RESISTANCE EXERCISE: KEY STRATEGY FOR HEALHTY LONGEVITY

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'Healthy Ageing & Geriatric Rehabilitation'

LONGEVITY AND AGEING

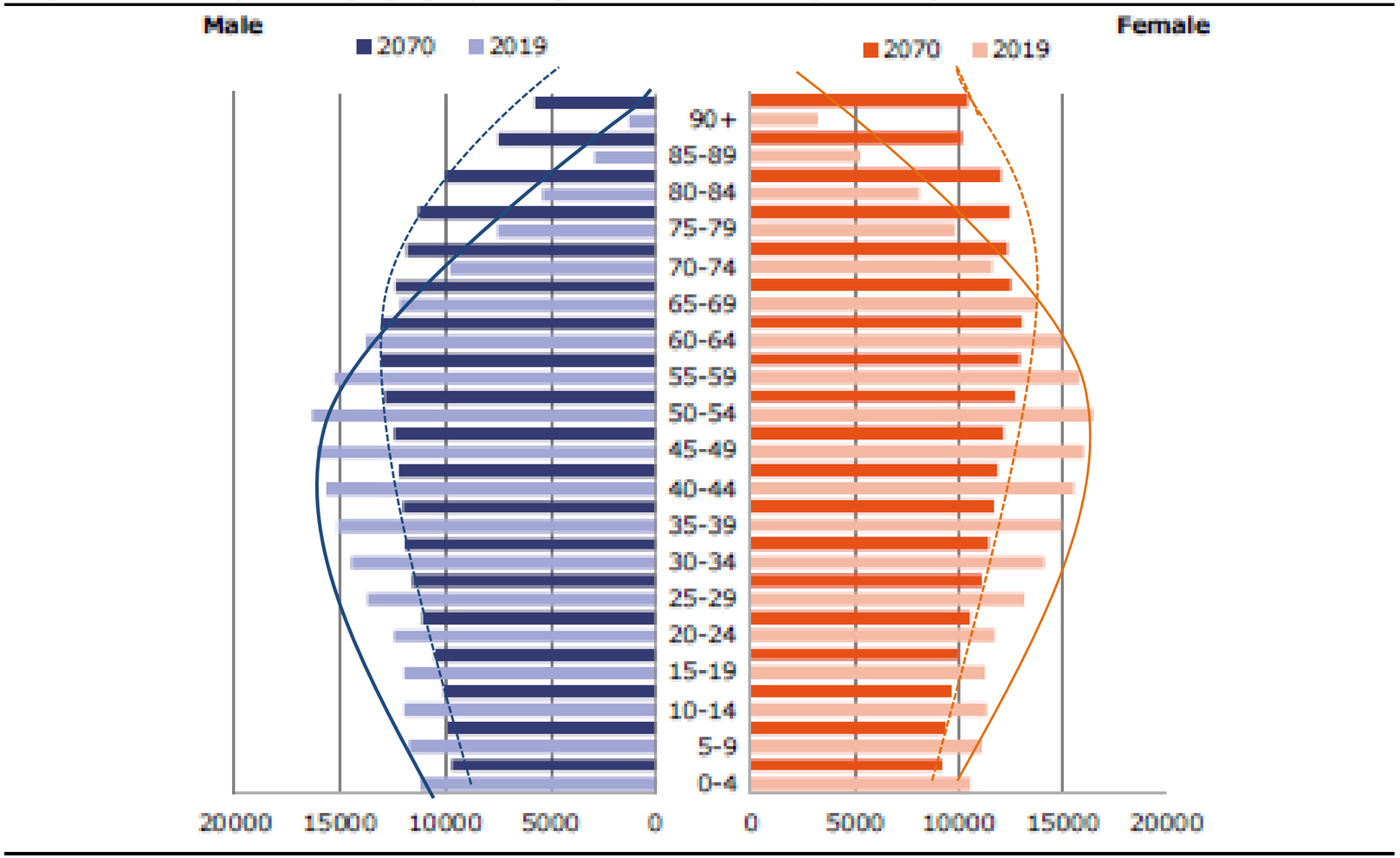
RESISTANCE EXERCISE FOR HEALTHY LONGEVITY

LONGEVITY AND AGEING

RESISTANCE EXERCISE FOR HEALTHY LONGEVITY

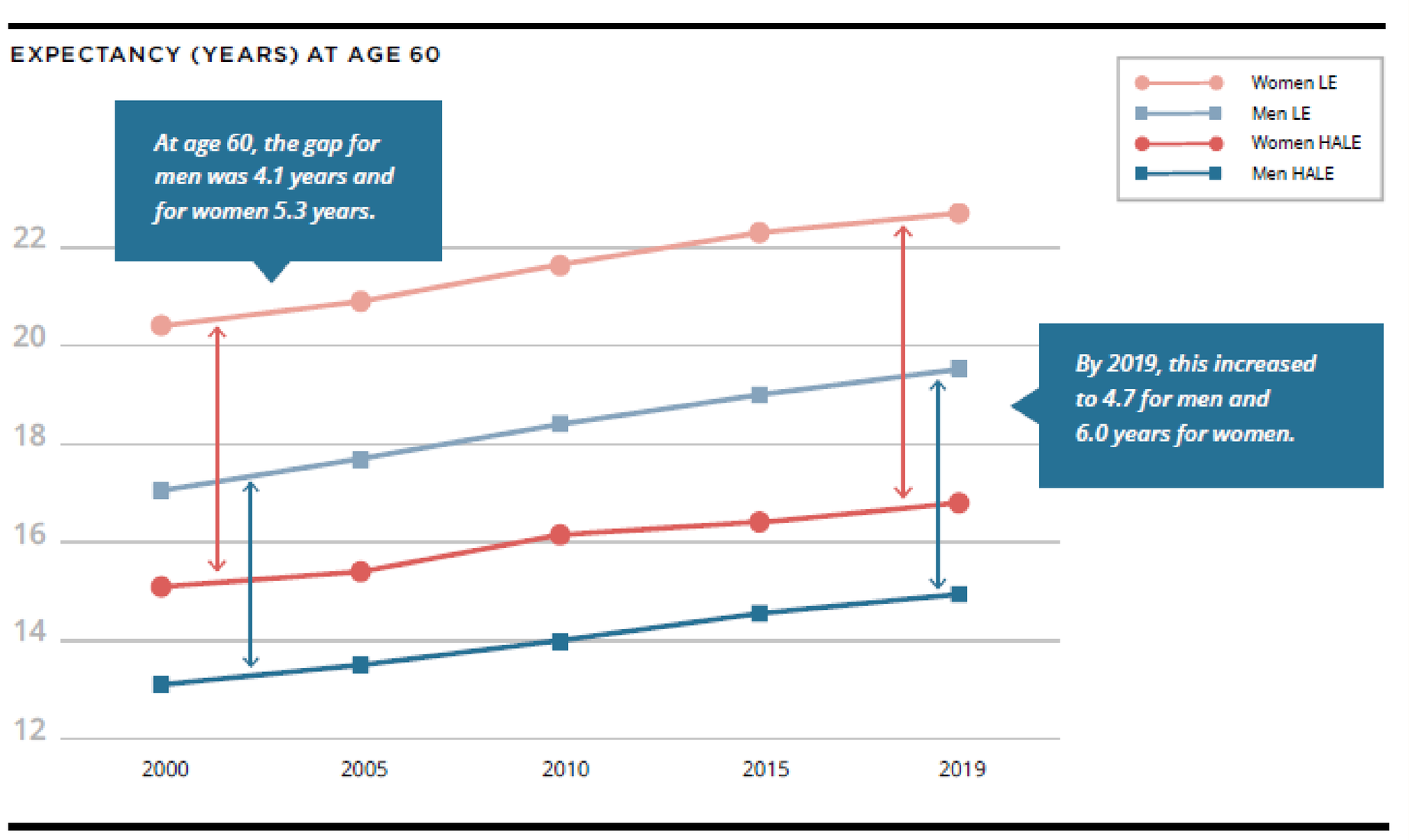
AGEING DEMOGRAPHICS

Birth rates
Life expectancy
Migration

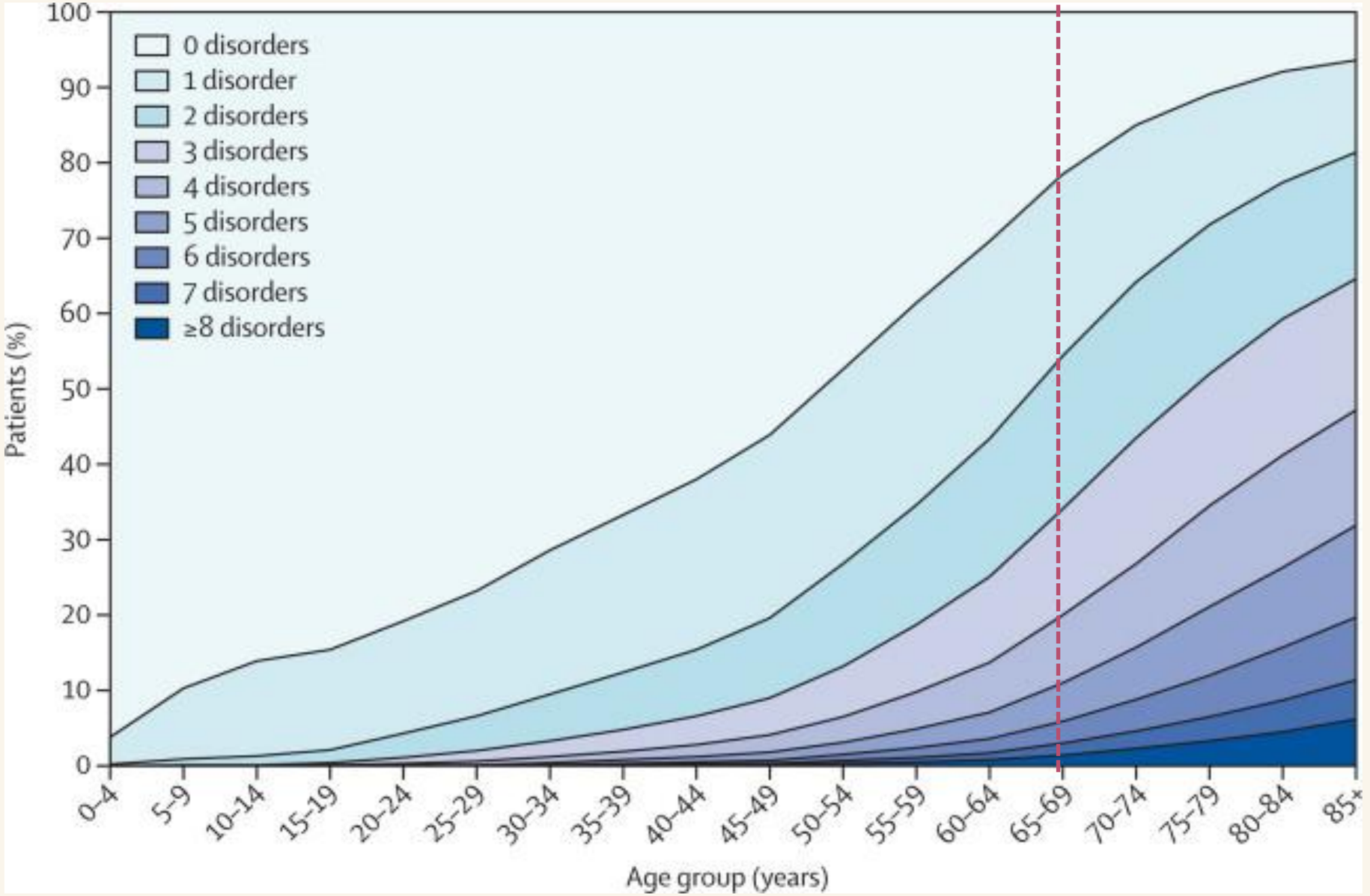


The 2021 Ageing Report: Economic & Budgetary Projections for the EU Member States (2019-2070). European Commission, 2021.

HEALTHY YEARS?

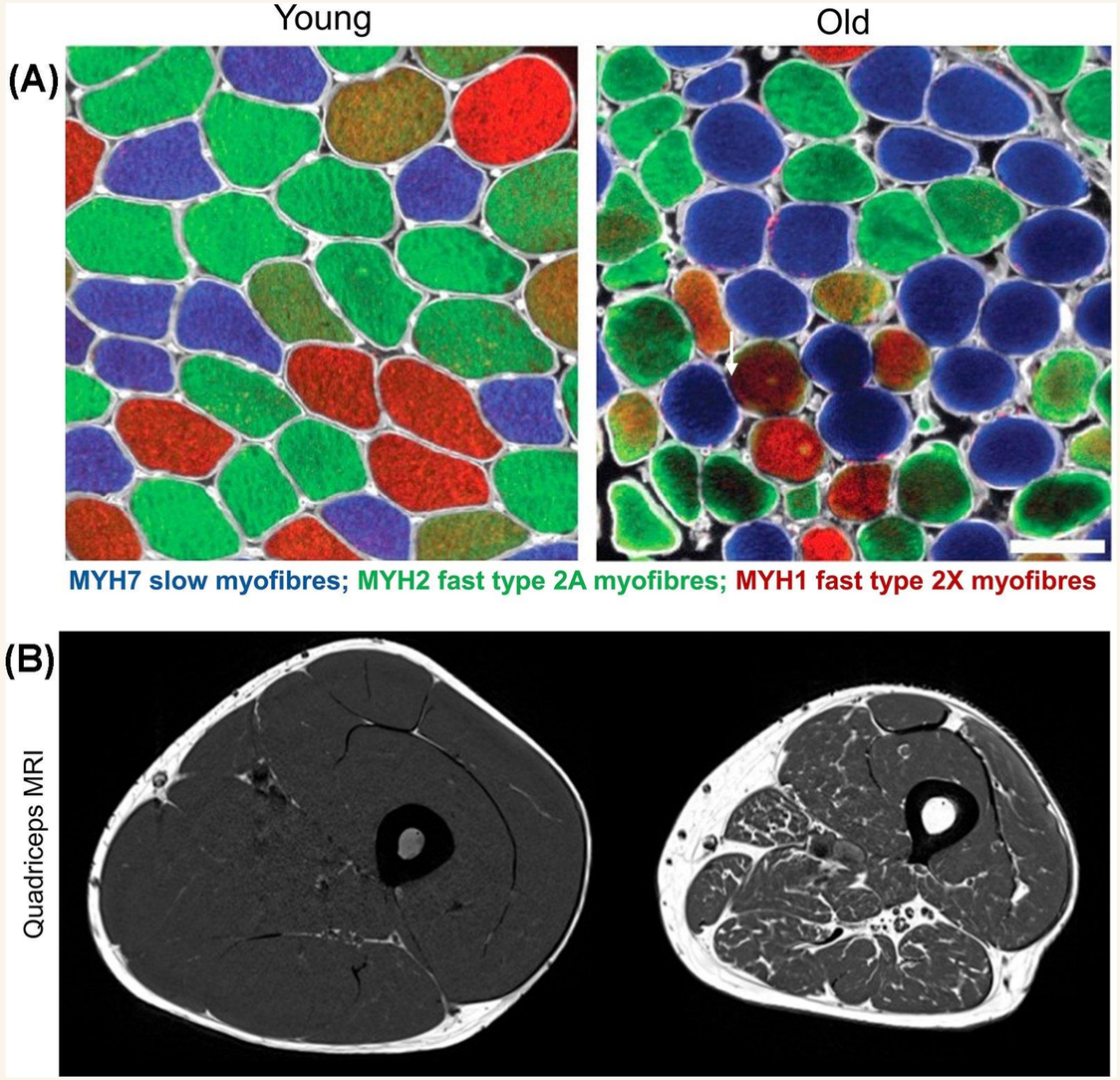


Decade of healthy ageing: baseline report. Summary. Geneva: World Health Organization, 2021.



Barnett et al, The Lancet, 2012.

AGEING OF MUSCLES

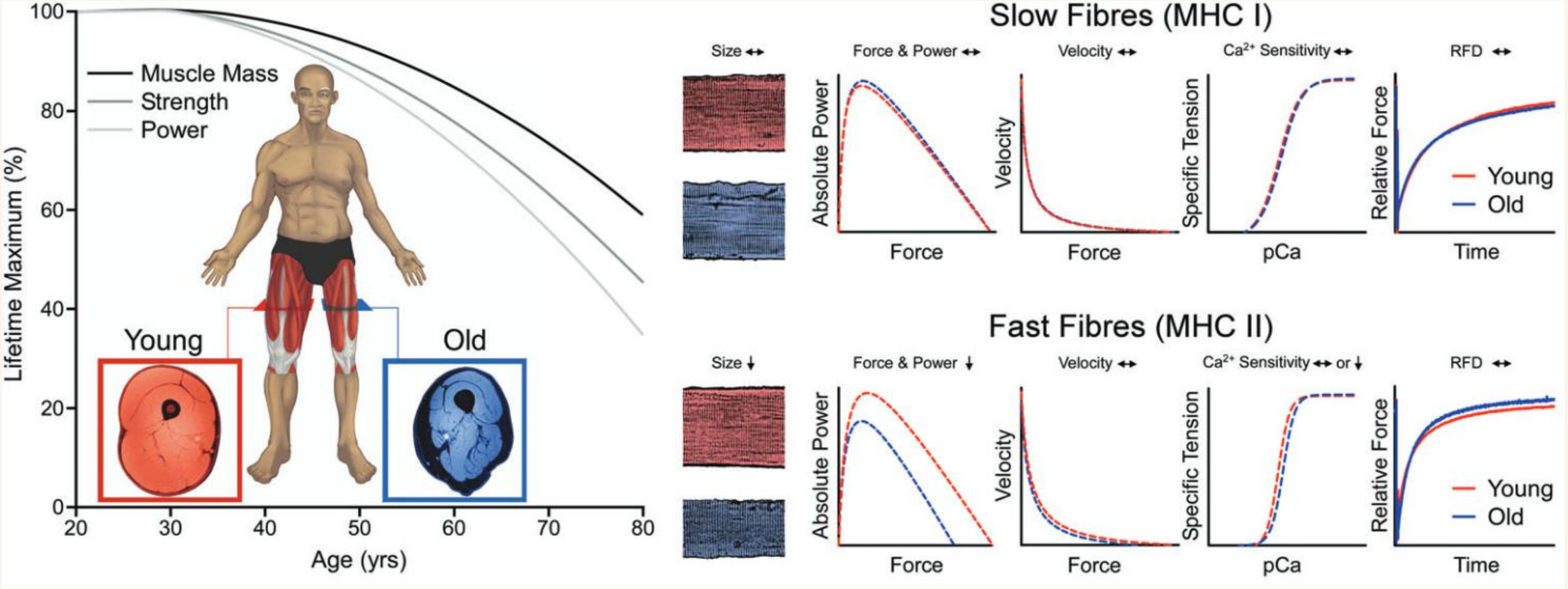


Muscle fibers
- Type II fibers (number & volume) ↓
- More grouped type I fibers
- More varied muscle fiber size and shape

Muscle volume ↓
Intramuscular (and subcutaneous) fat ↑

Granic et al., Clinical Science, 2023.

AGEING OF MUSCLE FIBERS



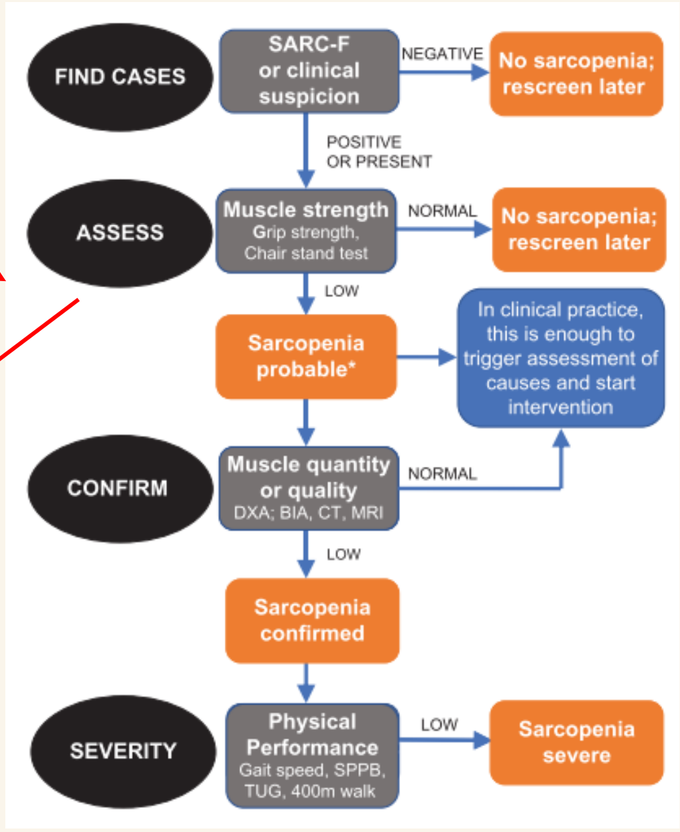
Grosicki et al., J Physiol, 2022.

SARCOPENIA

Sayers et al., Nat Rev Dis Primers, 2024.

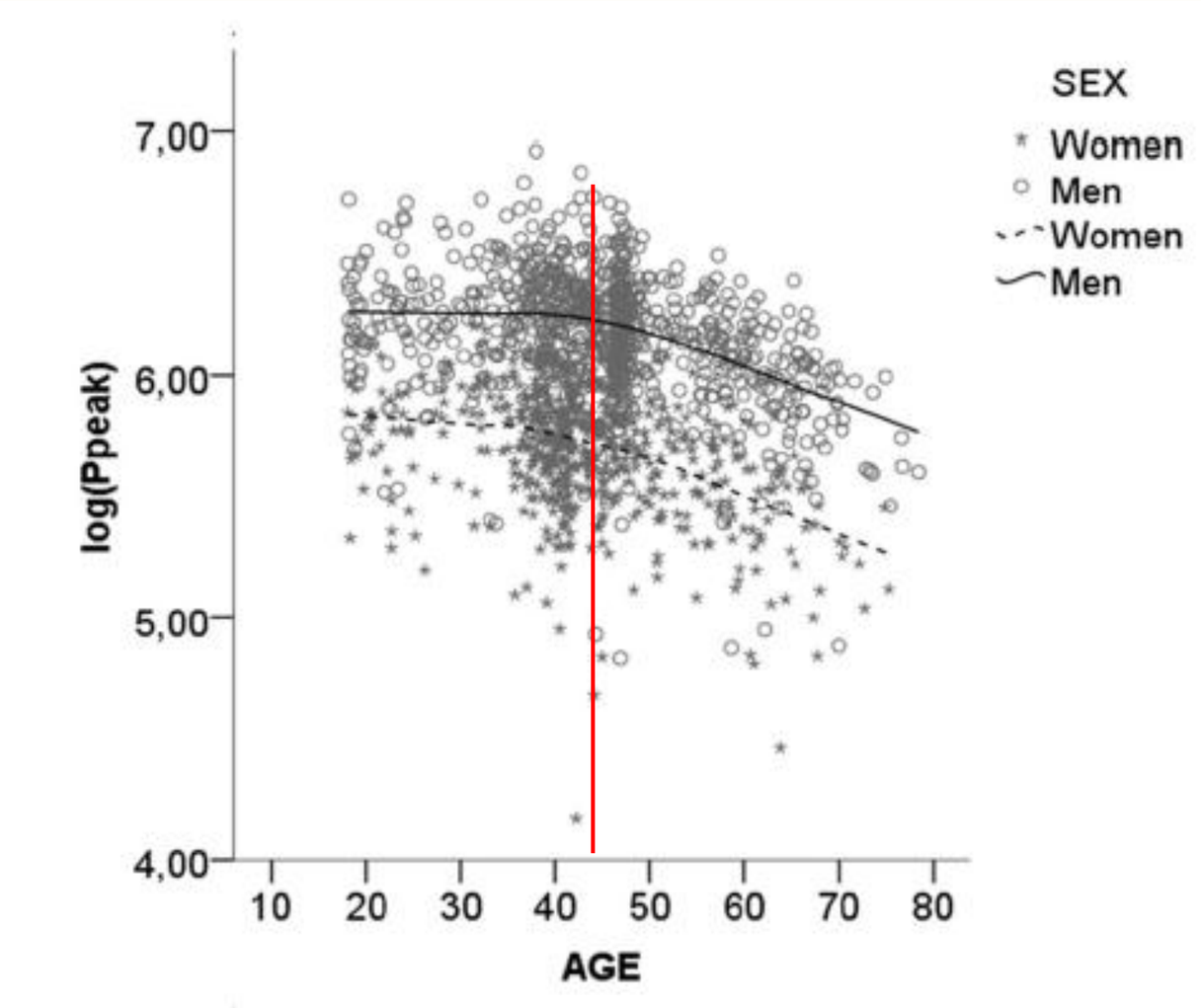
Table 3. EWGSOP2 sarcopenia cut-off points

Test	Cut-off points for men	Cut-off points for women	References
EWGSOP2 sarcopenia cut-off points for low strength by chair stand and grip strength			
Grip strength	**<27 kg**	**<16 kg**	Dodds (2014) [26]
Chair stand	**>15 s for five rises**		Cesari (2009) [67]
EWGSOP2 sarcopenia cut-off points for low muscle quantity			
ASM	**<20 kg**	**<15 kg**	Studenski (2014) [3]
ASM/height^2	**<7.0 kg/m^2**	**<6.0 kg/m^2**	Gould (2014) [125]
EWGSOP2 sarcopenia cut-off points for low performance			
Gait speed	**≤0.8 m/s**		Cruz-Jentoft (2010) [1] Studenski (2011) [84]
SPPB	**≤8 point score**		Pavasini (2016) [90] Guralnik (1995) [126]
TUG	**≥20 s**		Bischoff (2003) [127]
400 m walk test	**Non-completion or ≥6 min for completion**		Newman (2006) [128]



Cruz-Jentoft et al., Age Ageing, 2018

MUSCLE POWER (KNEE EXTENSORS)



	POWER	FORCE
Men (>45y)	-1.4%/year	-1.0%/year
Women (>45y)	-1.9%/year	-1.4%/year

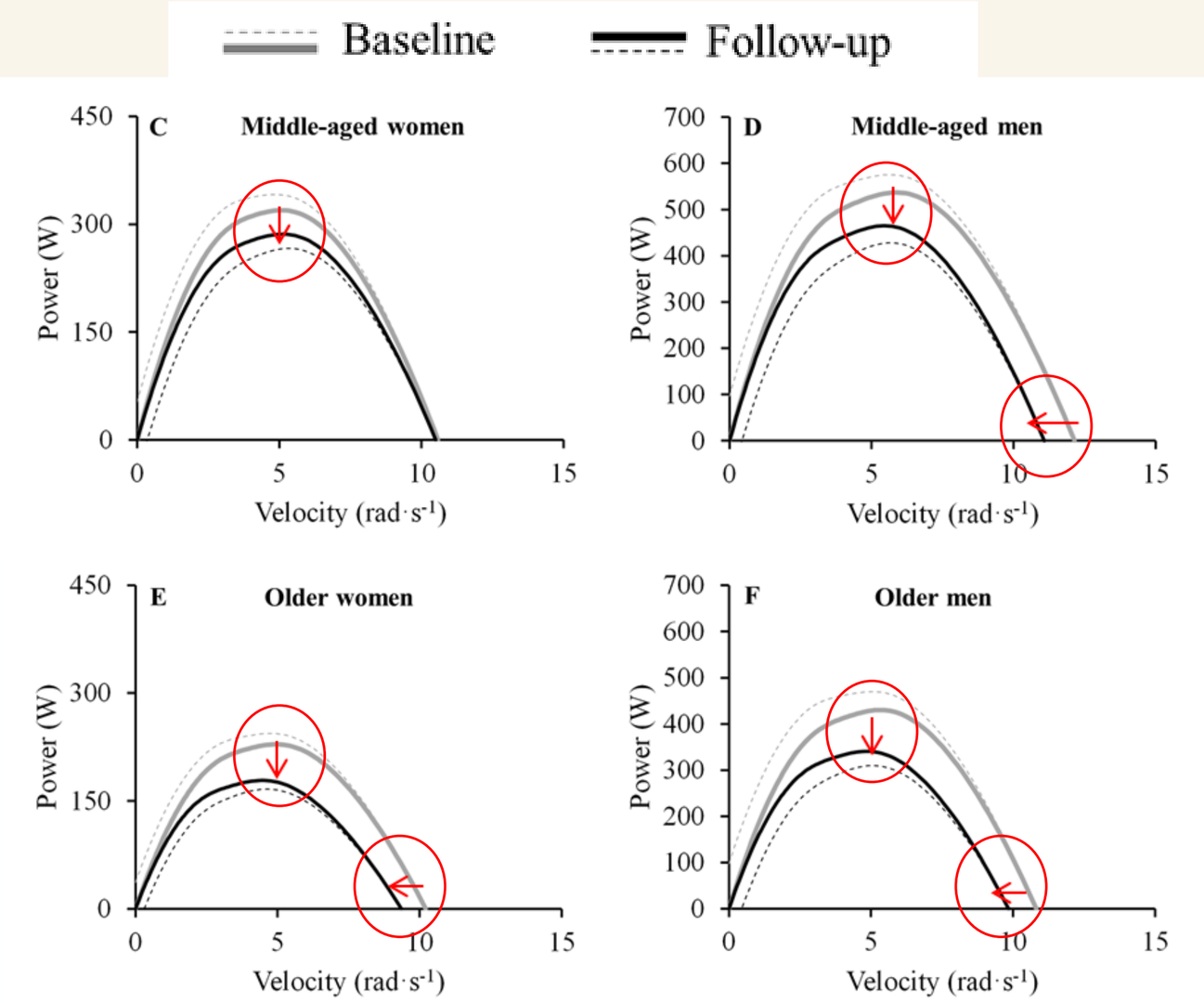
Muscle architecture
- ↓ CSA
- ↓ pennation angle
- ↓ fascicle length
- Changes in fiber type

Neural adaptations
- ↓ motor unit recruitment
- ↓ MU discharge rate
- ↑ antagonist co-activation

Van Roie et al., Exp Gerontol, 2018.

Baroni et al., J Appl Biomech, 2013; Deschenes, Sports Med, 2004; Klass et al., J Appl Physiol, 2008; Lexell, J Nutr, 1997.

MUSCLE POWER (KNEE EXTENSORS)

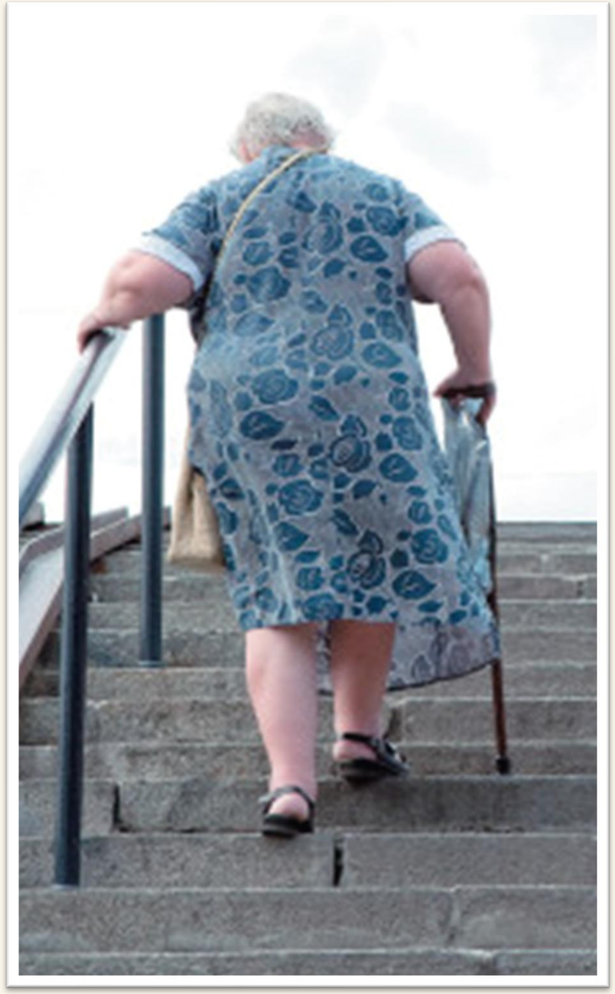


Middle-aged (40-60 years): ♂ -1.1% ♀ -1.4%/year

Older (60+years): ♂ -2.2% ♀ -2.4%/year

Alcazar et al., J Cachexia Sarcopenia Muscle, 2023.

MUSCLE FUNCTION & FUNCTIONAL CAPACITY



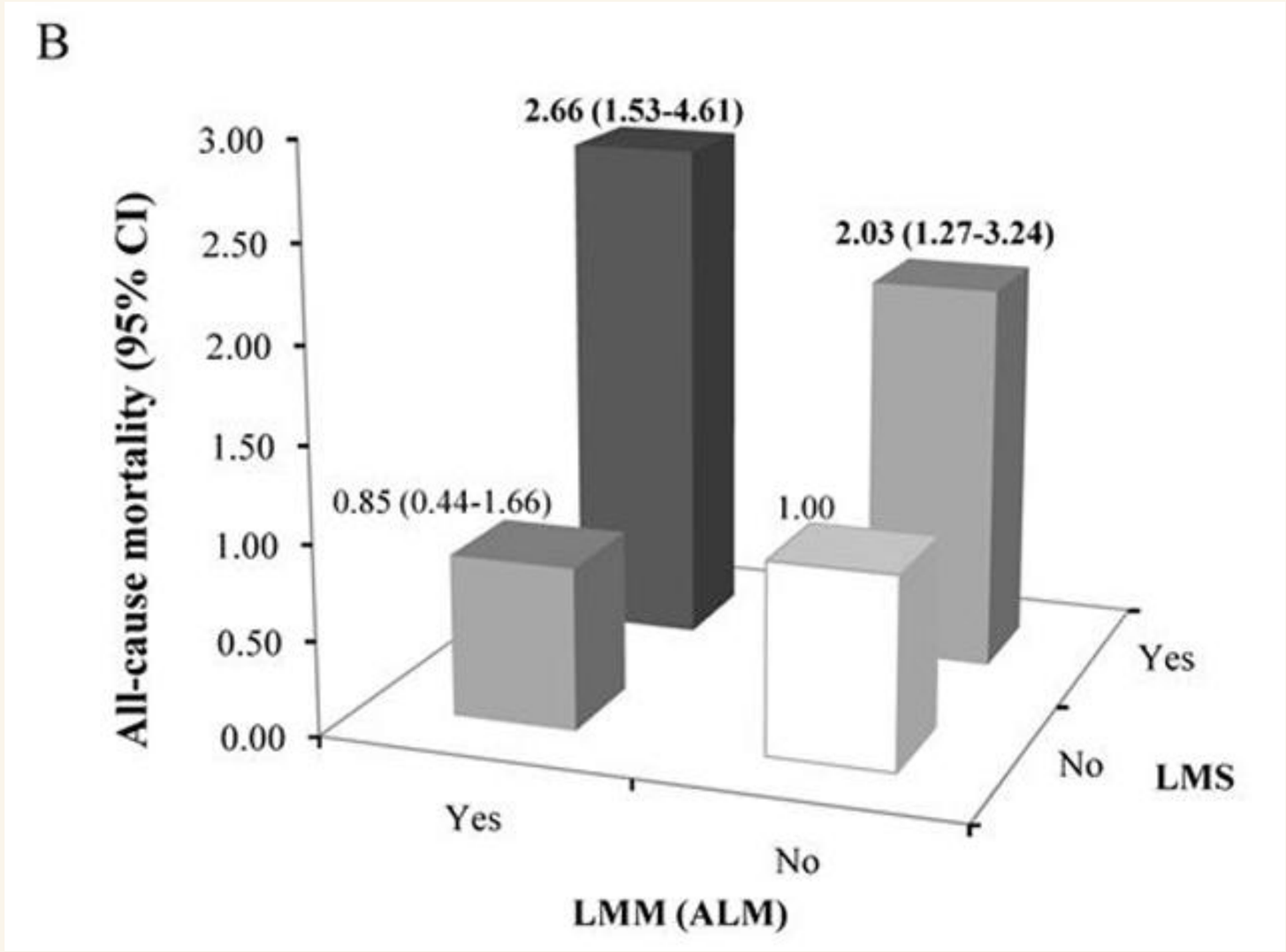
Journal of Gerontology: MEDICAL SCIENCES
2003, Vol. 58A, No. 8, 728–733

A Comparison of Leg Power and Leg Strength Within the InCHIANTI Study: Which Influences Mobility More?

Jonathan F. Bean,[1,2] Suzanne G. Leveille,[2] Dan K. Kiely,[2] Stephania Bandinelli,[3] Jack M. Guralnik,[4] and Luigi Ferrucci[3,5]

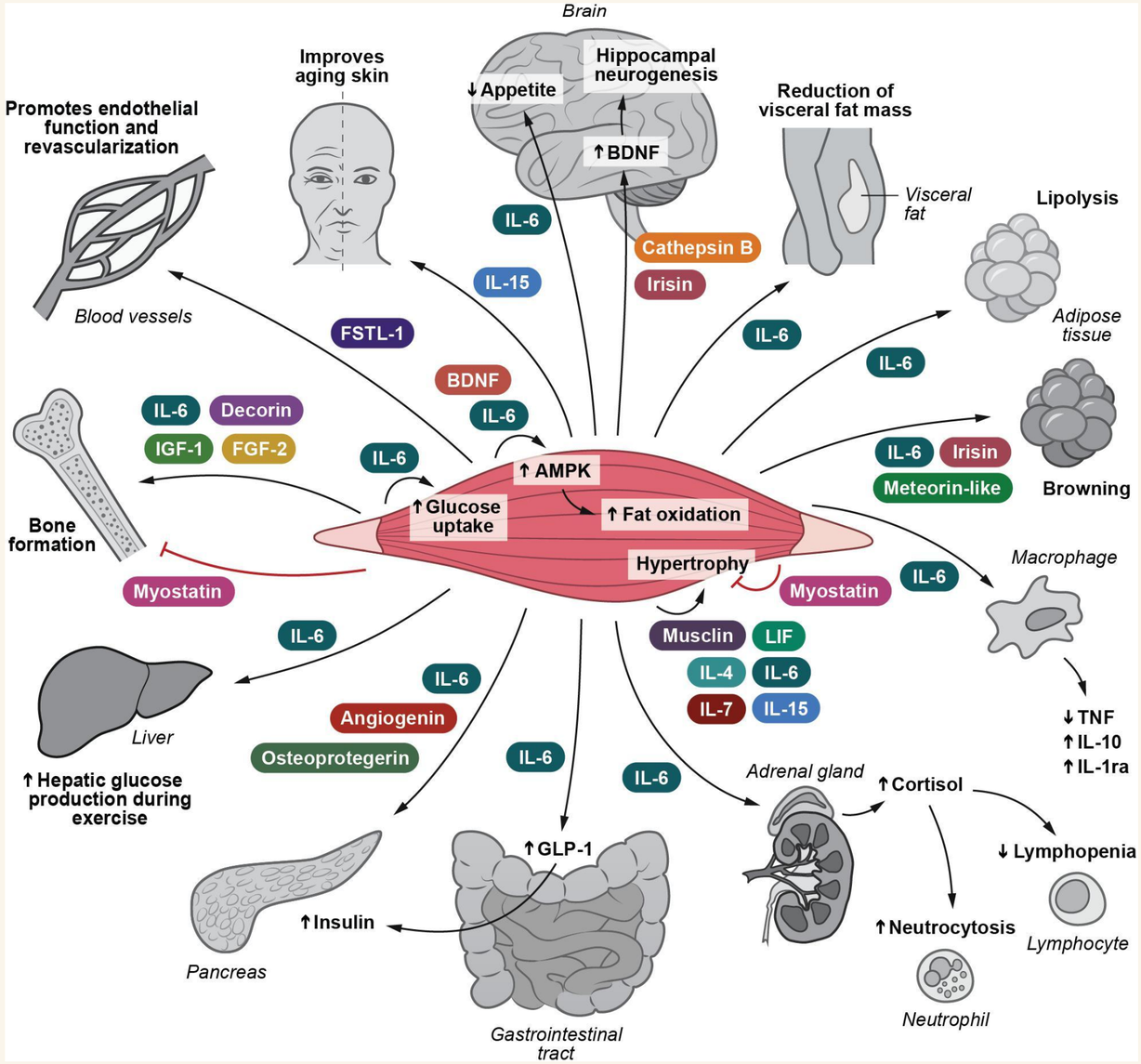
Functional Measure	Impairment	R^2
SPPB (0–12)	Leg power (Watts)	.35
	Hip strength (N)	.30
	Knee strength (N)	.28
Stair climb (s)	Leg power (Watts)	.44
	Hip strength (N)	.39
	Knee strength (N)	.38
Habitual gait (m/s)	Leg power (Watts)	.41
	Hip strength (N)	.38
	Knee strength (N)	.36
Balance	Leg power (Watts)	.29
	Hip strength (N)	.27
	Knee strength (N)	.26
Chair rise time (s)	Leg power (Watts)	.27
	Hip strength (N)	.27
	Knee strength (N)	.26

MUSCLE FUNCTION & ALL-CAUSE MORTALITY



Li et al., Med Sci Sports Exerc, 2018.

MUSCLE-ORGAN CROSSTALK



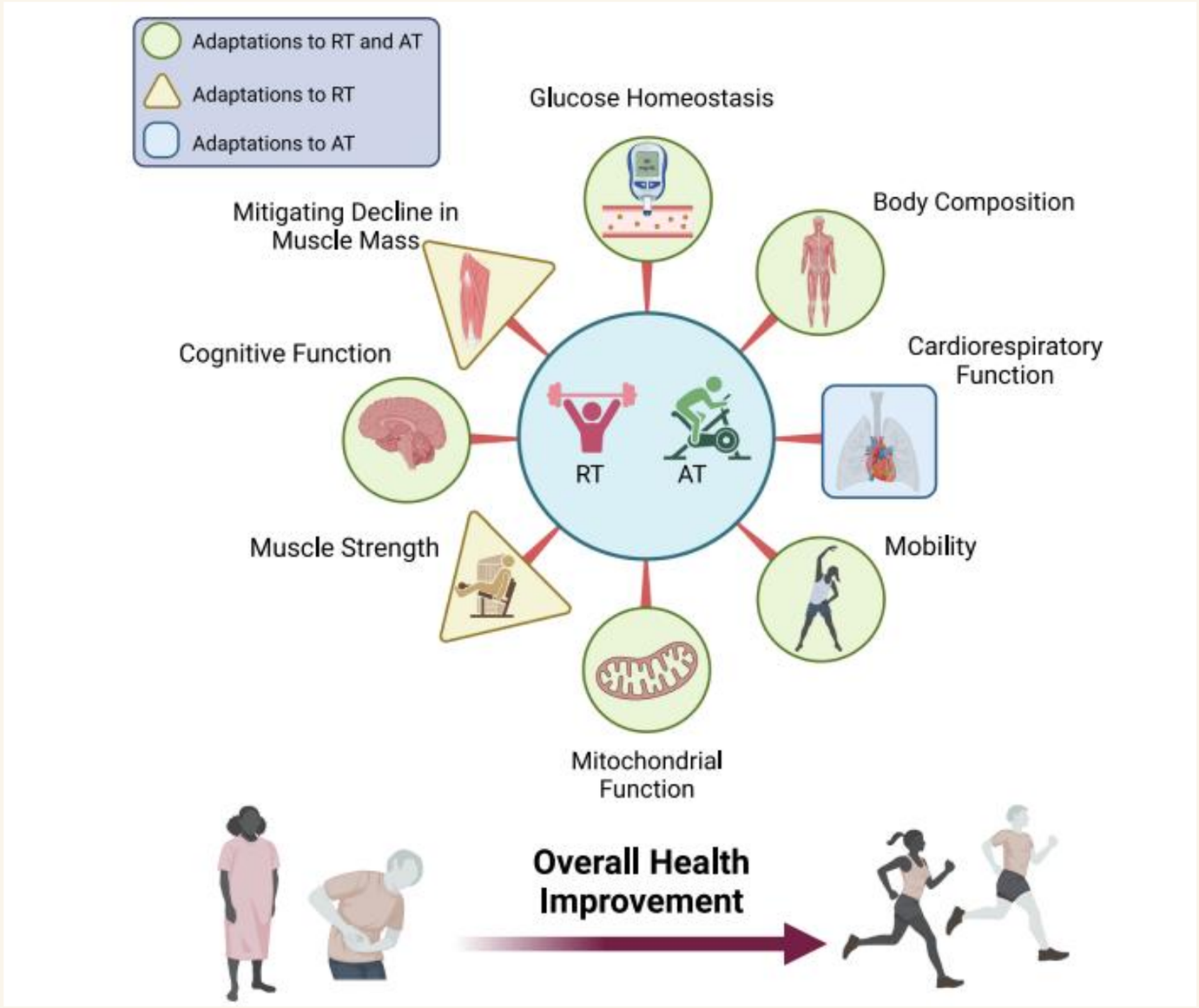
Lund Bay & Klarlund Pedersen, Frontiers Physiol, 2020.

LONGEVITY AND AGEING

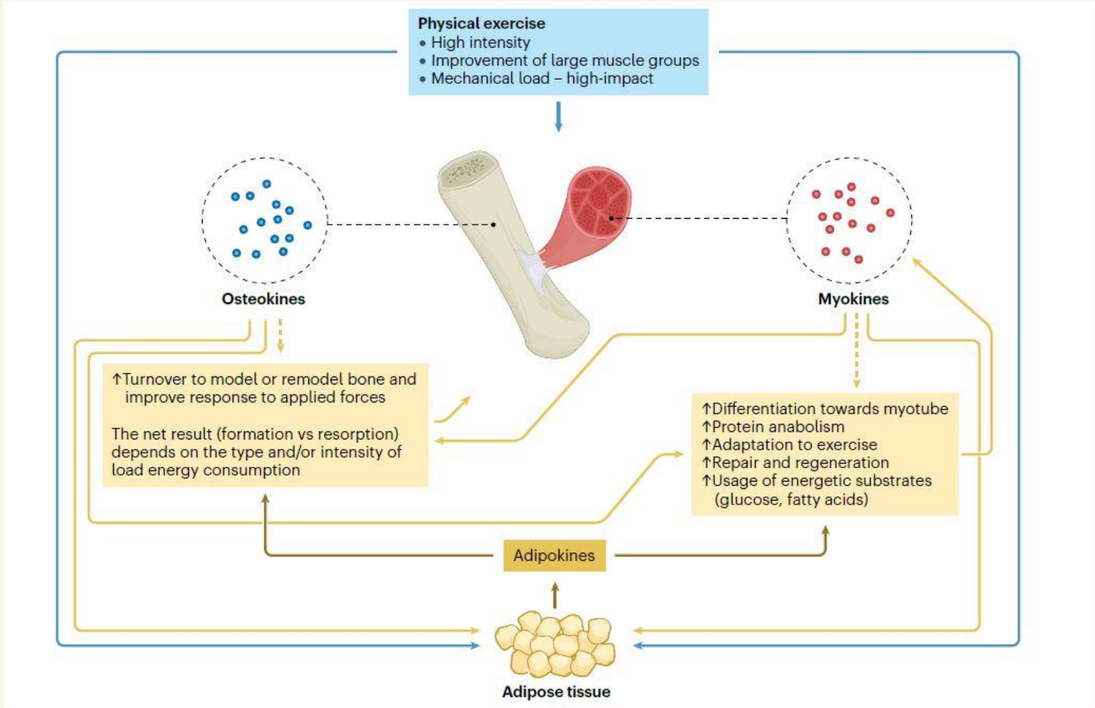
RESISTANCE EXERCISE FOR HEALTHY LONGEVITY

HEALTHY LIFESTYLE

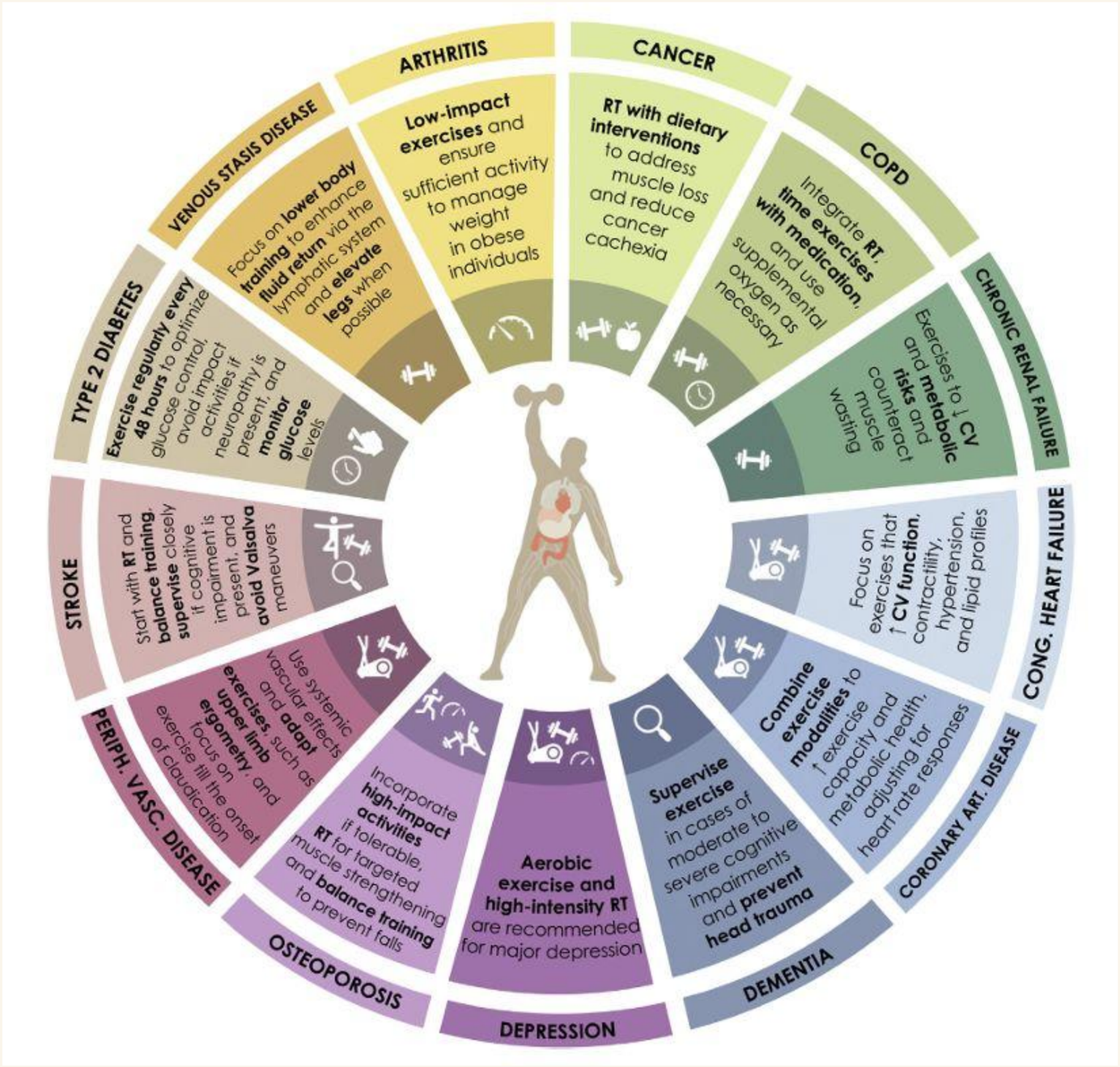
RESISTANCE TRAINING



Abou Sawan et al., Exercise, Sport, and Movement, 2023.

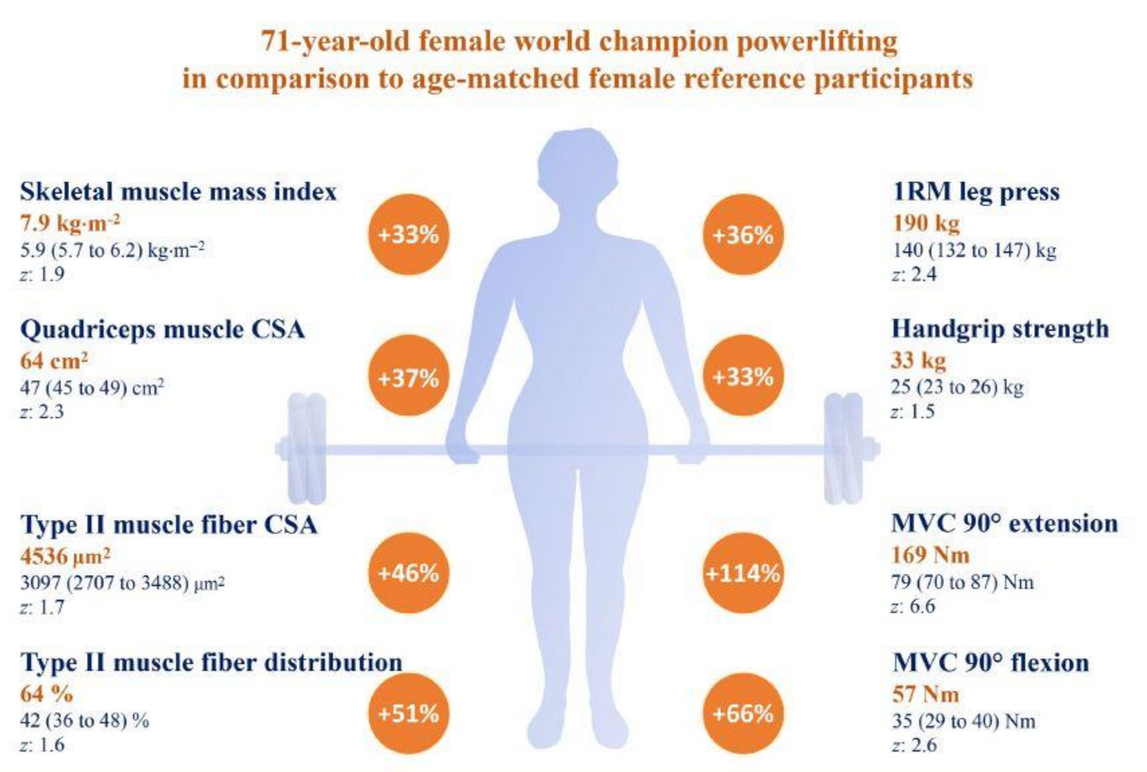


Kirk et al., Nature Reviews Endocrinology, 2025.

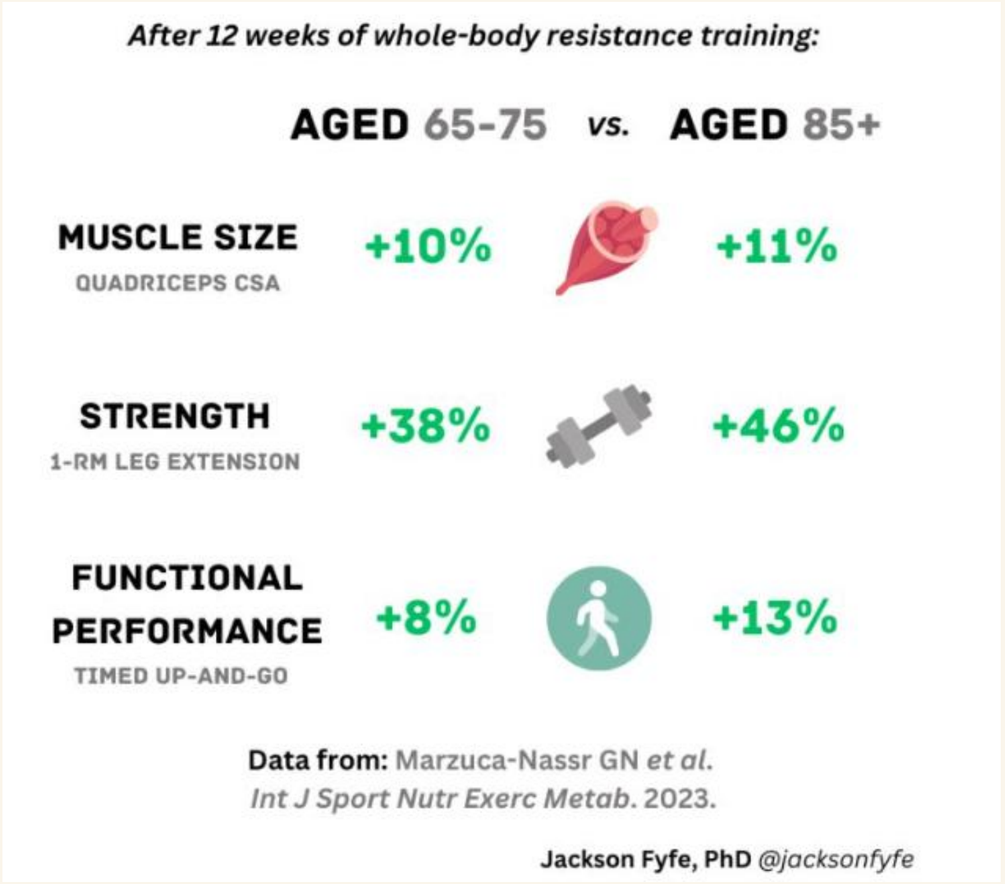


Izquierdo et al., J Nutr Health Aging, 2025.

RESISTANCE TRAINING: NEVER TOO LATE!



Fuchs et al., Int J Sports Nutr Exercise Metab, 2024.



RESISTANCE TRAINING GUIDELINES

For additional health benefits:

On at least **2** days a week

muscle-strengthening activities at moderate or greater intensity that involve all major muscle groups.

› Older adults should also do muscle-strengthening activities at moderate or greater intensity that involve all major muscle groups on 2 or more days a week, as these provide additional health benefits.

Strong recommendation, moderate certainty evidence

On at least **3** days a week

varied multicomponent physical activity that emphasizes functional balance and strength training at moderate or greater intensity.

› As part of their weekly physical activity, older adults should do varied multicomponent physical activity that emphasizes functional balance and strength training at moderate or greater intensity, on 3 or more days a week, to enhance functional capacity and to prevent falls.

Strong recommendation, moderate certainty evidence

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Contents lists available at ScienceDirect

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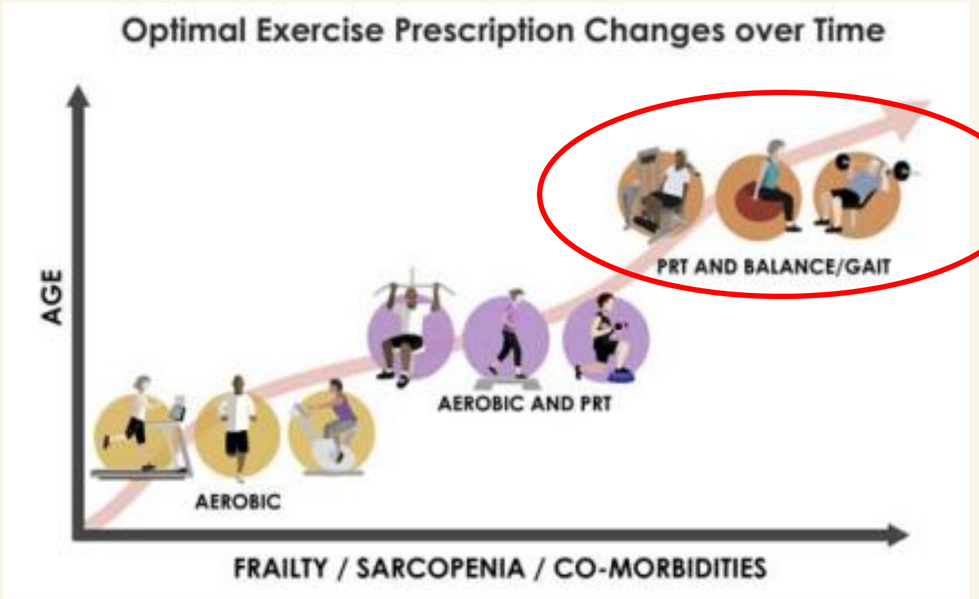
journal homepage: www.elsevier.com/locate/jnha

Review

Global consensus on optimal exercise recommendations for enhancing healthy longevity in older adults (ICFSR)

Mikel Izquierdo [a,b,*], Philipe de Souto Barreto [c,d], Hidenori Arai [e], Heike A. Bischoff-Ferrari [f], Eduardo L. Cadore [g], Matteo Cesari [h], Liang-Kung Chen [i], Paul M. Coen [j], Kerry S. Courneya [k], Gustavo Duque [l], Luigi Ferrucci [m], Roger A. Fielding [n], Antonio García-Hermoso [a,b], Luis Miguel Gutiérrez-Robledo [o], Stephen D.R. Harridge [p], Ben Kirk [q], Stephen Kritchevsky [r], Francesco Landi [s,t], Norman Lazarus [p], Teresa Liu-Ambrose [u], Emanuele Marzetti [s,t], Reshma A. Merchant [v,w], John E. Morley [x], Kaisu H. Pitkälä [y], Robinson Ramírez-Vélez [a,b], Leocadio Rodriguez-Mañas [b,z], Yves Rolland [c,d], Jorge G. Ruiz [A], Mikel L. Sáez de Asteasu [a,b], Dennis T. Villareal [B], Debra L. Waters [C,D], Chang Won Won [E], Bruno Vellas [c,d], Maria A. Fiatarone Singh [F]



WHO guidelines on physical activity and sedentary behaviour. Geneva: World Health Organization; 2020.

RESISTANCE TRAINING GUIDELINES

- 2-3x/week

Borg's Rating of Perceived Exertion (RPE) Scale	
Perceived Exertion Rating	Description of Exertion
6	No exertion; sitting and resting
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

- Progress to 70-80% 1-RM ~ RPE 15-18
- Power exercises 40-60% 1-RM ~ RPE 13-15

- 1-3 sets
- 8-12 repetitions
- 6-10 exercises, large muscle groups, multi-joint

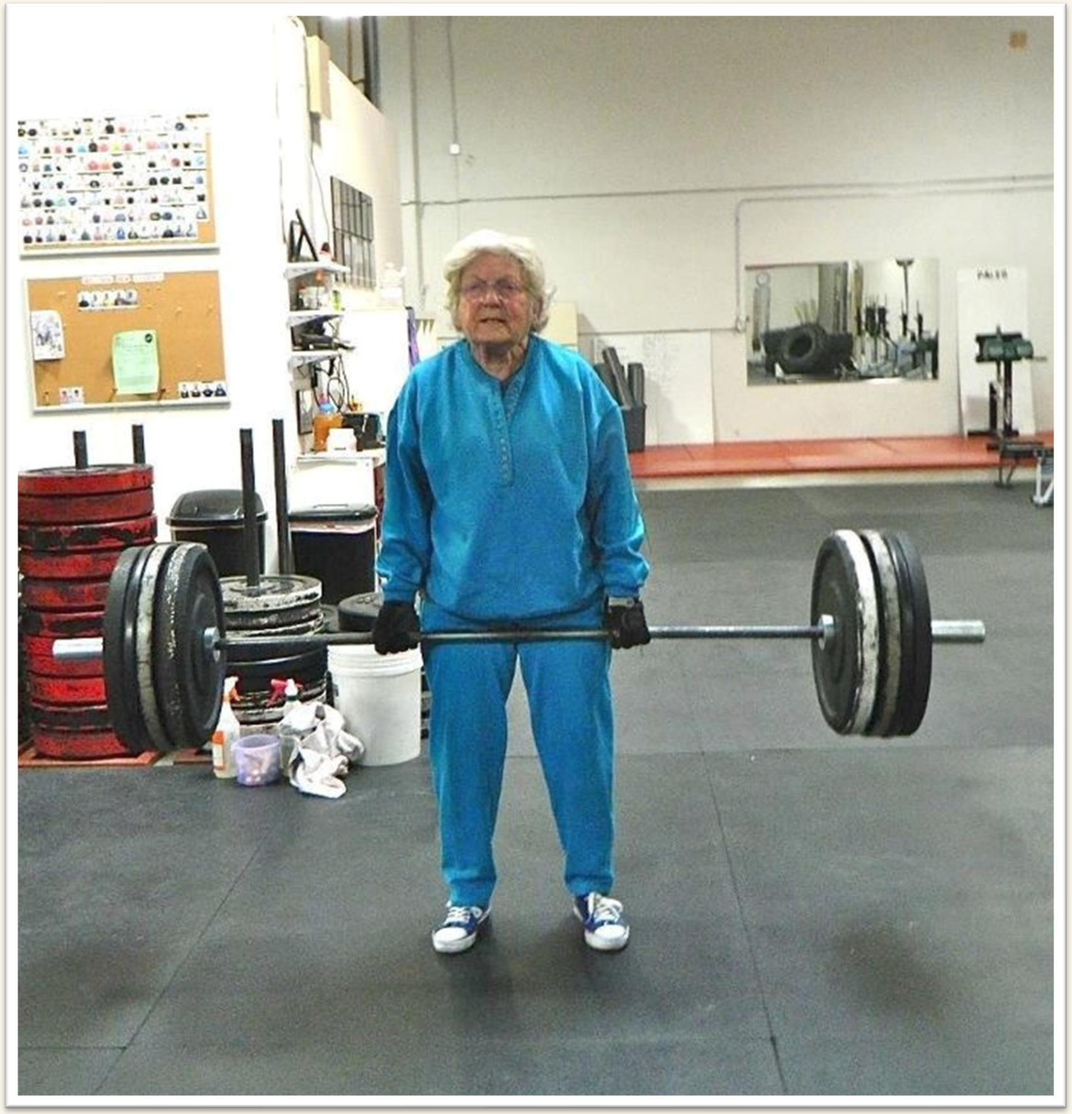
TRAINING PRINCIPLES

- Progressive 'overload'
- Specificity

UNDERTRAINING more dangerous than OVERTRAINING!

Izquierdo et al., J Nutr Health Aging, 2025.

HIGH LOADS NECESSARY?



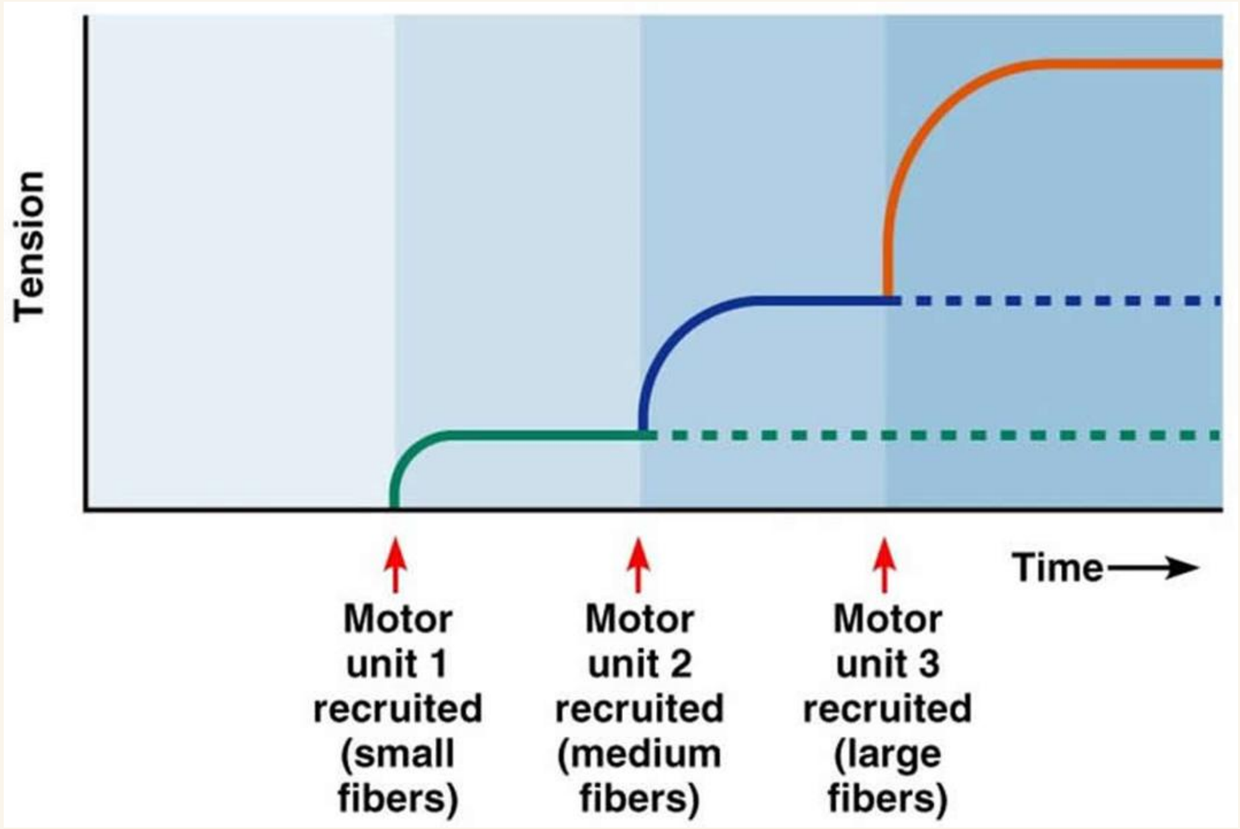
- Contra-indications?
- Older adults afraid
- Therapists/coaches too hesitant

UNDERTRAINING!

HIGH LOADS NECESSARY?

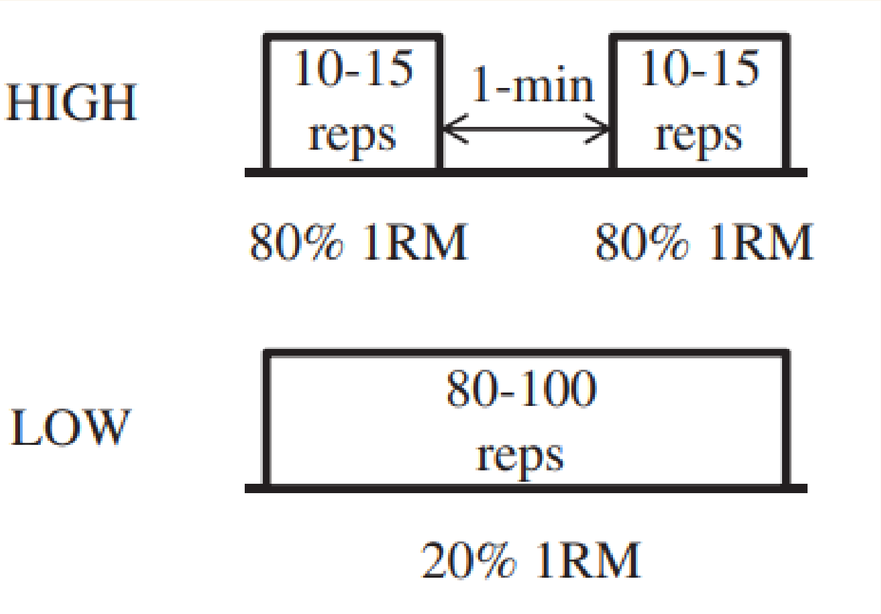
“It does not require a maximal or near maximal load to recruit a large amount of muscle fibers. It simply requires a (near) maximal effort, which occurs near or at the end of any commonly used RM performance.”

(Carpinelli, 2008)



STUDY - HIGH VS. LOW LOADS

PRE | 12-week training (3x/w) | POST | 24-week detraining | FU



Experimental Gerontology 48 (2013) 1351–1361

Contents lists available at ScienceDirect

Experimental Gerontology

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

Strength training at high versus low external resistance in older adults: Effects on muscle volume, muscle strength, and force–velocity characteristics

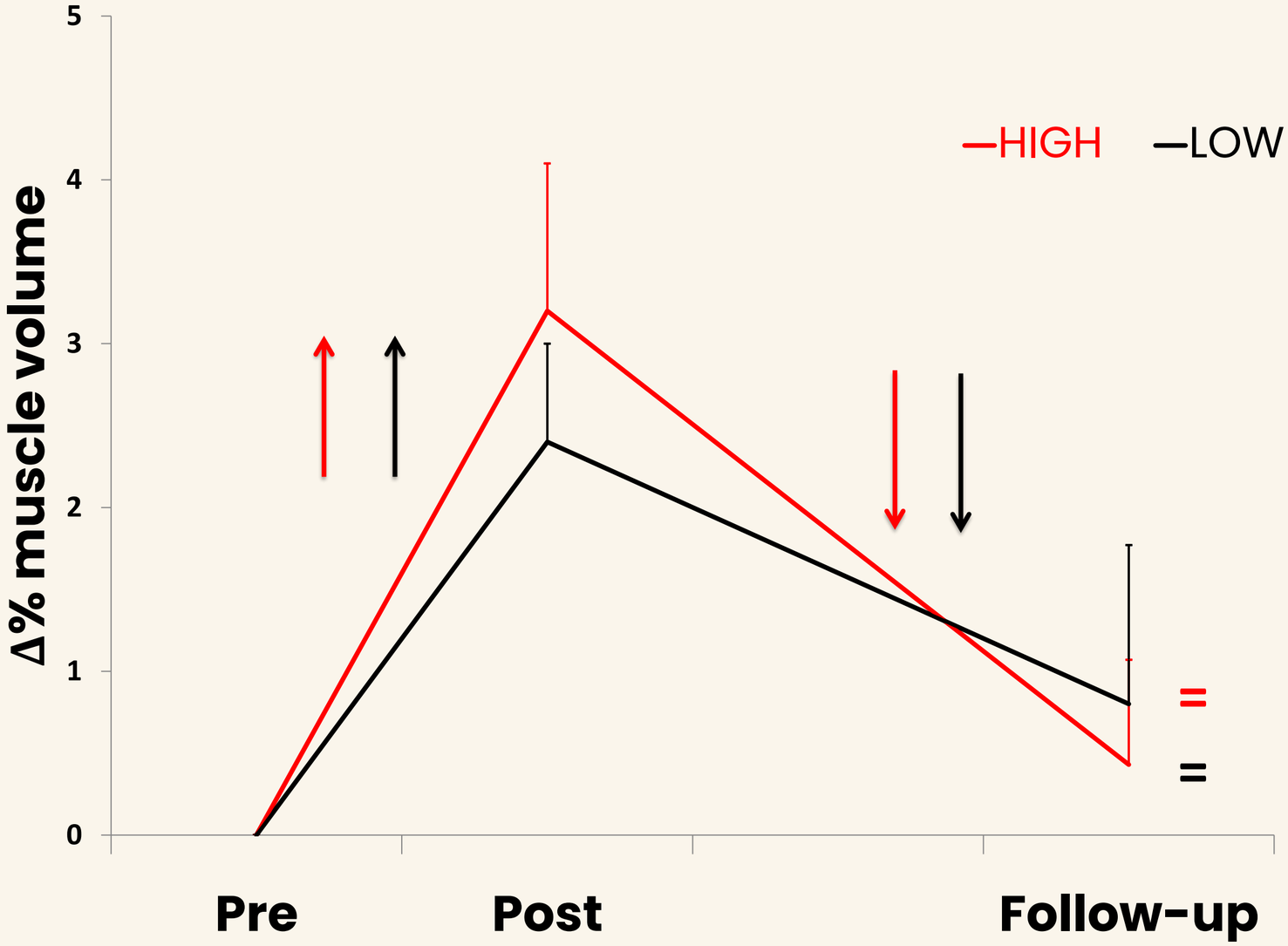
Evelien Van Roie [a,*], Christophe Delecluse [a], Walter Coudyzer [b], Steven Boonen [c], Ivan Bautmans [d]

Experimental Gerontology
Volume 98, November 2017, Pages 30-37

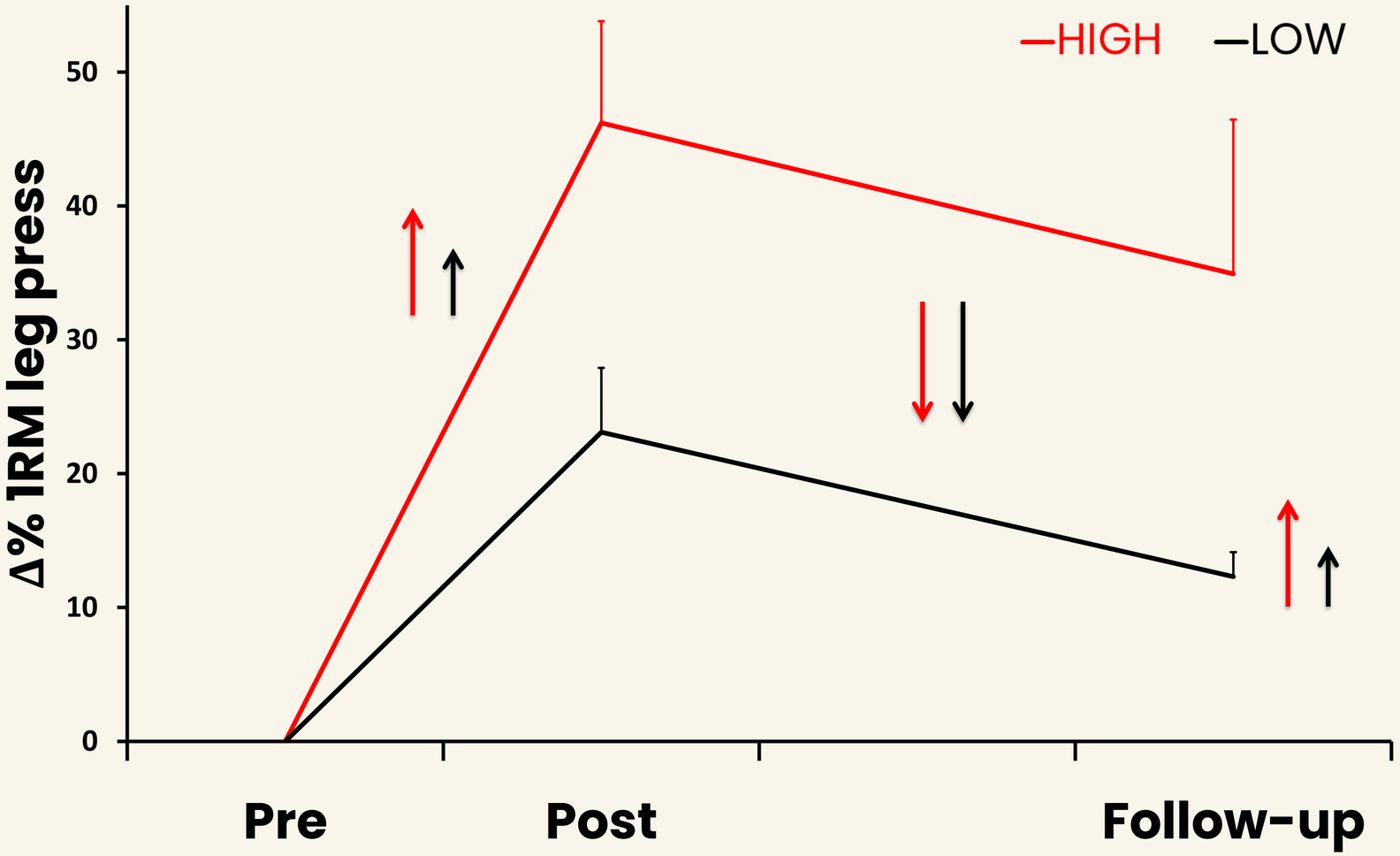
Training load does not affect detraining's effect on muscle volume, muscle strength and functional capacity among older adults

Evelien Van Roie [a], Simon Walker [b], Stijn Van Driessche [a], Remco Baggen [a], Walter Coudyzer [c], Ivan Bautmans [d], Christophe Delecluse [a]

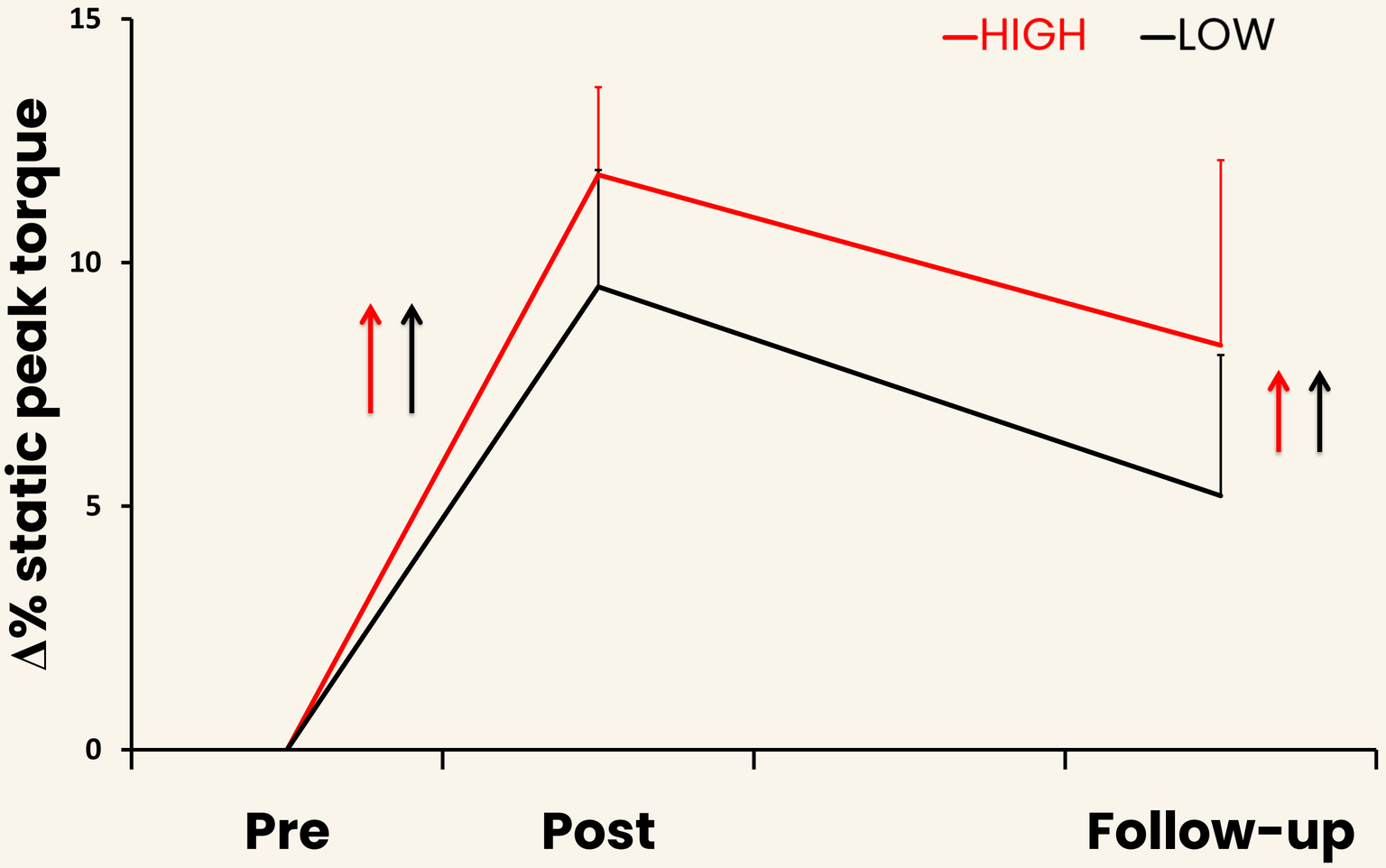
RESULTS – MUSCLE VOLUME



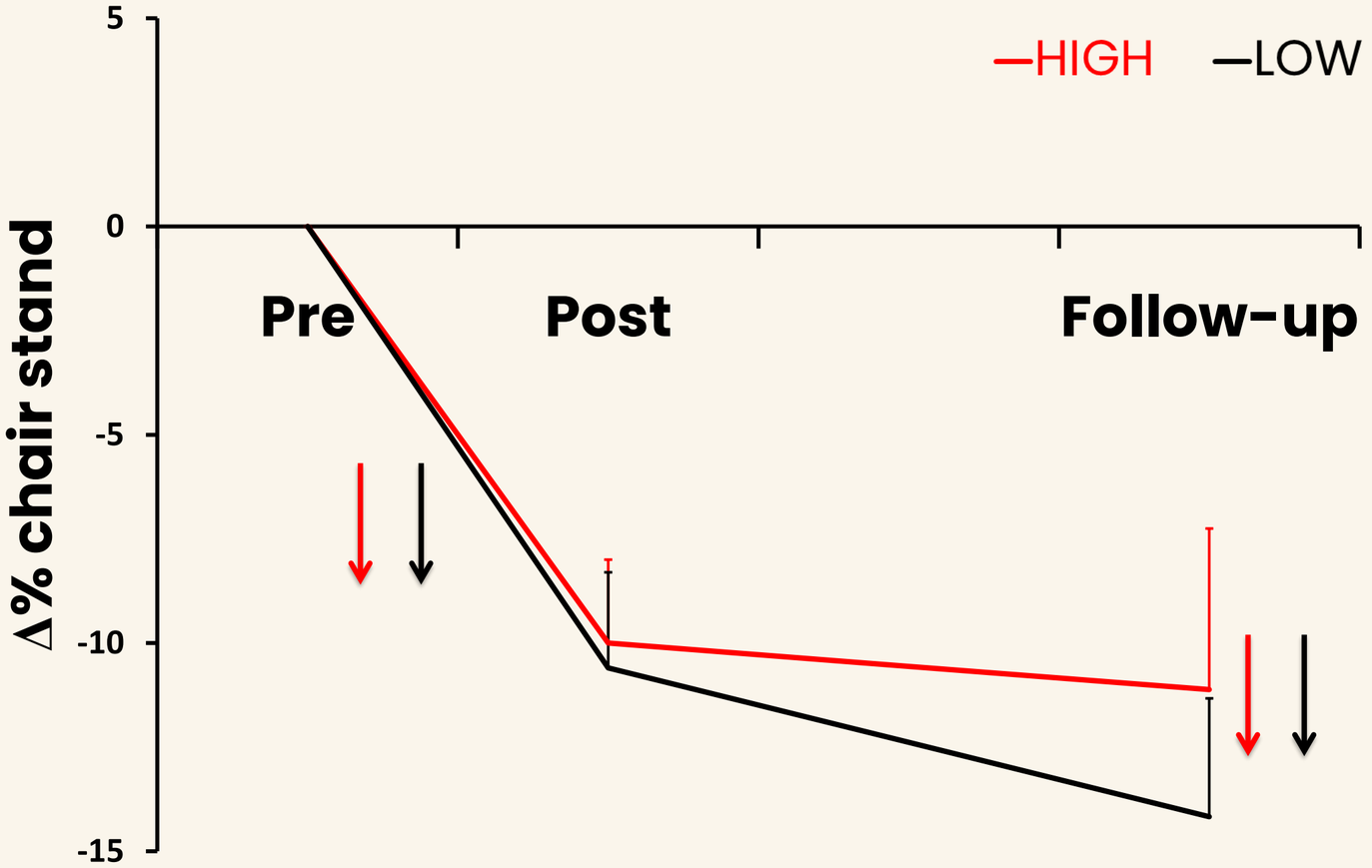
RESULTS - 1-RM



RESULTS – MAX. VOLUNTARY ISOMETRIC CONTRACTION

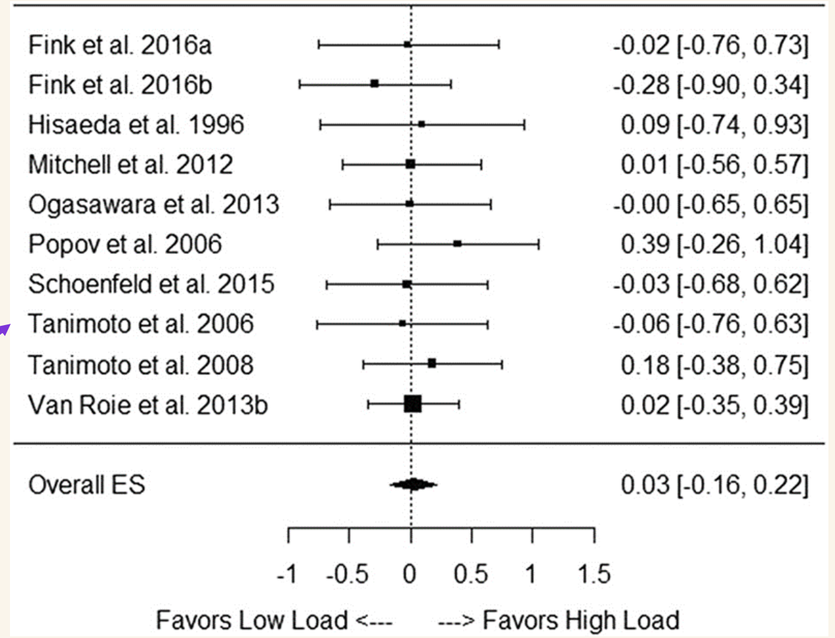


RESULTS – 5-REP STS TEST



LOW LOAD

- Similar training volume and until volitional fatigue:



High and low load equally effective for **hypertrophy**

(Alegre et al., 2015; Bemben et al., 2000; Schoenfeld et al., 2017; Van Roie et al., 2013)

High load: greater gains in **1-RM**, but not in **non-specific strength**

(Anderson & Kearney, 1982; Campos et al., 2002; Holm et al., 2008; Mitchell et al., 2012; Schoenfeld et al., 2014; Van Roie et al., 2013)

High and low load equally effective for **functional capacity**

(Steib, Schoene, & Pfeifer, 2010; Van Roie et al., 2013)

DETRAINING

- Muscle strength and functional capacity remain elevated after up to 6 months of detraining
- Muscle volume returns to baseline levels (already after 3 months)

Long-term improved muscle quality

(Bickel, Cross, & Bamman, 2011; Buendia et al., 2025; Correa et al., 2013; Hakkinen et al., 2000; Henwood & Taaffe, 2008; Ivey et al., 2000; Kennis et al., 2013; Taaffe & Marcus, 1997; Trappe et al., 2002; Van Roie et al., 2013)

REDUCED TRAINING FREQUENCY

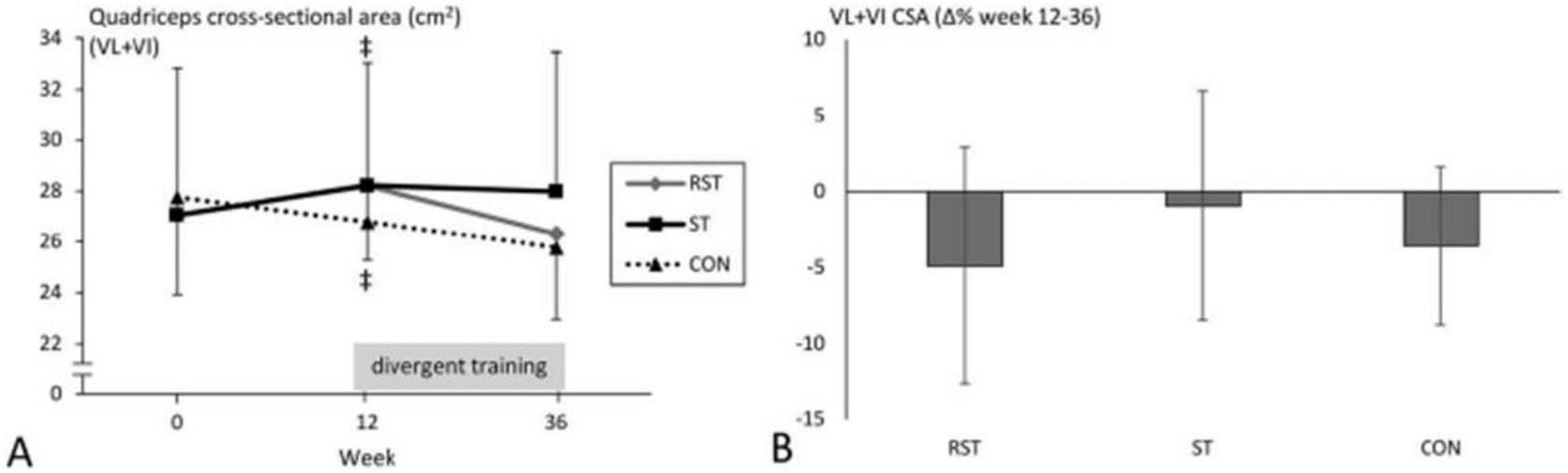


Figure 3. Quadriceps cross-sectional area load (mean ± *SD*) throughout the study (A) and relative changes (B) (Δ%; mean ± *SD*) during the divergent training frequency period. RST = reduced strength training group; ST = strength training group; CON = control group. ‡$p \leq 0.05$ compared with week 0. For clarity, there are no *SD* bars for the control group.

Walker et al, J Strength Cond Res, 2018.

RETRAINING

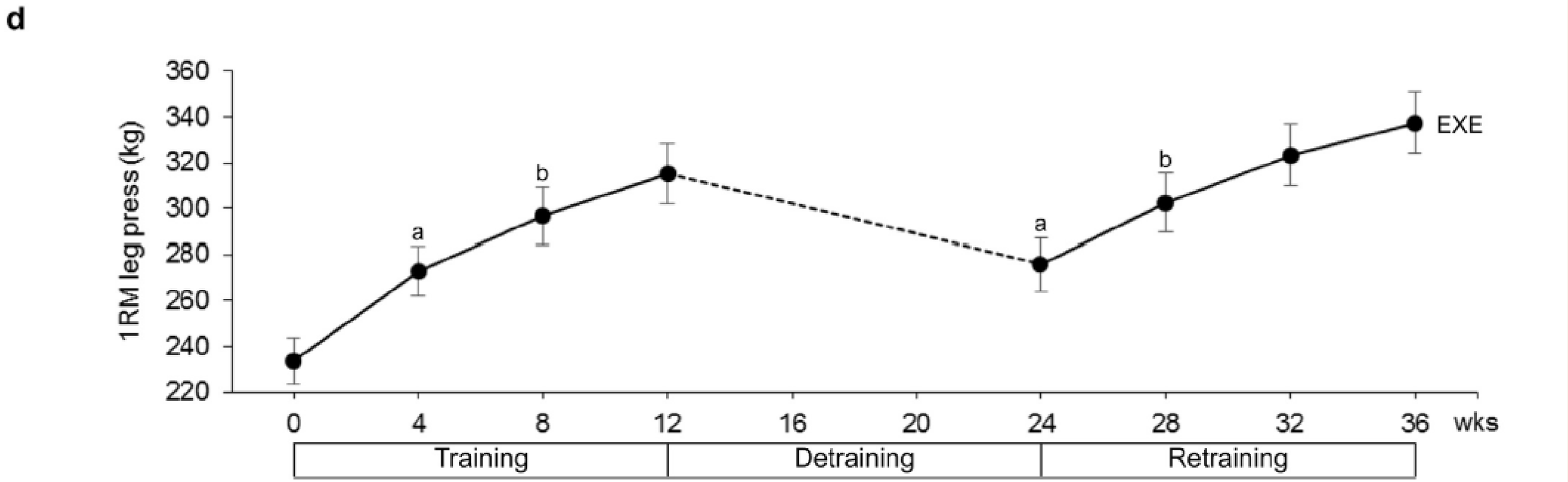


Fig. 3. Knee extension strength and power changes with training (T), detraining (D) and retraining (R). Values of (a) static peak torque, (b) peak power and (c) isokinetic peak torque are estimated marginal means ± SEM. Transparent dots are means of the CTR group ($n = 10$). Filled dots are means of the EXE group ($n = 30$ with missing data reported in Fig. 1 and Section 2.2). Within-EXE time effect: significantly different from the indicated time point at the level of: * $p \leq .001$, # $p \leq .01$, $\Delta\, p \leq .05$. There were no significant differences within CTR. Between-group effect: there were no significant differences between EXE and CTR. (d) Values of 1-repetition maximum are estimated marginal means ± SEM of the EXE group (n = 30). Time points indicated with the same letter are not significantly different from each other. All other time points are significantly different at the level of $p \leq .001$ (except week 12 vs week 32: $p = .028$).

Blocquiaux et al., Exp Gerontol, 2020.

LONG-TERM IMPACT OF TRAINING

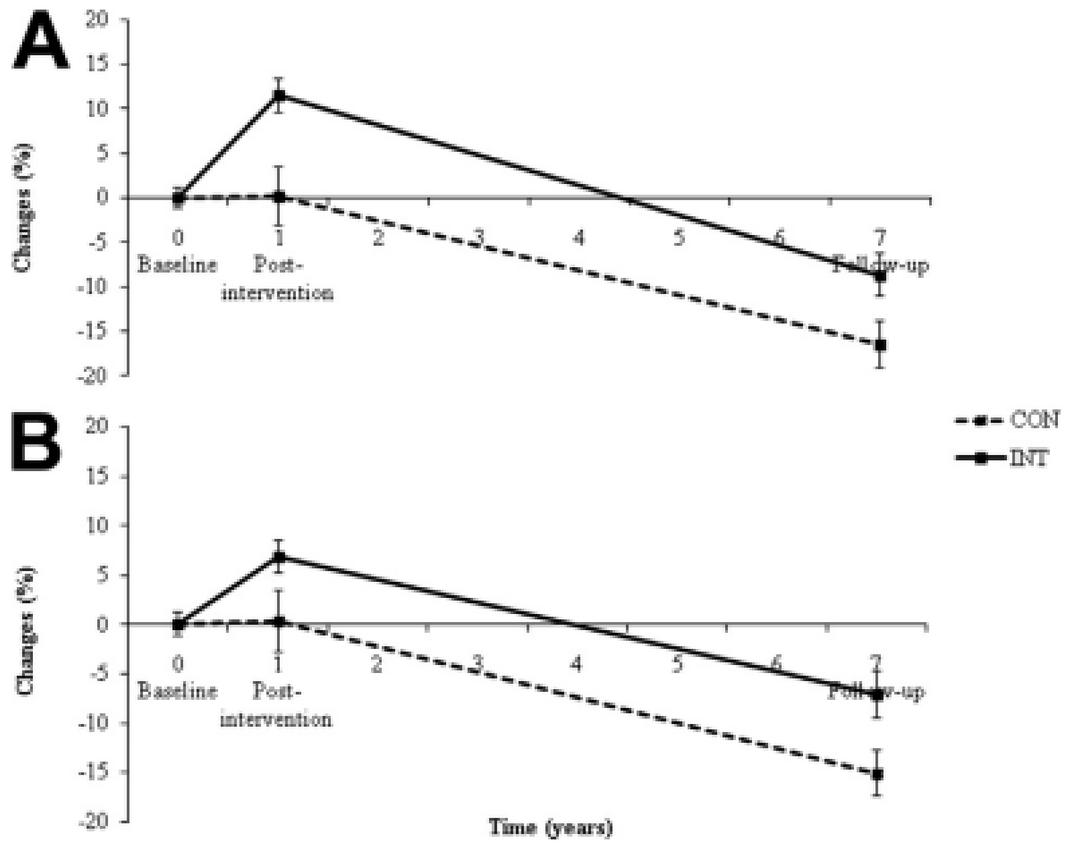


Fig 1 Percent changes (±SE) over time with respect to baseline values in basic strength, including (A) STAT and (B) DYN_{60} in the CON group and INT group.

Kennis et al., Arch Phys Med Rehab, 2013.

GOOD NEWS: NO HIGH LOADS NECESSARY …

Long-term adherence?

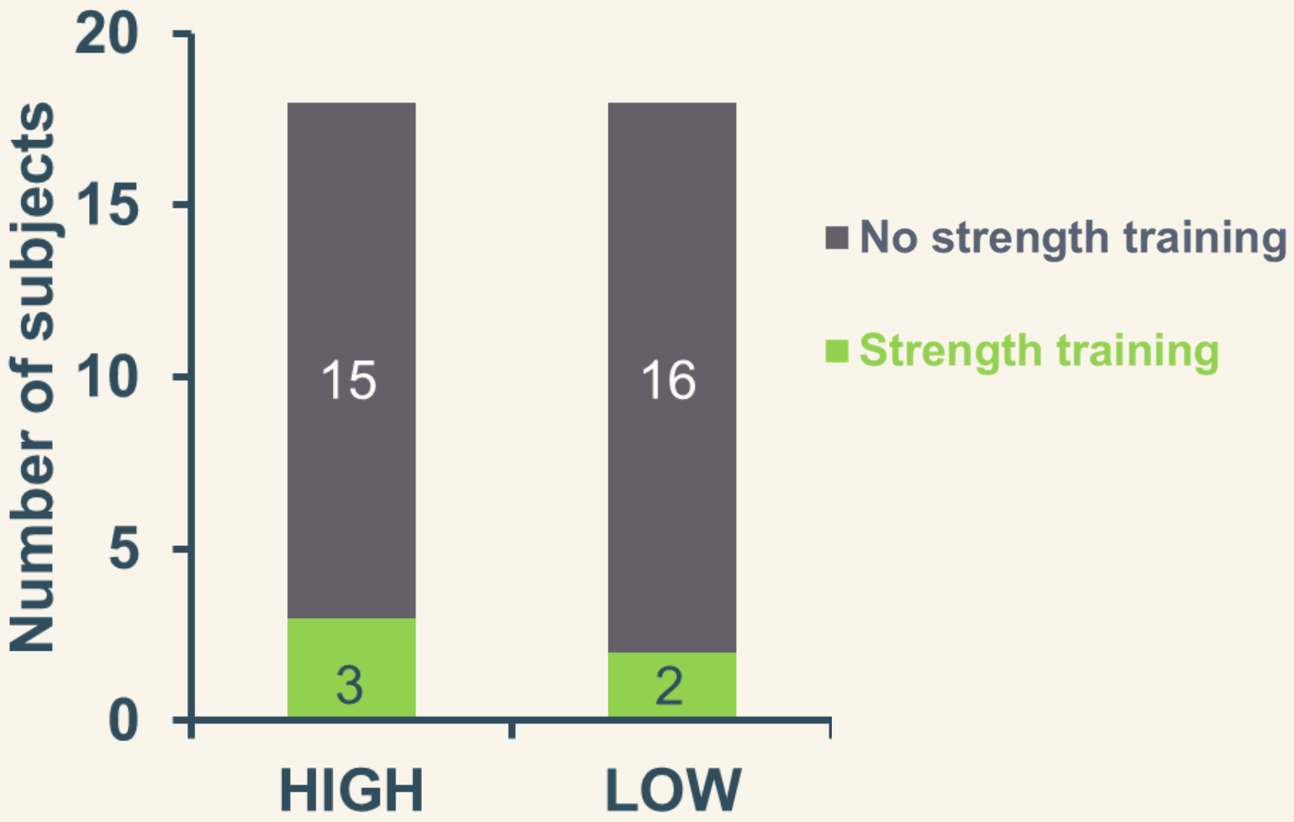


Table 2. Perceived barriers for continuation of strength training after cessation of the supervised intervention

Perceived barriers	Mean ± SD	Subjects grading 4 or 5, %
Intrapersonal factors		
Lack of interest in resistance exercise	2.5±1.1	15.6
Health-related issues	1.8±1.4	15.6
More interested in other physical activities	3.0±1.4	40.0
Resistance exercise is too strenuous	1.9±0.9	4.4
Low outcome expectations	1.5±0.7	0.0
Perceived lack of time	3.1±1.5	45.7
Planned vacation/travel	2.1±1.4	20.0
Interpersonal factors		
Lack of social support	1.4±0.7	2.3
Exercise companion quitted	1.6±1.0	6.7
Care of siblings/others	2.2±1.3	17.4
No continuation of instructor's supervision	2.3±1.3	20.0
Environmental factors		
Financial cost	2.5±1.2	28.3
Seasonal reasons	2.7±1.5	40.0
Lack of access to a fitness center	1.7±1.2	8.9
Fitness centers are too busy	1.7±1.1	6.7
Uncomfortable feeling in fitness center	1.5±1.0	6.7

Barriers were rated on a 5-point Likert scale (ranging from 1 = 'strongly disagree' to 5 = 'strongly agree').

Van Roie et al., Gerontology, 2015

ALTERNATIVE EXERCISE PROGRAMS: STEP-BASED EXERCISE IN GROUP

Step-training: 3x/week, 12w

- 2 x 32 reps per side
- Forward step
- Lateral step

Baggen et al., Exp Gerontol, 2019

ALTERNATIVE EXERCISE PROGRAMS: STEP-BASED EXERCISE IN GROUP

Table 1
Overview of the STEEP program.

		Step height Fstep (cm)	*Step height Lstep (cm)*	*Body mass Fstep (%)*	*Body mass Lstep (%)*
Level 1	*Week 1*	18	18		
	Week 2	18	18		
Level 2	*Week 1*	24	18		
	Week 2	24	18		
Level 3	*Week 1*	24	24		
	Week 2	24	24		
Level 4	*Week 1*	30	24		
	Week 2	30	24		
Level 5	*Week 1*	30	30		
	Week 2	30	30		
Level 6	*Week 1*	36	30		
	Week 2	36	30		
Level 7	*Week 1*	36	36		
	Week 2	36	36		
Level 8	*Week 1*	36	36	5	
	Week 2	36	36	5	
Level 9	*Week 1*	36	36	5	5
	Week 2	36	36	5	5
Level 10	*Week 1*	36	36	10	5
	Week 2	36	36	10	5

Progressive step height

Weighted vest at max. step height

Different starting levels

Baggen et al., Exp Gerontol, 2019.

ALTERNATIVE EXERCISE PROGRAMS: STAIR CLIMBING (POWER)

Table 2

Training variables and progression for the resistance training (RT) and stair-climbing exercise (STAIR) program.*

	Focus	Exercise	Sets and repetitions	Load	Interset rest	Velocity
RT						
Week 1–4	Hypertrophy	Unilateral leg press	4 × 12–15	55% 1RM	45 s	2 s ecc – 2 s conc
Week 5–8	Power	Unilateral leg press	4 × 12	40% 1RM	45 s	2 s ecc – maximal conc
Week 9–12	Power	Unilateral leg press	4 × 12	40% 1RM + 10%	45 s	2 s ecc – maximal conc
STAIR						
Week 1–4	Hypertrophy	Forward step-up	4 × 12–15	Step height of 30–40 cm, BM	45 s	2 s ecc – 2 s conc
Week 5–8	Power	Stair climbing	4 × 2 flights of 6 stairs	BM	45 s	Maximal
Week 9–12	Power	Stair climbing	4 × 2 flights of 6 stairs	BM + 10%	45 s	Maximal

*1RM = 1 repetition maximum; BM = body mass; ecc = eccentric; conc = concentric.

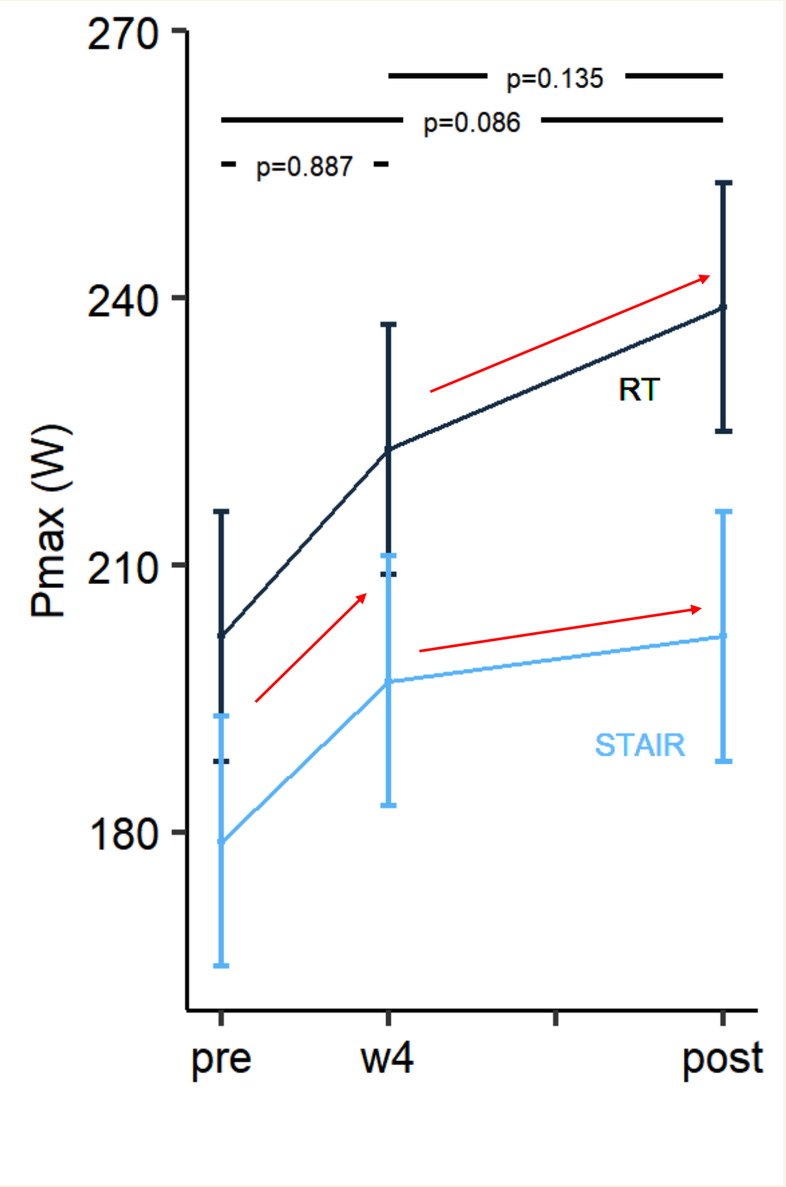
Original Research

the Journal of Strength and Conditioning Research™

Stair-Climbing Versus Machine-Based Resistance Exercise to Improve Muscle Power Among Older Adults: A Noninferiority Trial

Evelien Van Roie,[1,2] Jannique van Uffelen,[1] and Christophe Delecluse[1]

RESULTS - STAIR CLIMBING (POWER)



+19.5 ± 12.2%

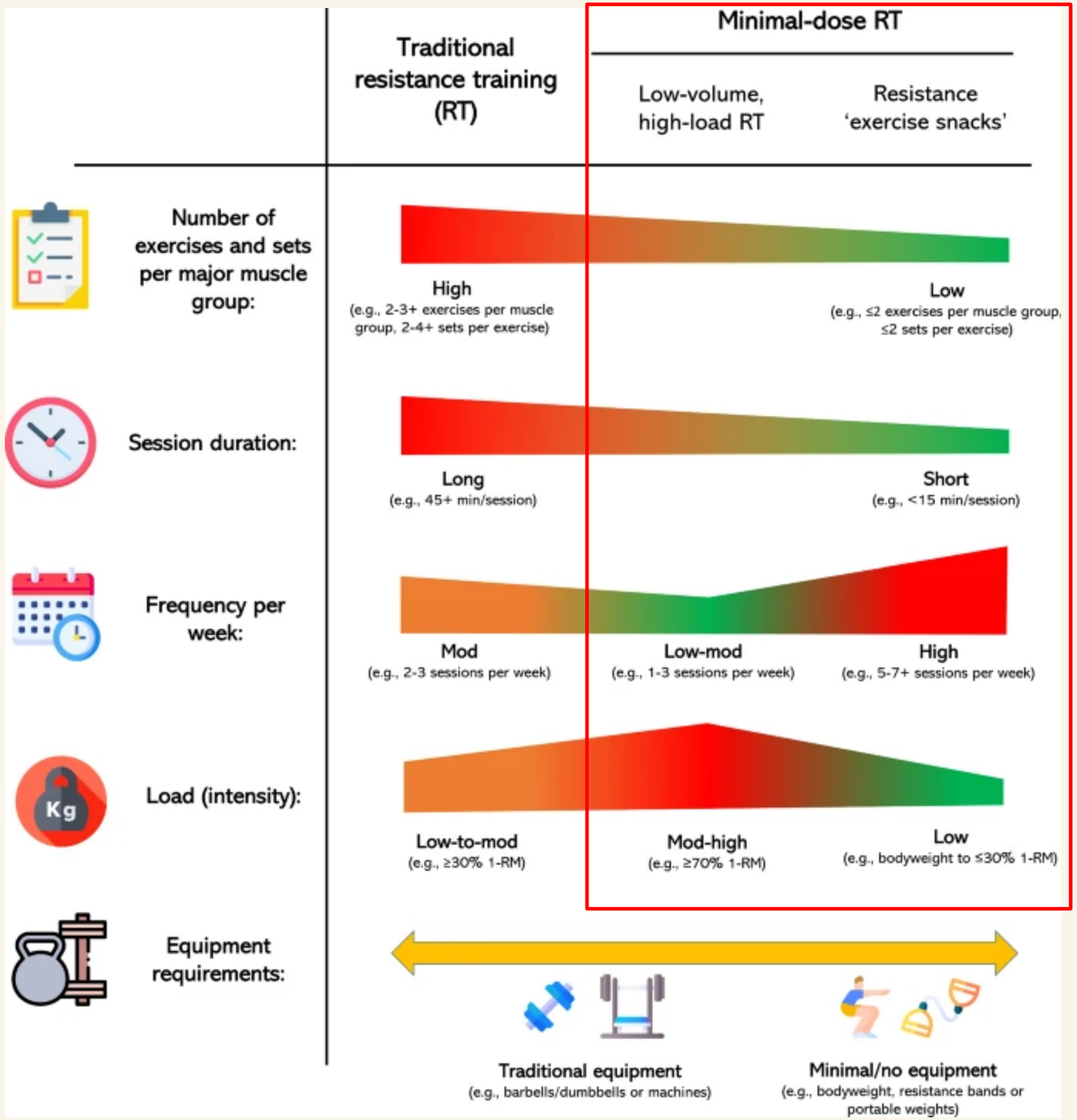
+13.7 ± 16.5%

Table 3

Estimated mean and *SE* at baseline (preintervention) and postintervention test for functional capacity in the resistance training (RT) and the stair-climbing exercise (STAIR) group.*†‡

	RT		STAIR		*p*	
Functional capacity	**Mean**	***SE***	**Mean**	***SE***	**Time**	**Time × group**
10-m fast walk (s)						
Pre	4.77	0.15	5.01	0.15		
Post	4.41	0.15	4.52	0.15	**<0.001**	0.263
5×STS duration (s)						
Pre	8.51	0.28	8.28	0.28		
Post	8.16	0.28	7.62	0.28	**<0.001**	0.197
5×STS power (W)						
Pre	305	16	290	16		
Post	308	16	311§	16	**0.026**	0.087
6-Step stair ascent duration (s)						
Pre	1.92	0.11	1.86	0.11		
Post	1.78§	0.11	1.59§	0.11	**<0.001**	**0.007‖**
6-Step stair ascent power (W)						
Pre	581	42	552	42		
Post	594	42	614§	42	**<0.001**	**0.035**
CMJ jump height (cm)						
Pre	17.5	1.1	17.0	1.1		
Post	18.7	1.1	18.5	1.1	**<0.001**	0.686

RESISTANCE EXERCISE: MINIMAL DOSE?



TRAINING PRINCIPLES!

Frequency > volume!

REPEAT!

Fyfe et al., Sports Med, 2022

LONGEVITY AND AGEING

Muscle power declines progressively from the 4th decade onwards, and more than muscle strength and muscle mass

Muscle = locomotor + metabolic organ → sarcopenia affects more than locomotor function alone!

RESISTANCE EXERCISE FOR HEALTHY LONGEVITY

Priority nr. 1 in older adults (never TOO old!)

Benefits go far beyond ‘building muscle’ or ‘gaining strength/power’

Progressive overload & consistency is key

Long-term adherence is challenging

THANK YOU!

KU LEUVEN

UHASSELT

KNOWLEDGE IN ACTION

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