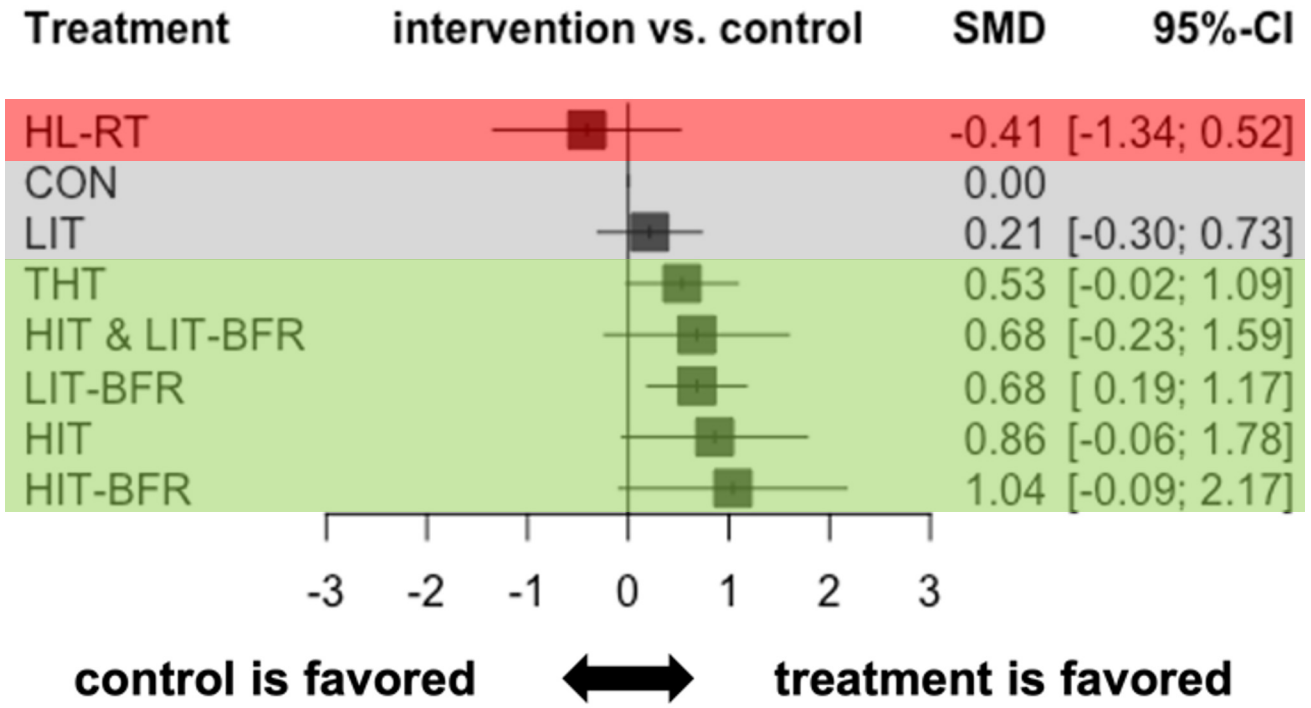
BFR: NMA

Wiedenmann, Held, Rappelt & Donath
PROSPERO (CRD42021249069)
registered network meta-analysis

(Wiedenmann et al., 2023)

VO_2max





BFR: NMA

Wiedenmann, Held, Rappelt & Donath
PROSPERO (CRD42021249069)
registered network meta-analysis

(Wiedenmann et al., 2023)

Eur J Appl Physiol (2002) 88: 243–246
DOI 10.1007/s00421-002-0699-9

ORIGINAL ARTICLE

S.A. Ingham · G.P. Whyte · K. Jones · A.M. Nevill

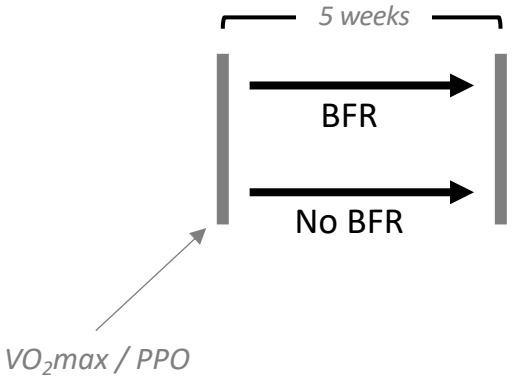
Determinants of 2,000 m rowing ergometer performance in elite rowers

	Women	Men	Total
	r	*r*	*r*
$\dot{W}_{\dot{V}O2max}$	0.91***	0.93***	0.95***
$\dot{V}_{max}$	0.76***	0.89***	0.95***
$\dot{W}_{max}$	0.74***	0.88***	0.95***
m_{ff}	0.75***	0.84***	0.94***
$\dot{W}_{2mmol^{-1}}$	0.92***	0.93***	0.92***
$\dot{W}_{4mmol}$	0.89***	0.92***	0.92***
$\dot{V}O_{2max}$	0.80***	0.82***	0.88***
$\dot{W}_{LT}$	0.57*	0.85***	0.88***
$\dot{V}O_{2LT,LSS}$	0.69**	0.81***	0.87***
$\dot{V}O_{2LT}$	0.52*	0.82***	0.86***
m_b	0.79***	0.76***	0.82***
h	0.70**	0.66***	0.76***
SL	0.53**	0.54**	0.76***
m_f	–0.68**	–0.68***	–0.79***
mf%	–0.49*	–0.48*	

EXKURS

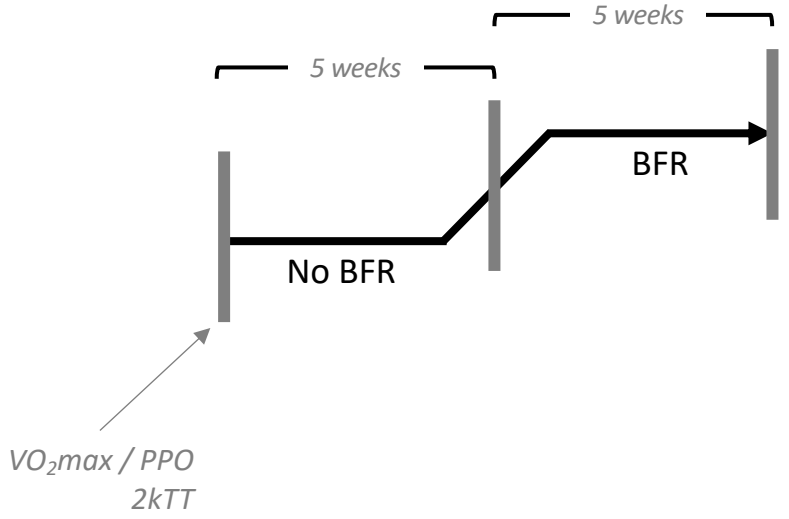
BFR [2020]

31 highly trained rowers



BFR [2022]

11 elite rowers



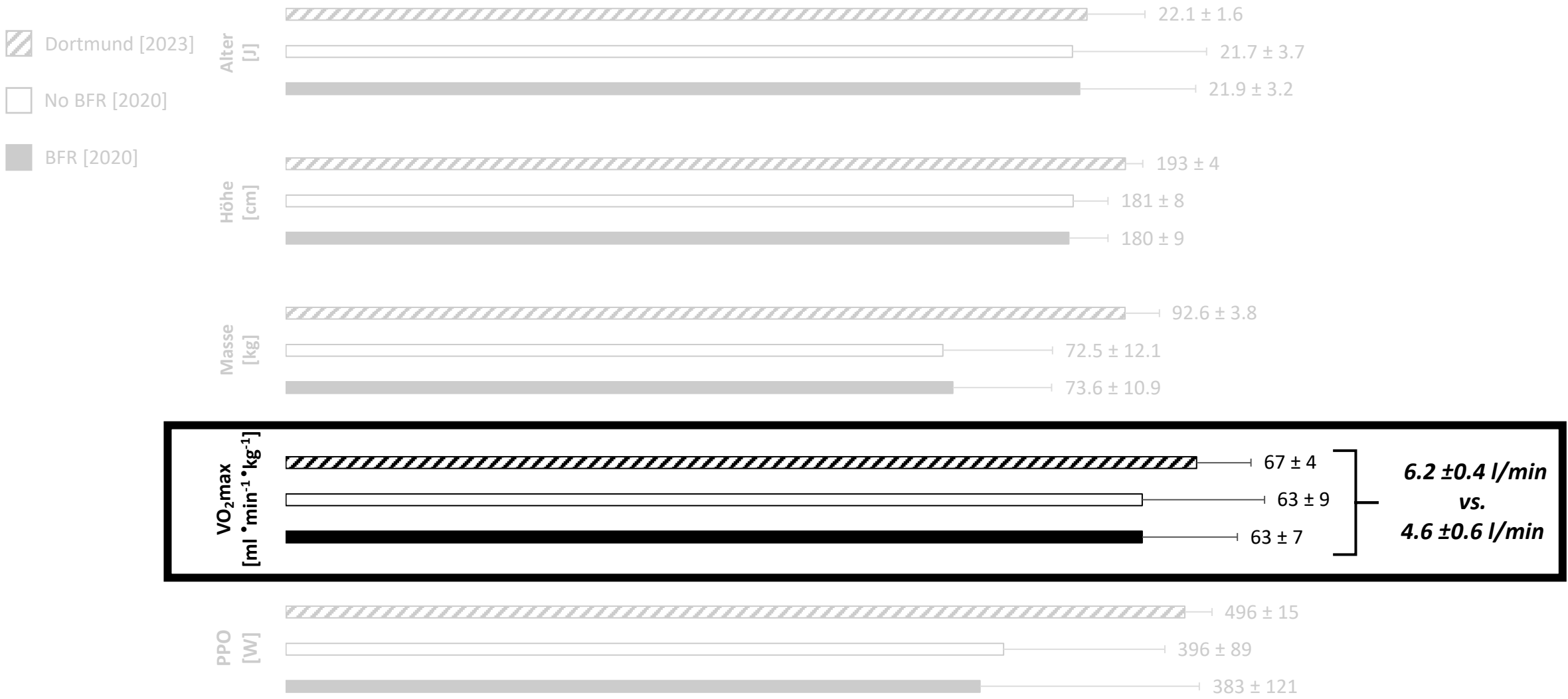
(Held et al., 2020; Held et al., 2023)

BFR amplication

2x10min low intensity /10min; 3/week

(Behringer et al., 2017)

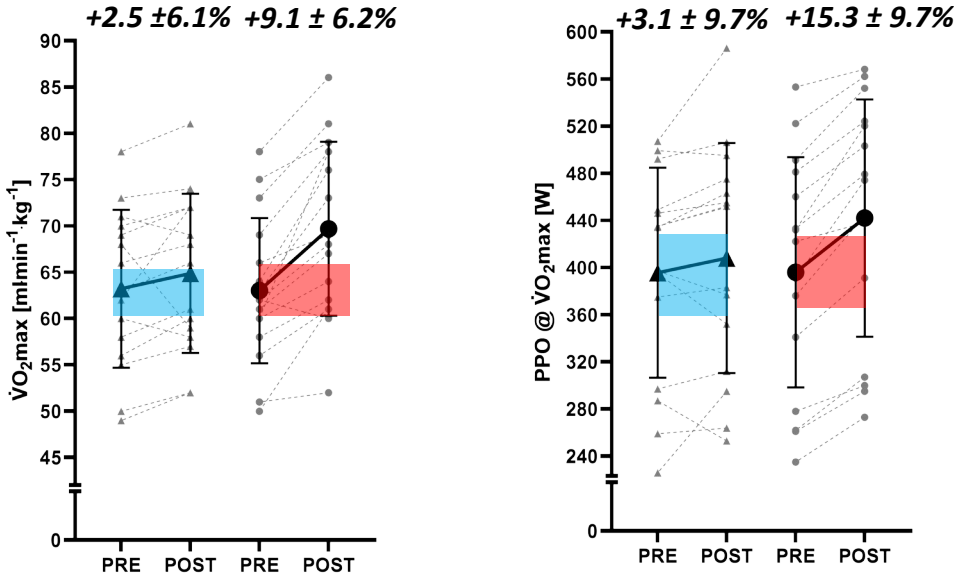
Athleten



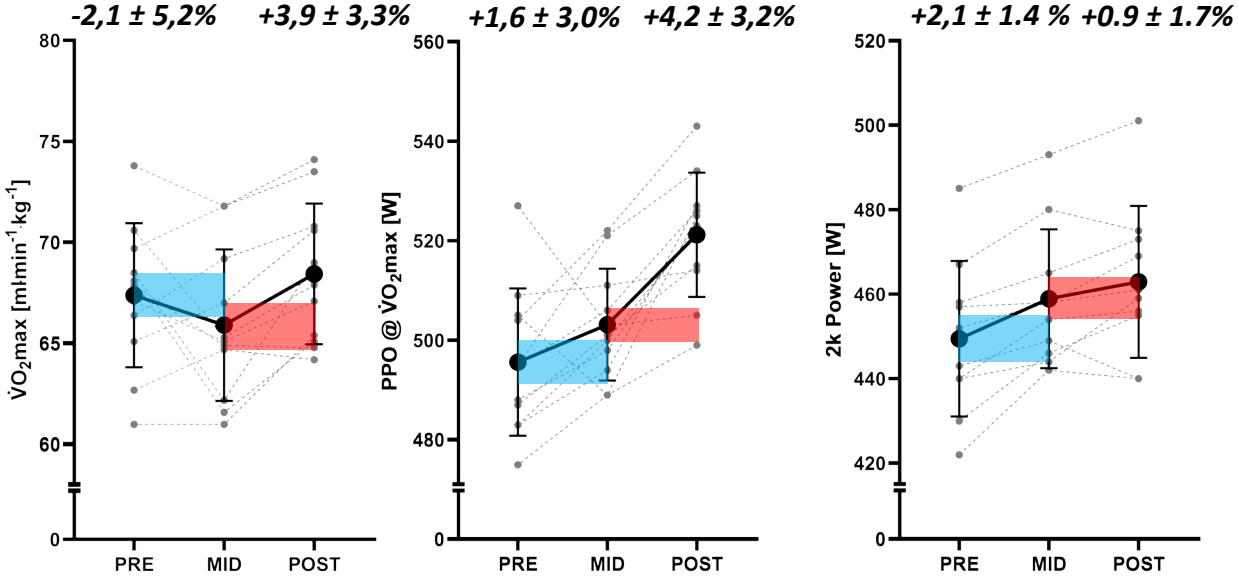
(Held et al., 2020; Held et al., 2023)

Ergebnisse

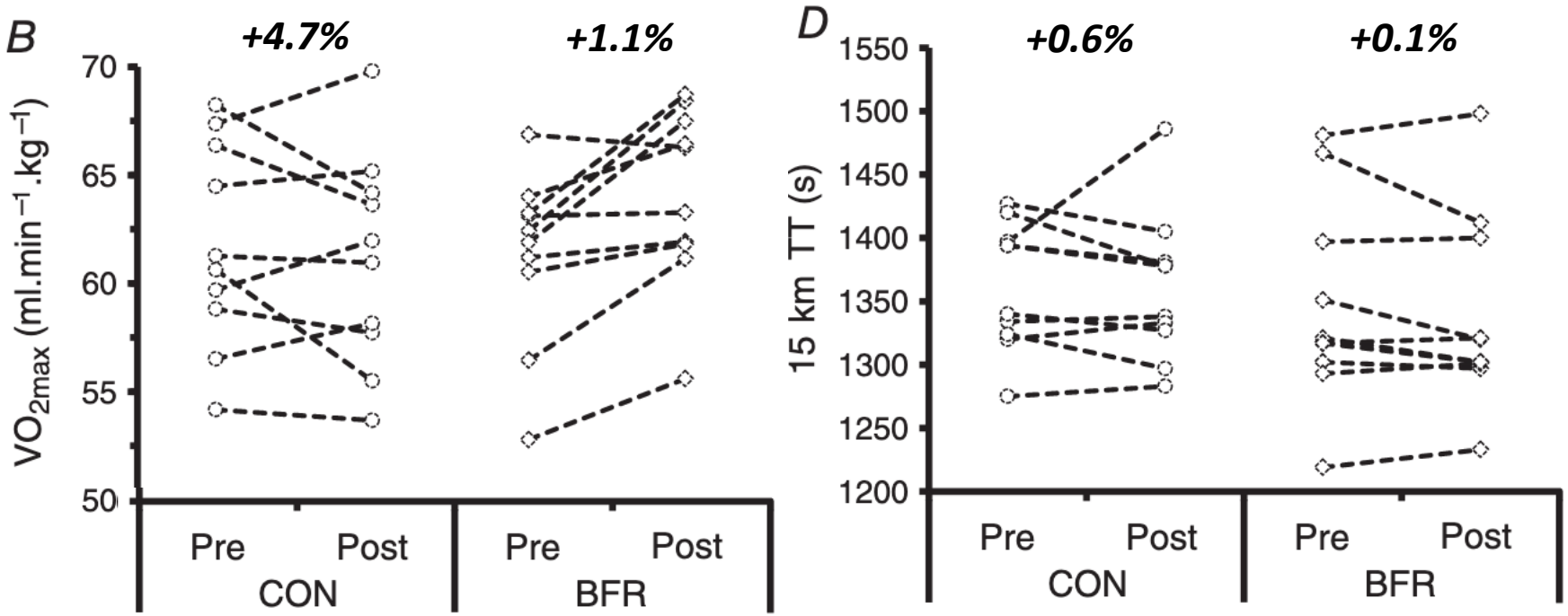
BFR [2020]



BFR [2022]



(Held et al., 2020; Held et al., 2023)



> Exp Physiol. 2016 Jan;101(1):143-54.
doi: 10.1113/EP085293. Epub 2015 Oct 30.

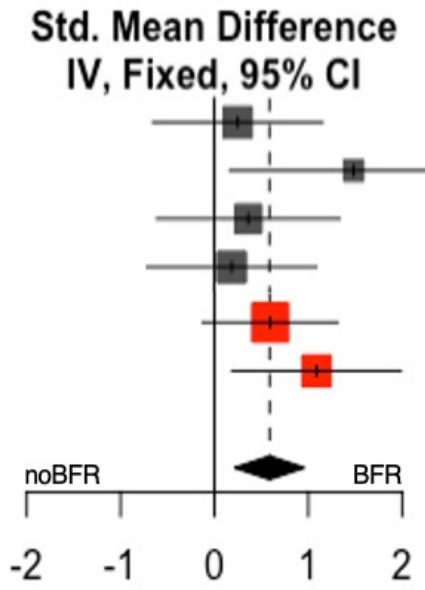
Acute and chronic effect of sprint interval training combined with postexercise blood-flow restriction in trained individuals

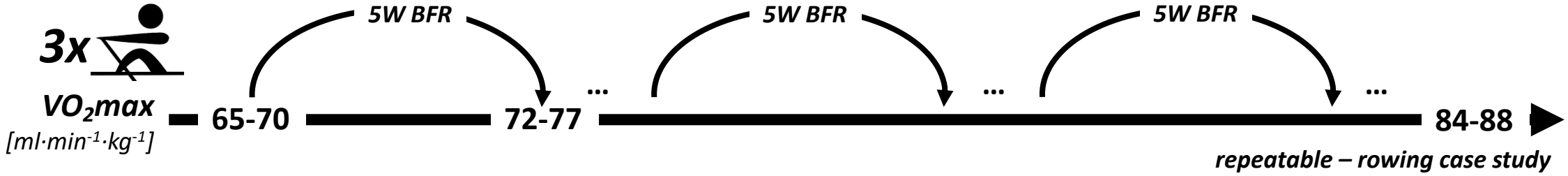
Conor W Taylor [1] [2], Stephen A Ingham [2], Richard A Ferguson [1]

VO2max

Study	TE	SE	Weight	Std. Mean Difference IV, Fixed, 95% CI	VO_2max [ml/min/kg]	Intervention
Abe2010	0.25	0.4615	16.9%	0.25 [-0.65; 1.15]	42.8 ± 8.1	18min 40% VO_2max cycling, 3/w, 8w
Park2010	1.49	0.6733	7.9%	1.49 [0.17; 2.81]	48.2 ± 4.5	19min 40% VO_2max walking, 12/w, 2w
deOliveira2016	0.36	0.4972	14.6%	0.36 [-0.61; 1.34]	46.3 ± 6.5	≈25min 30% VO_2max cycling, 3/w, 4w
Amani2018	0.19	0.4606	17.0%	0.19 [-0.72; 1.09]	54.3 ± 6.1	≈12min 60% HRR running, 4/w, 2w
Held2020	0.59	0.3678	26.6%	0.59 [-0.13; 1.31]	63.6 ± 8.2	20min ≤ 2mmol/L rowing, 3/w, 5w
Held2022	1.09	0.4598	17.0%	1.09 [0.19; 1.99]	67.4 ± 3.6	20min ≤ 2mmol/L rowing, 3/w, 5w
Total (95% CI)			**100.0%**	**0.59 [0.22; 0.96]**		

Heterogeneity: $Tau^2 < 0.0001$; $Chi^2 = 4.46$, df = 5 (P = 0.48); $I^2 = 0\%$





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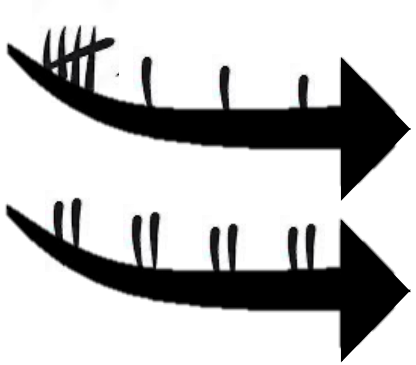
journal homepage: www.elsevier.com/locate/jsams

Original research

Low intensity rowing with blood flow restriction over 5 weeks increases $V\dot{O}_2$max in elite rowers: A randomized controlled trial

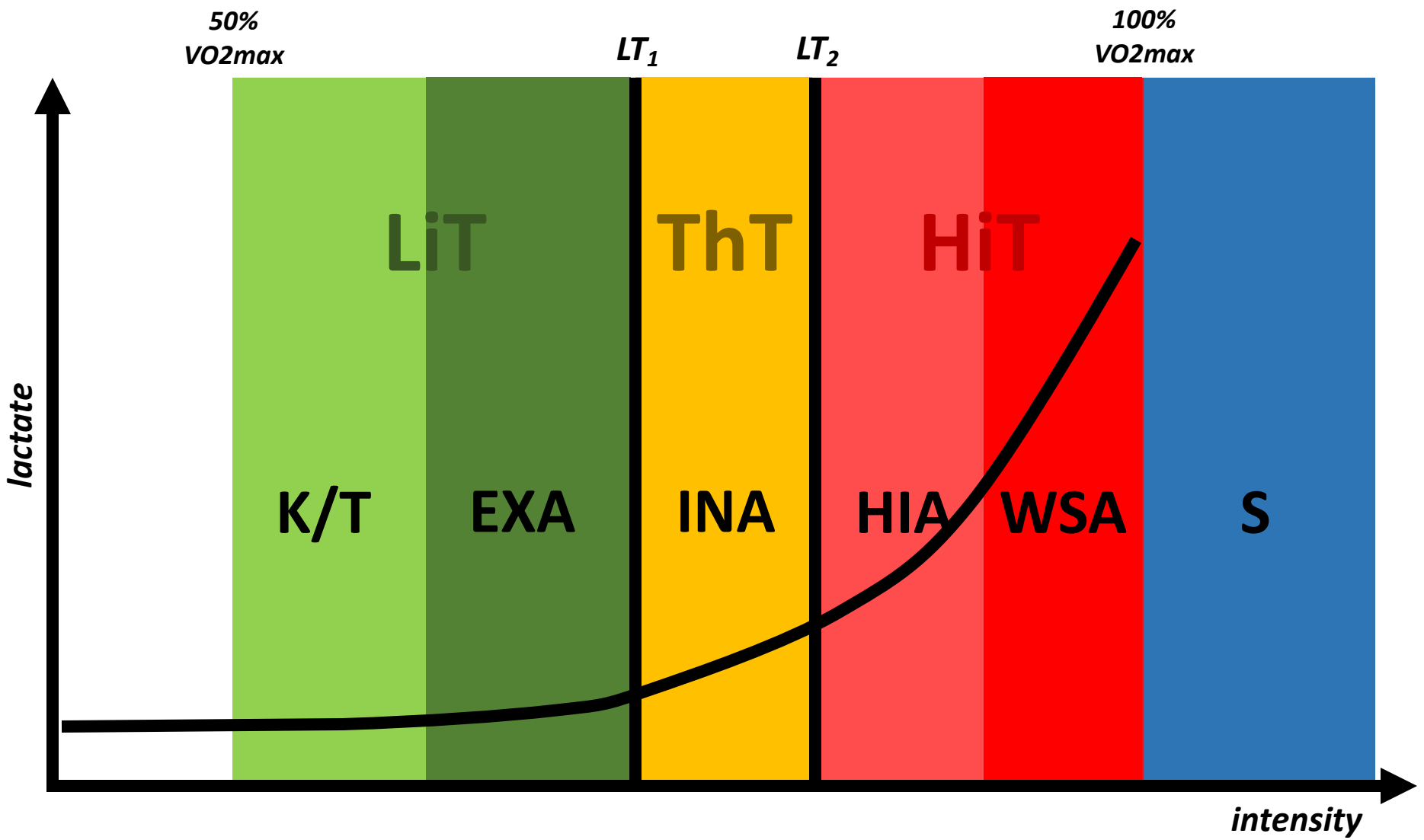
Steffen Held [a,*], Michael Behringer [b], Lars Donath [a]

[a] Department of Intervention Research in Exercise Training, German Sport University Cologne, Germany
[b] Institute of Sports Sciences, Goethe University Frankfurt, Germany



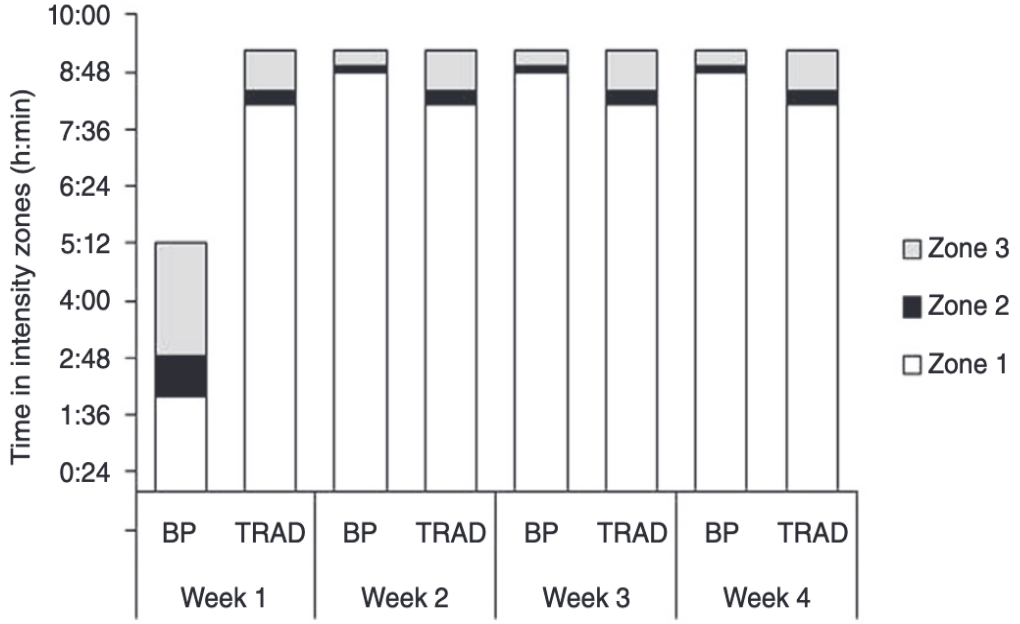
Block vs. Traditional Periodization of HiT

intensity zones



adapted Seiler et al., 2009

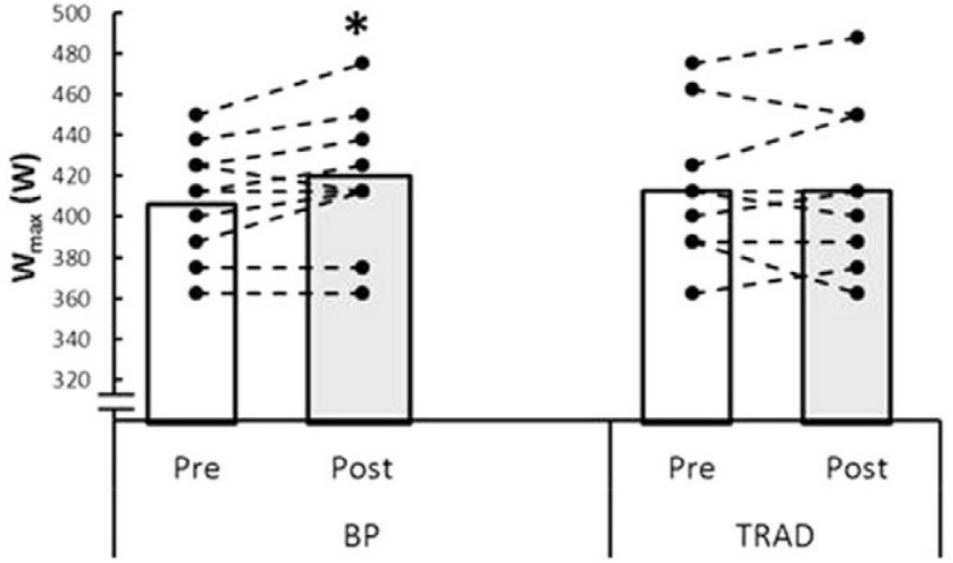
HiT - Block



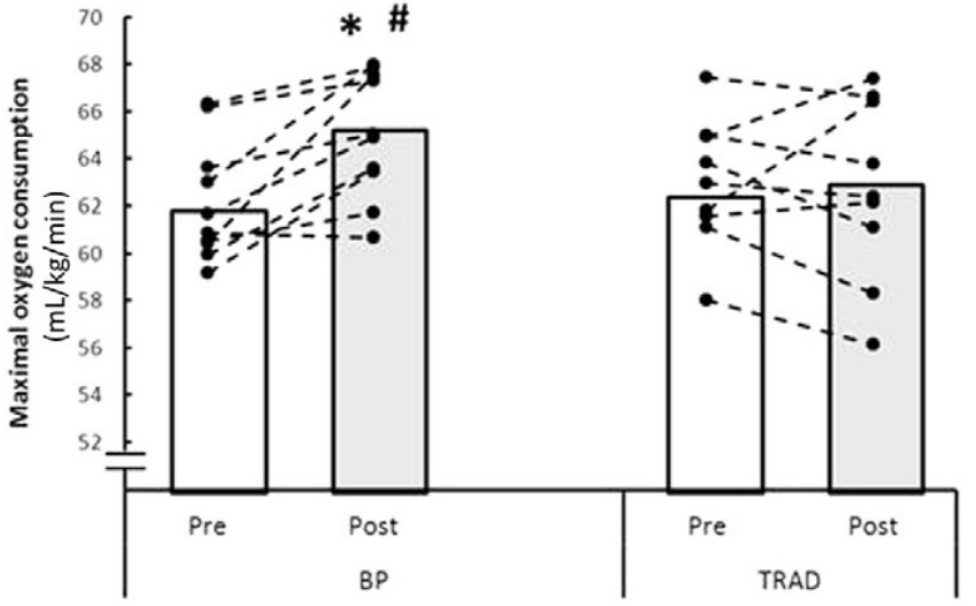
BP: ***5 + 1 + 1 + 1 = 8***

TRAD: ***2 + 2 + 2 + 2 = 8***

+2.1 ±2.8%



+4.6 ±3.7%

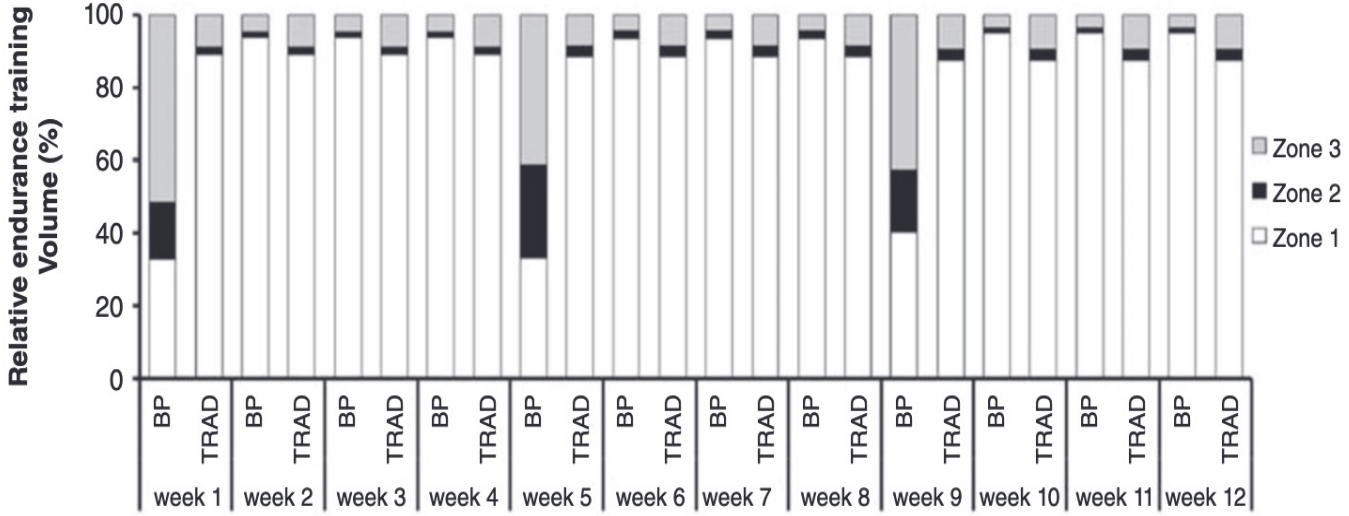


> Scand J Med Sci Sports. 2014 Feb;24(1):34-42.
doi: 10.1111/j.1600-0838.2012.01485.x. Epub 2012 May 31.

Block periodization of high-intensity aerobic intervals provides superior training effects in trained cyclists

B R Rønnestad [1], J Hansen, S Ellefsen

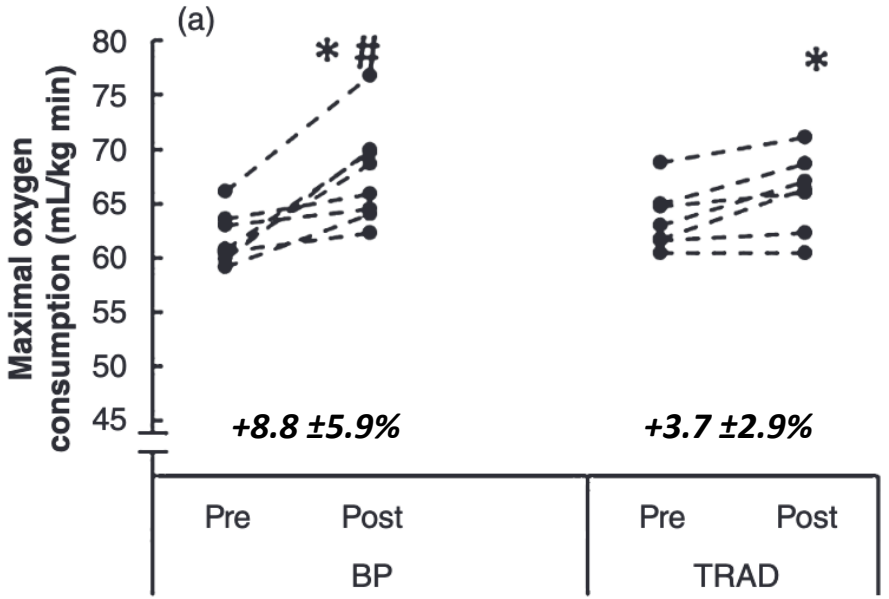
HiT - Block

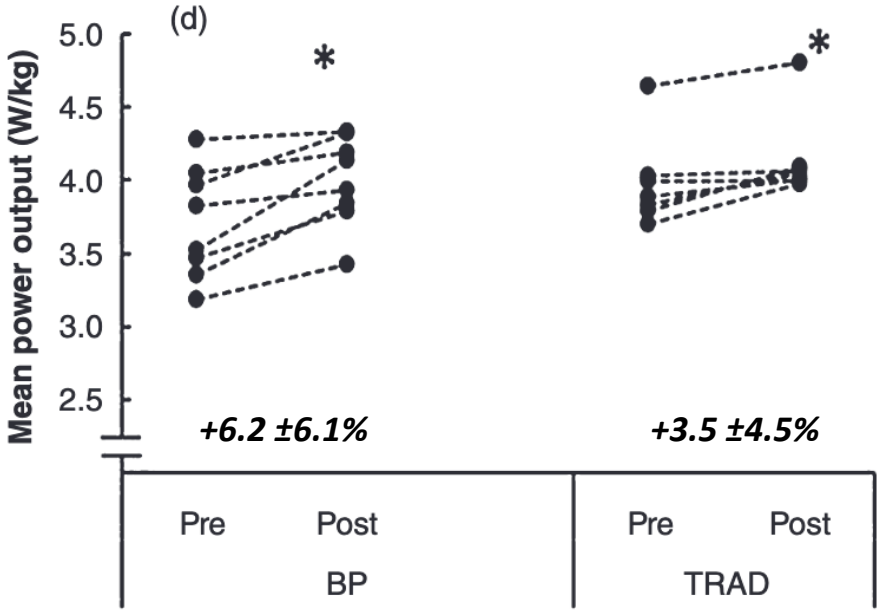


> Scand J Med Sci Sports. 2014 Apr;24(2):327-35.
doi: 10.1111/sms.12016. Epub 2012 Nov 8.

Effects of 12 weeks of block periodization on performance and performance indices in well-trained cyclists

B R Rønnestad [1], S Ellefsen, H Nygaard, E E Zacharoff, O Vikmoen, J Hansen, J Hallén





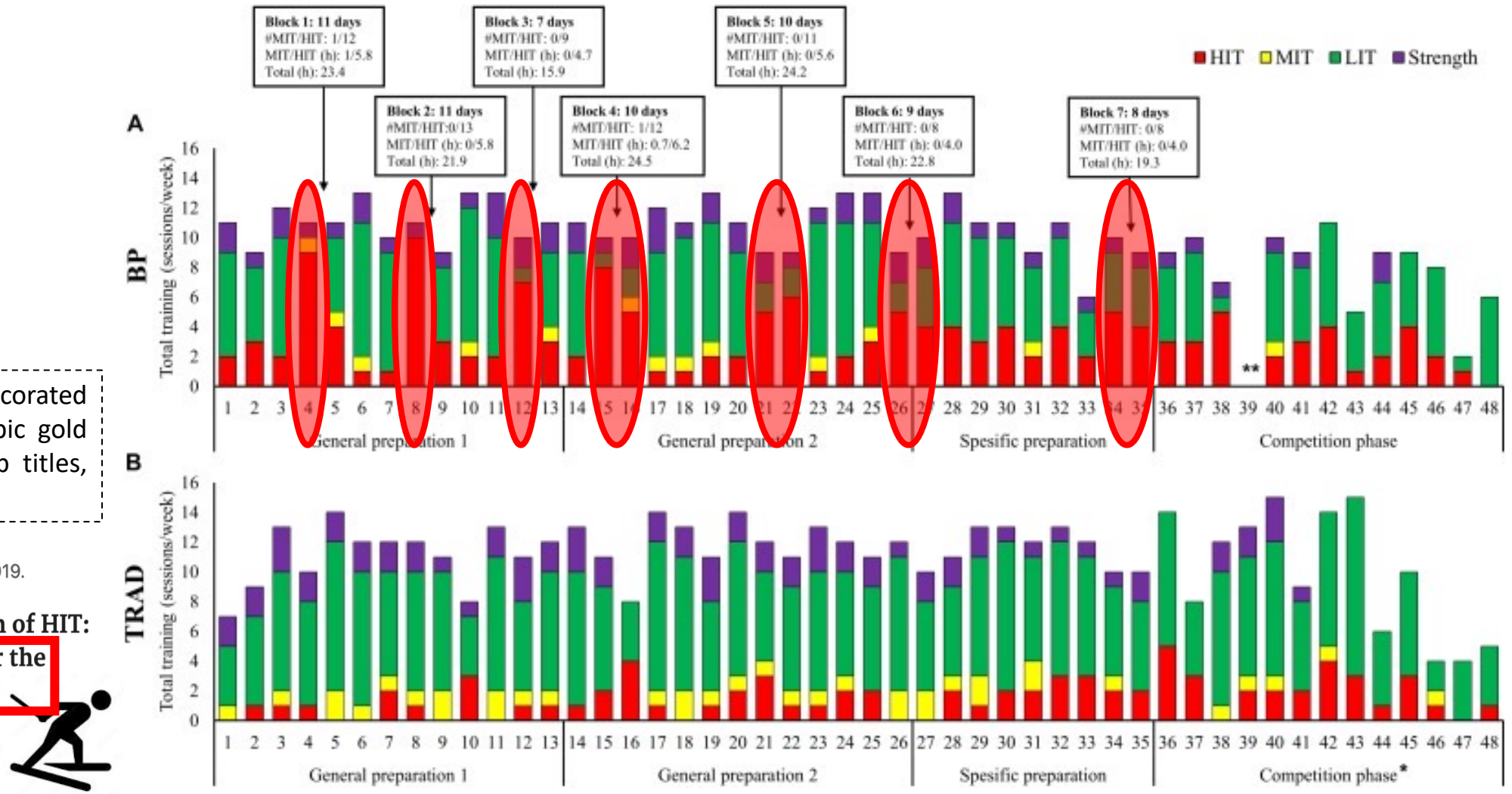
HiT – Block - season

The participant is the most-decorated winter Olympian, with 8 Olympic gold medals, 18 world championship titles, and 114 world cup victories.

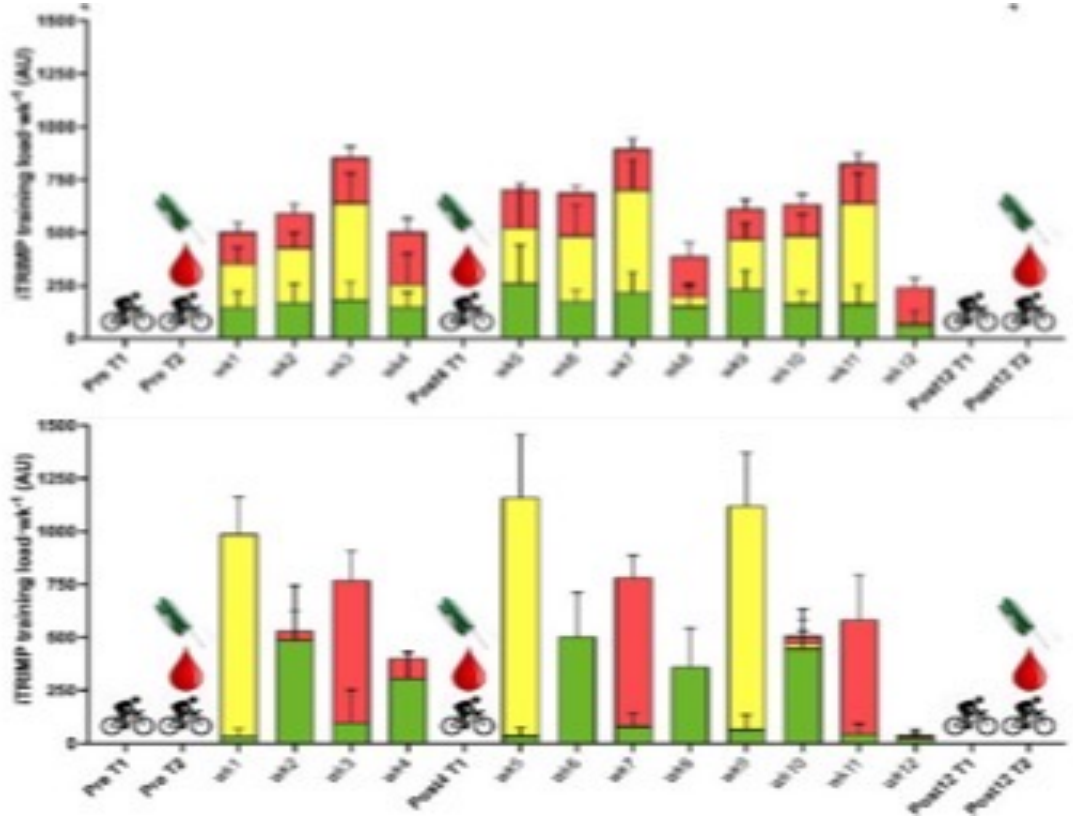
> Front Physiol. 2019 Apr 5;10:375.
doi: 10.3389/fphys.2019.00375. eCollection 2019.

Block vs. Traditional Periodization of HIT: Two Different Paths to Success for the World's Best Cross-Country Skier

Guro Strøm Solli [1 2], Espen Tønnessen [3], Øyvind Sandbakk [2]



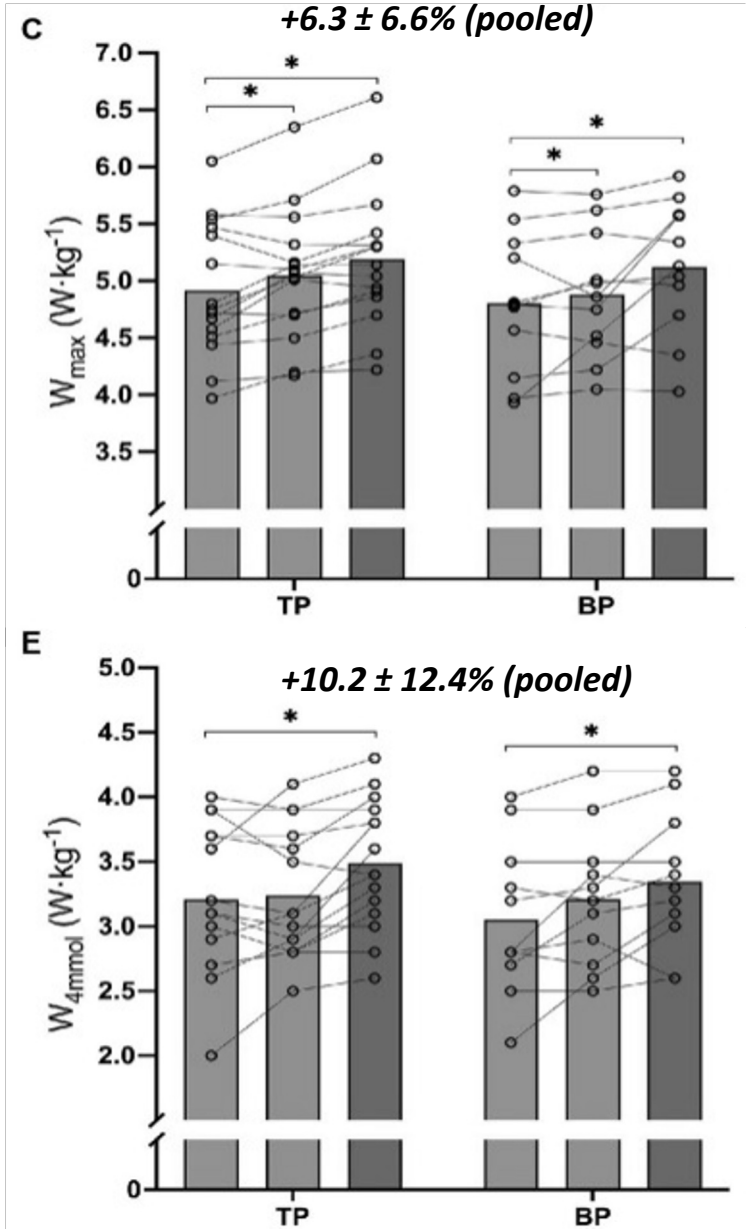
HiT - Block



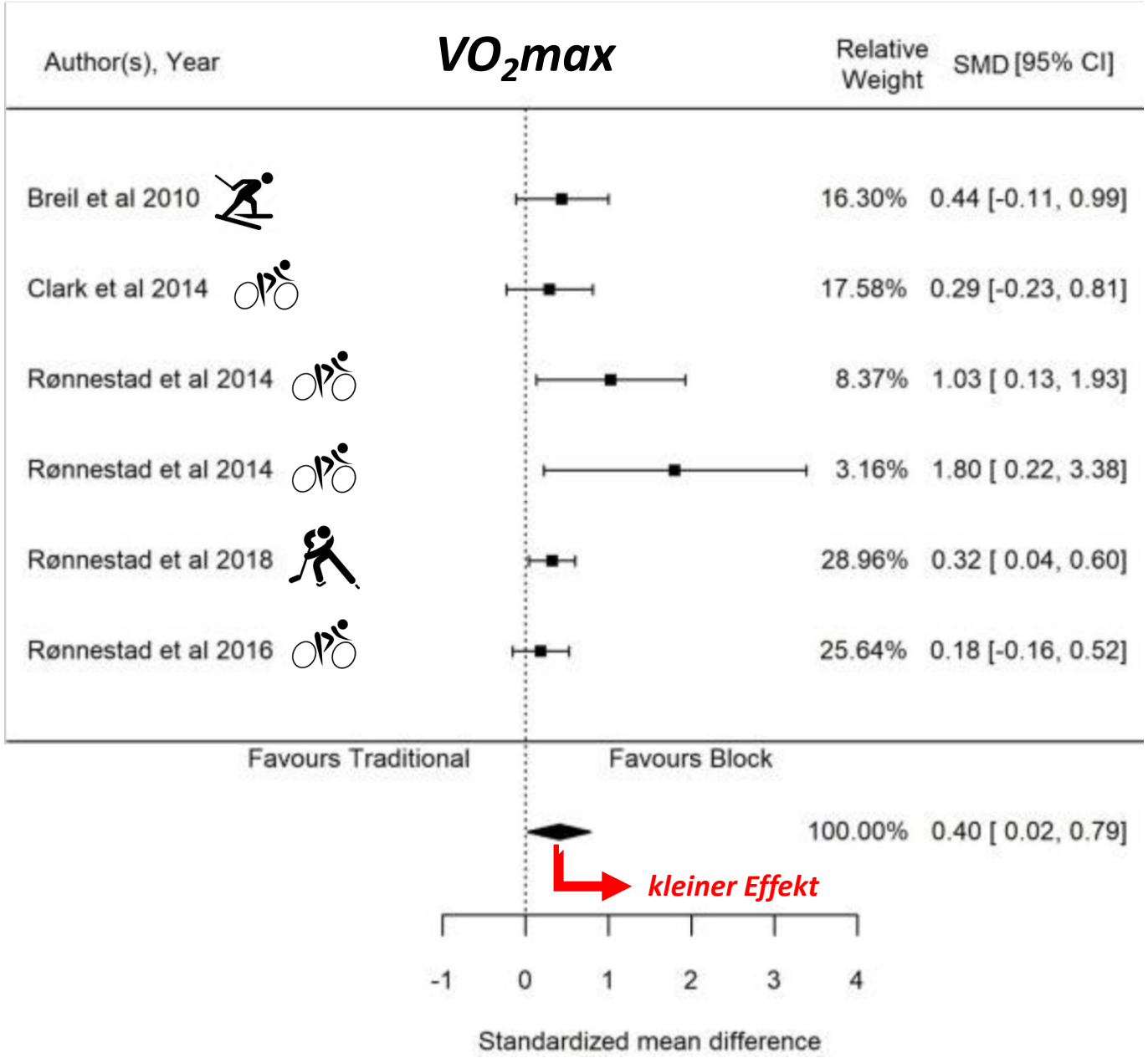
> Front Physiol. 2022 Mar 1;13:837634.
doi: 10.3389/fphys.2022.837634. eCollection 2022.

No Differences Between 12 Weeks of Block- vs. Traditional-Periodized Training in Performance Adaptations in Trained Cyclists

Nicki Winfield Almquist [1 2], Hanne Berg Eriksen [1], Malene Wilhelmsen [1], Håvard Hamarsland [1], Steven Ing [2], Stian Ellefsen [1], Øyvind Sandbakk [2], Bent R Rønnestad [1], Knut Skovereng [2]



HiT - Block



> Open Access J Sports Med. 2019 Oct 17;10:145-160.
doi: 10.2147/OAJSM.S180408. eCollection 2019.

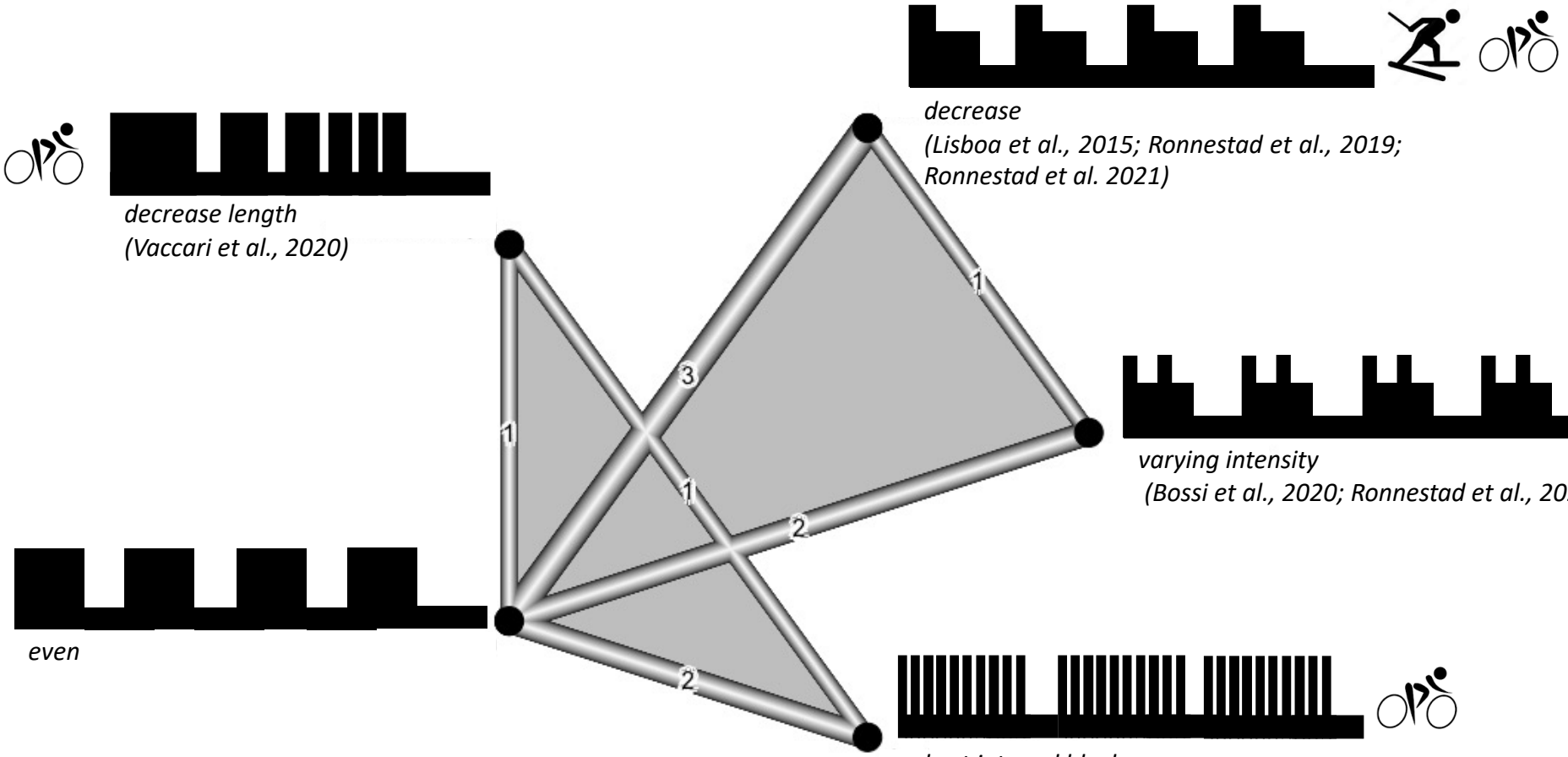
Block periodization of endurance training – a systematic review and meta-analysis

Knut Sindre Mølmen [#1], Sjur Johansen Øfsteng [#1], Bent R Rønnestad [1]

(Held et al., 2023)

HiT = HiT?!

accumulated time ≥ 90% VO_2max



PRELIMINARY DATA

Held, Wiedenmann, Rappelt & Donath

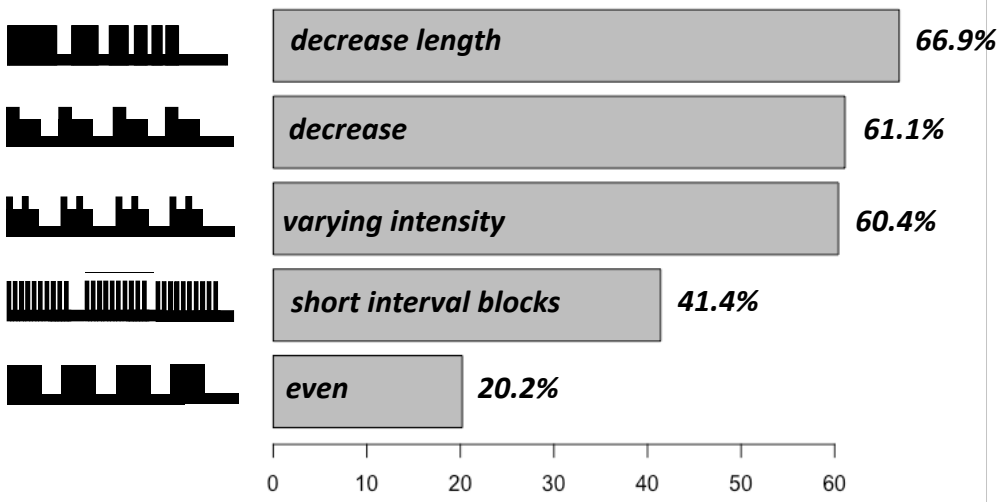
*PROSPERO (CRD**391814**)*

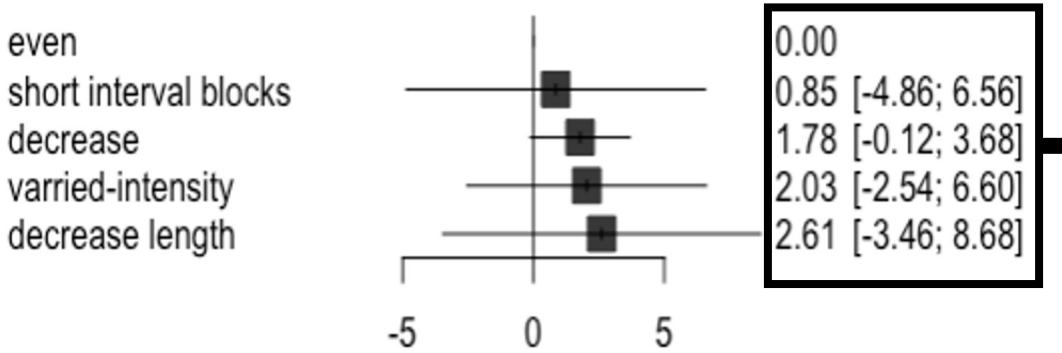
registered network meta-analysis

(Held et al., 2023)

HiT: NMA

I^2 = 0.0% (95CI: 0.0 to 79.2%)
Q_{total} = 0.5 (p = 0.98)
$Q_{within\ designs}$ = 0.0 (p = 0.89)
$Q_{between\ designs}$ = 0.4 (p = 0.93)



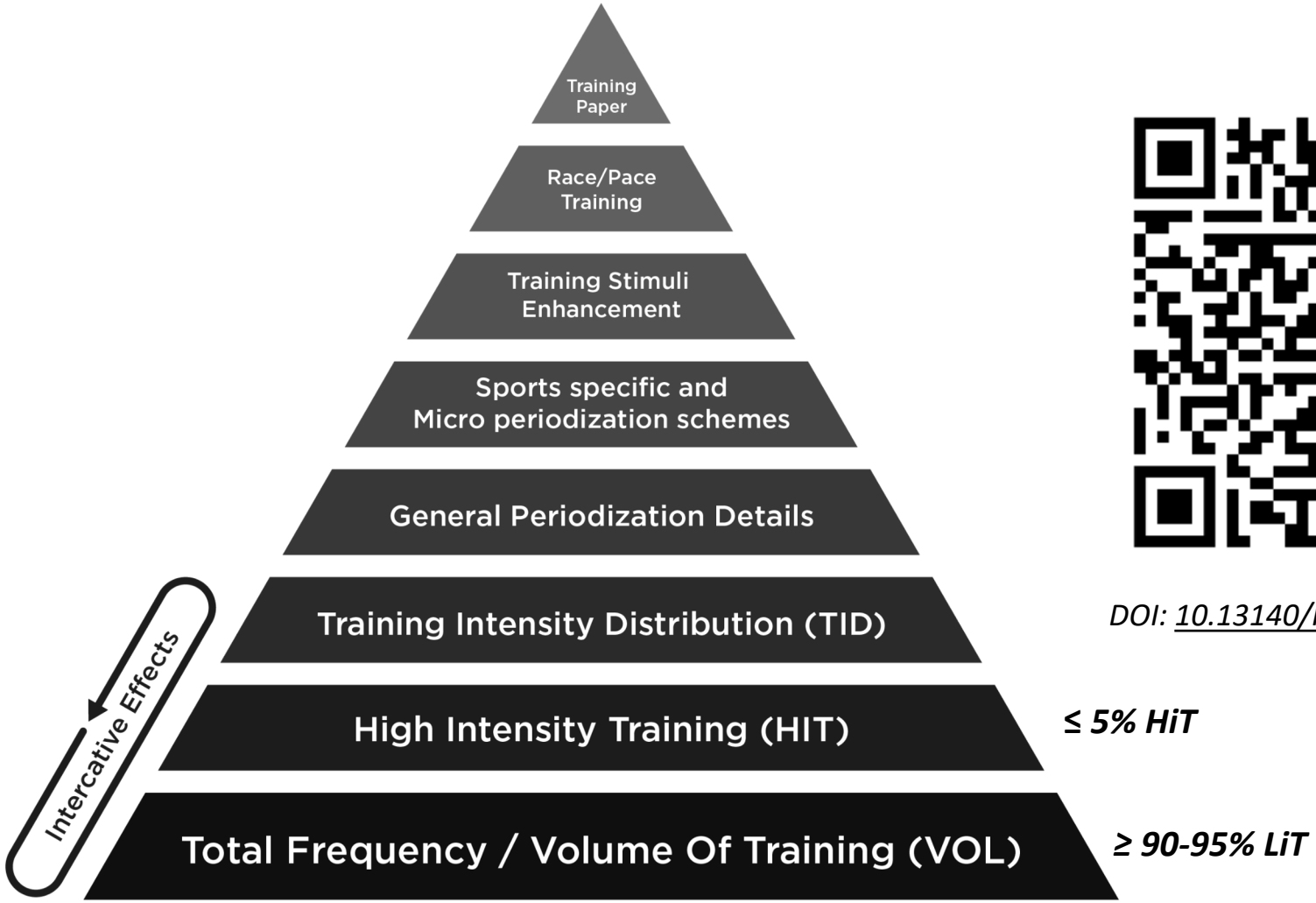


6w (2 HiT/w), equals to:

+2 ±5 HiT sessions
+3 ±2 HiT sessions
+4 ±4 HiT sessions
+5 ±6 HiT sessions

PRELIMINARY DATA

(Held et al., 2023)



SEILER'S HIERARCHY OF ENDURANCE TRAINING NEEDS

DOI: 10.13140/RG.2.2.16667.05924

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German Sport University Cologne

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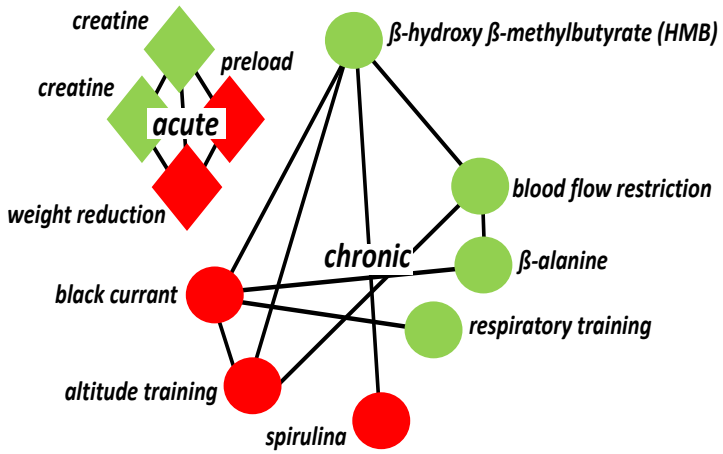
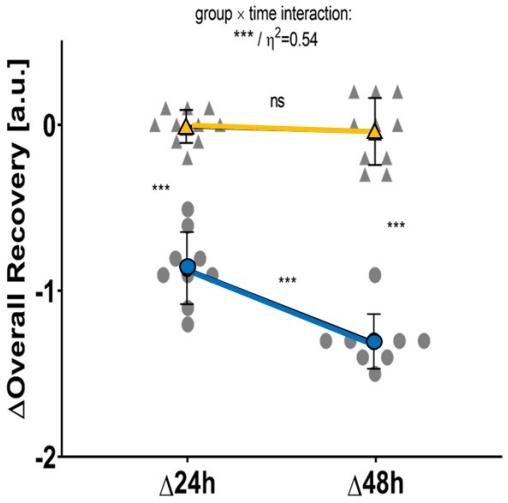
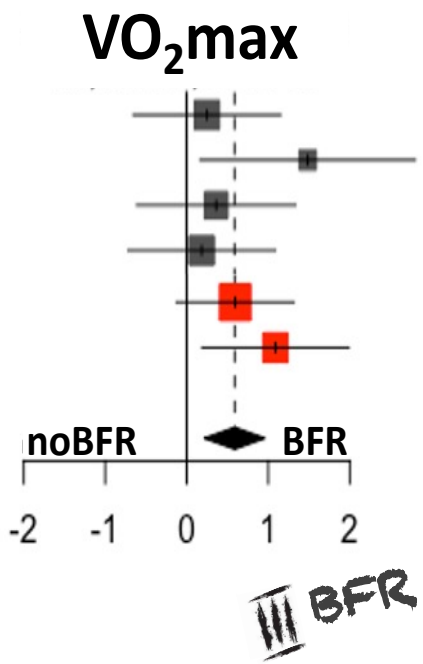
@steffen_held



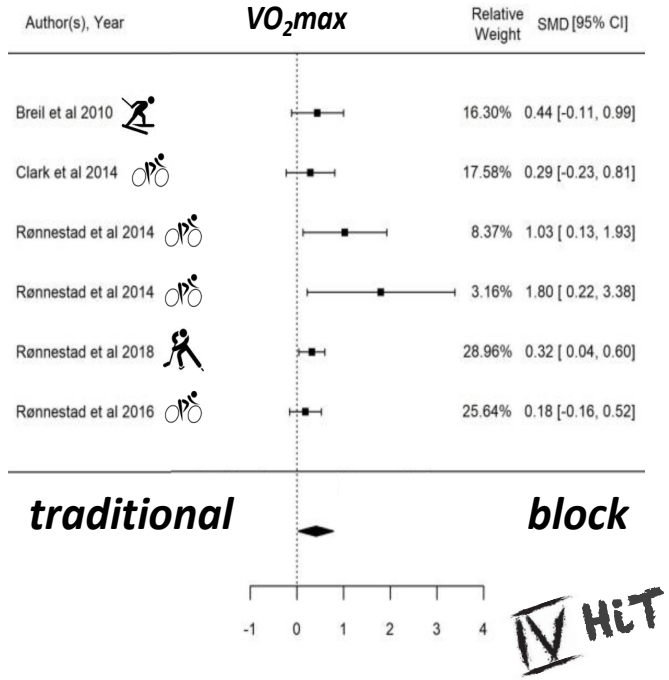
I NMA



II VBT



III BFR



IV HiT

DANKE