Power Training: Research-Based Insights for Training Older Adults

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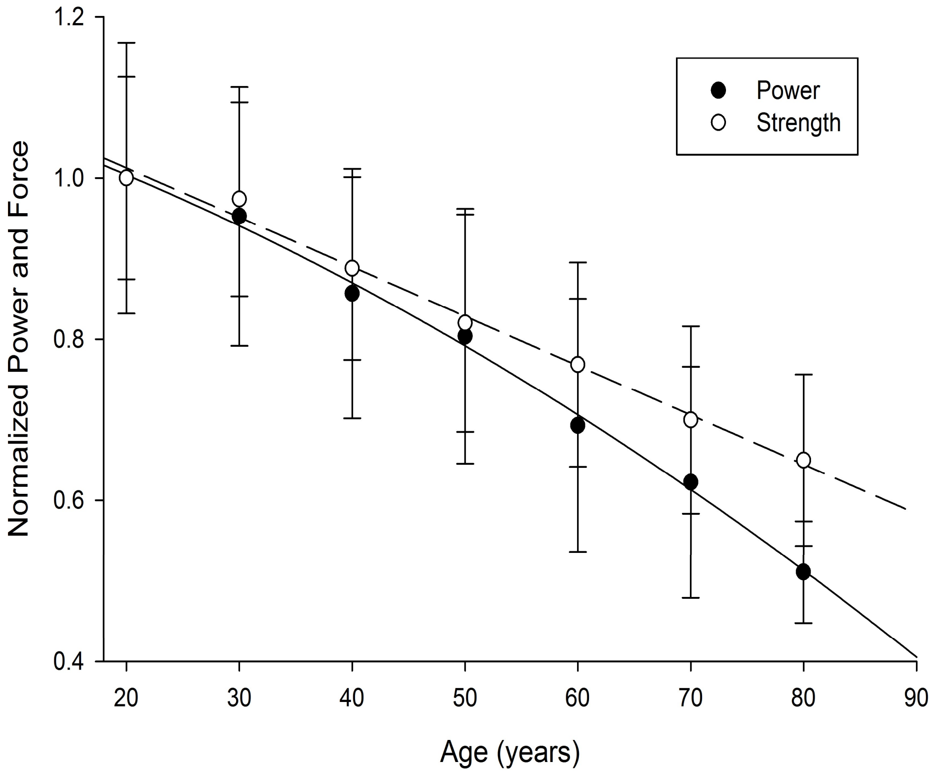
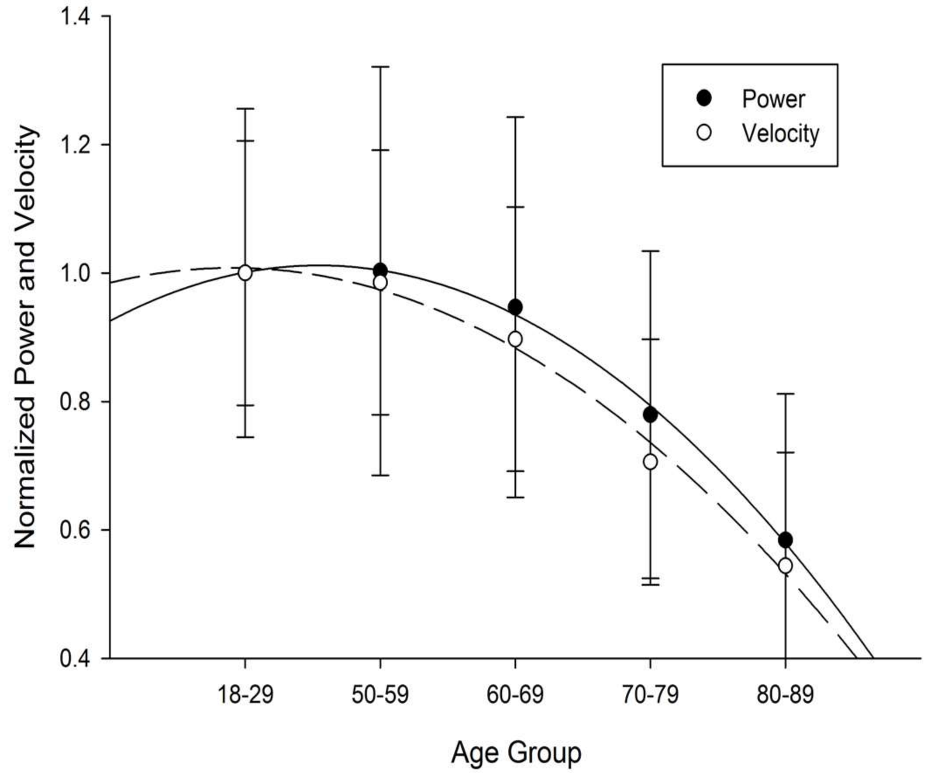
Power, strength and velocity declines with age



After data from Metter et al., J Gerontol A: Bio Med Sci, 1997



After data from Campitelli et al., J Aging Phys Act, 2021

Power training, daily activities, and fall probability

Maintaining independence and reducing fall probability

There is little doubt that lower body and upper body power are linked to maintaining independence (Foldvari et al., 2000; Cuoco et al., 2004; Bean et al., 2002; Reid et al 2012) and reducing the probability of injurious falls (Skelton et al., 2002; Whipple et al., 1987; Sran et al., 2010; Troy et al., 2009).

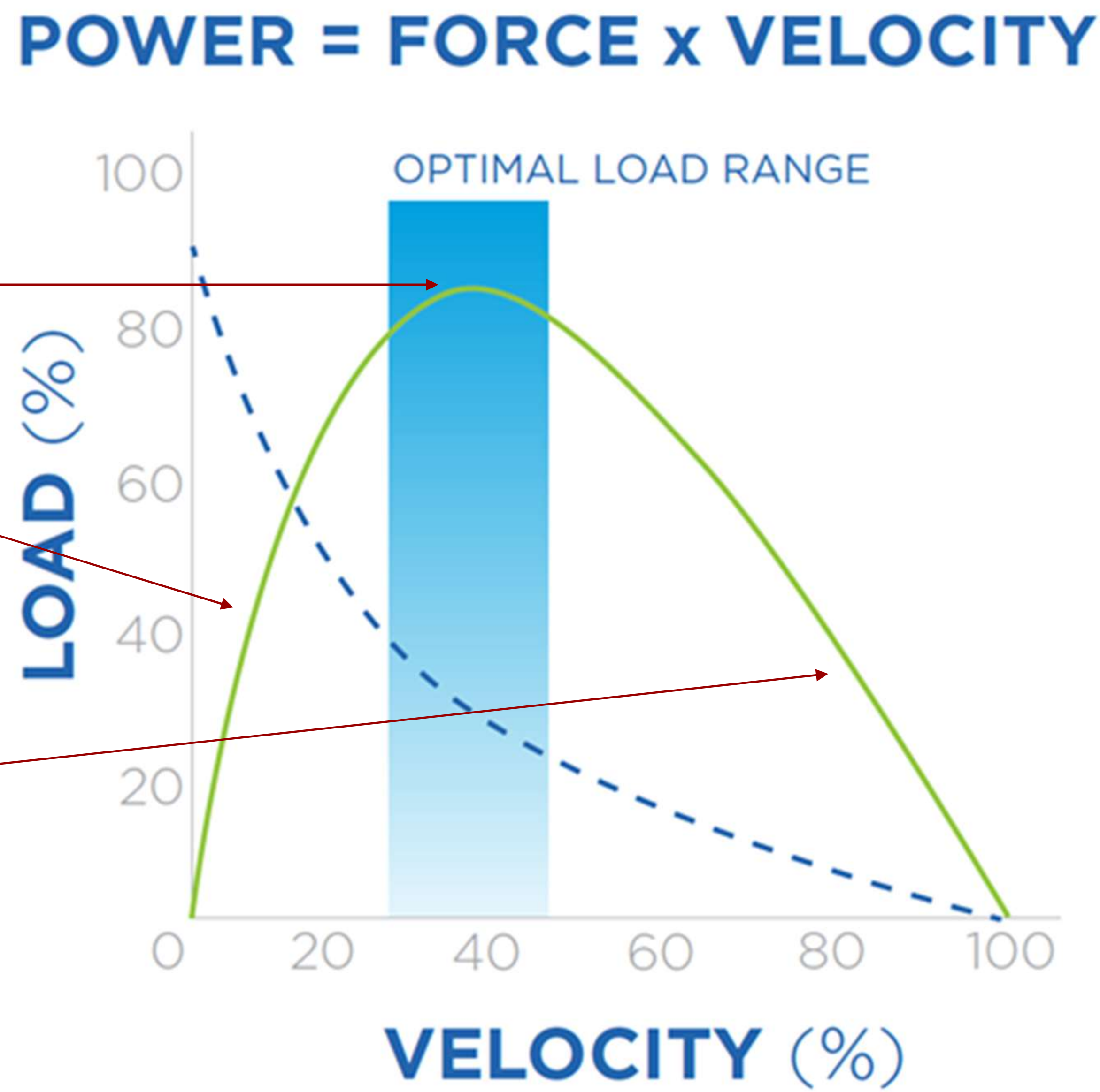
The optimal load for power

Session Title

- Maximum Power

- Training at the load end of the curve, not enough velocity, low power.

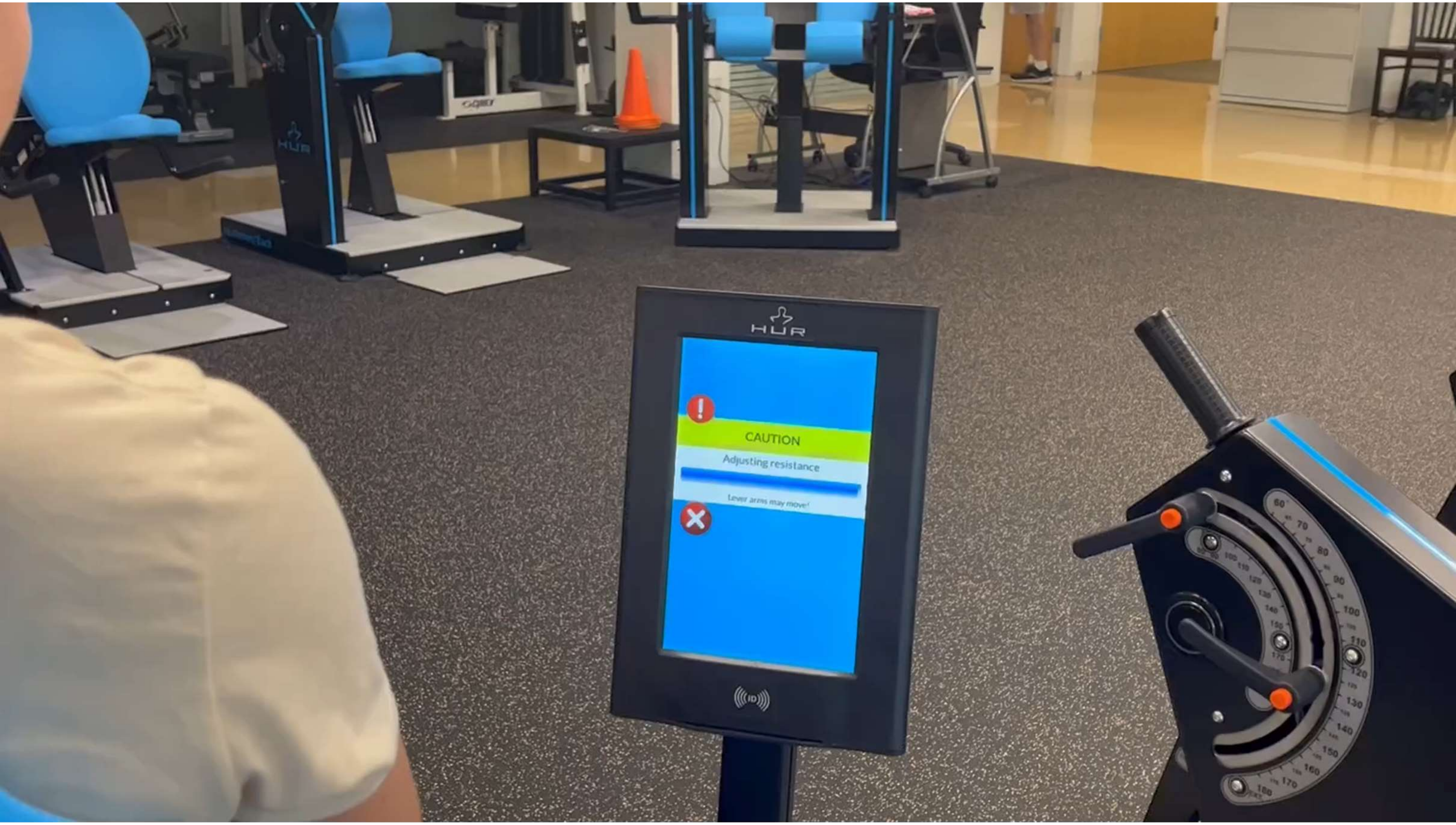
- Training at the velocity end of the curve, not enough load, low power.

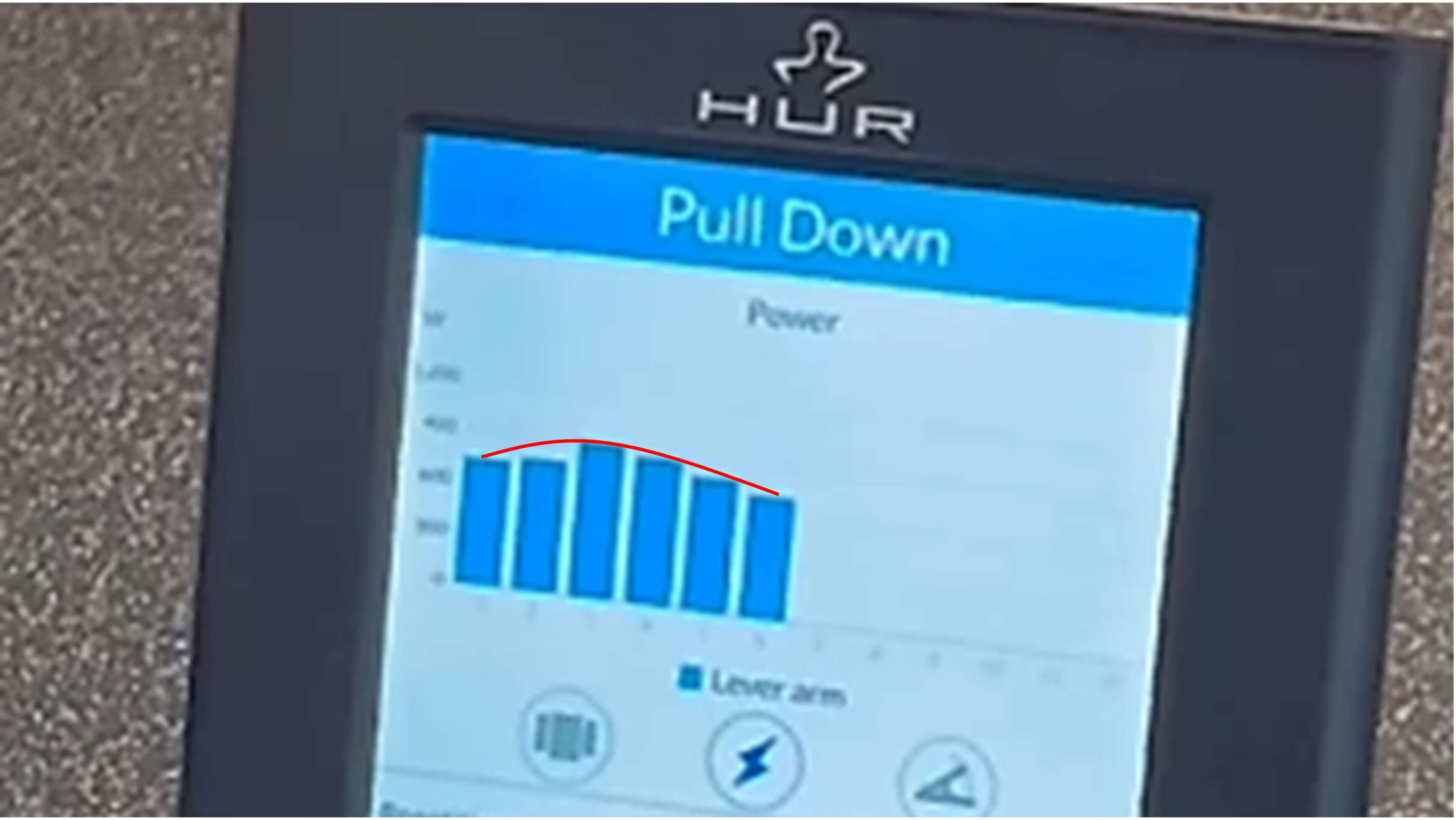


When examining the load-velocity and power curves, there are several questions that become immediately evident.

- Can the effects of the force-velocity curve be visualized during training?
- Is there truly an optimal load for training?
- Can I manipulate loads to target my client's needs?

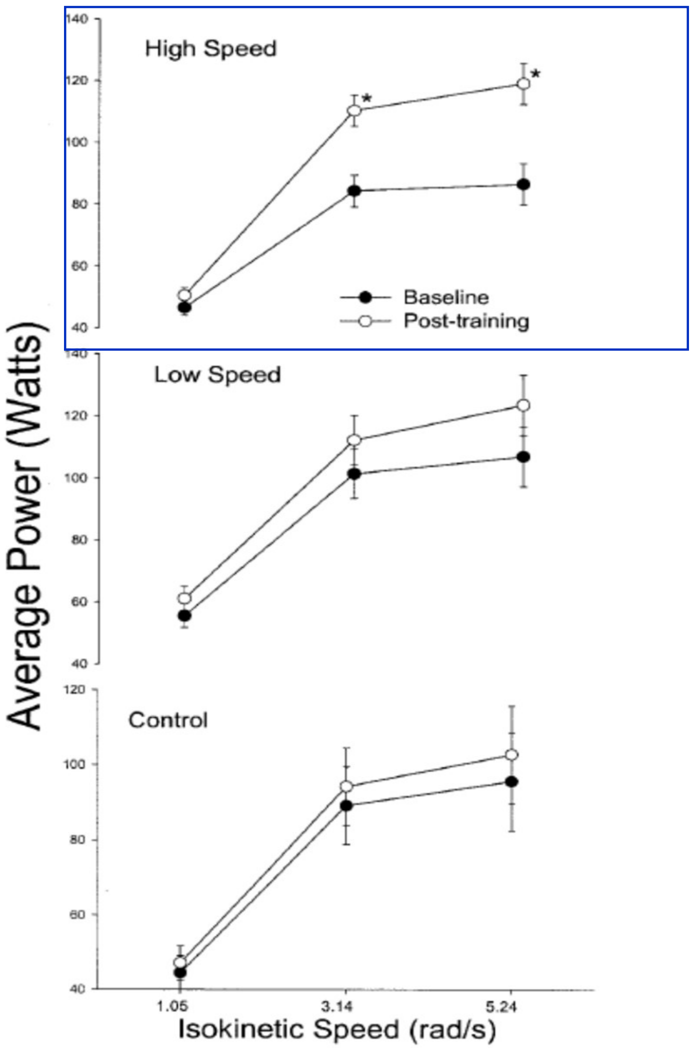
Can the effects of the force-velocity curve be visualized during training?


HUR
CAUTION
Adjusting resistance
Lever arms may move!
HUR

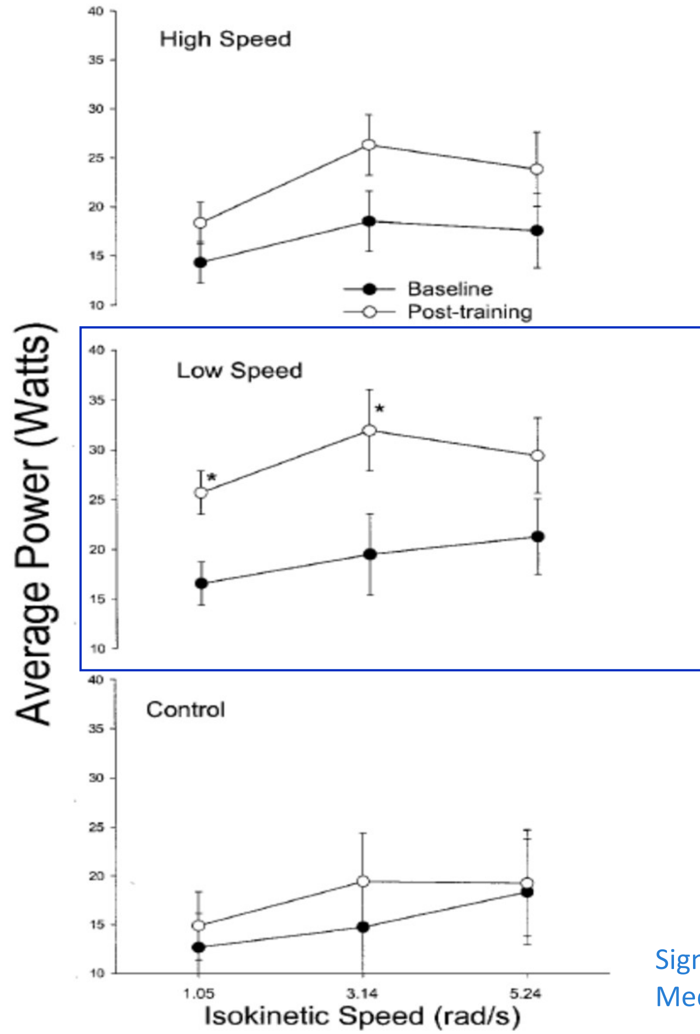

HUR
Pull Down
Power
Lever arm

Is there truly an optimal load for training?

Biomechanical Considerations



Knee Extensors



Plantar Flexors

Signorile et al., J Gerontol A Bio Med Sci. 2002

Optimal load by exercise

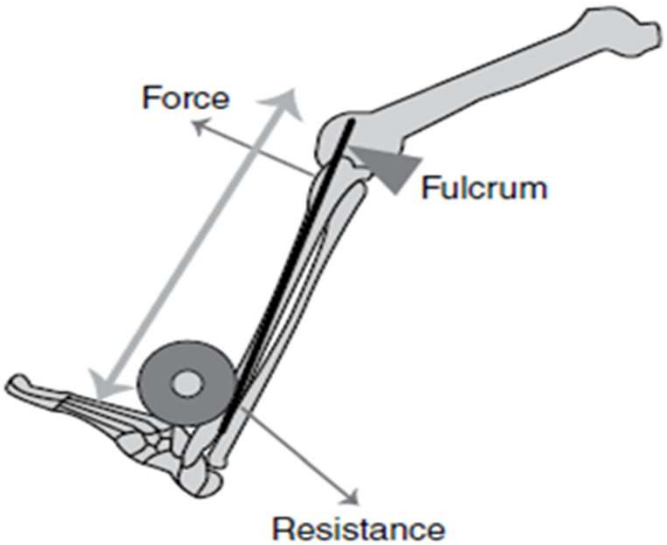
Table 2
Relative peak power at each load among exercises.

Exercise	40%	50%	60%	70%	80%
Multi-joint exercises					
Leg press	0.761 ± 0.034^{c}	0.841 ± 0.026^{ab}	0.887 ± 0.023^{ab†}	0.839 ± 0.020^{bc}	0.822 ± 0.027^{bc}
Chest press	0.859 ± 0.025^{bc}	0.913 ± 0.019^{ab†}	0.897 ± 0.018^{bc}	0.861 ± 0.024^{c}	0.735 ± 0.028^{d}
Seated row	0.859 ± 0.025^{a}	0.893 ± 0.021^{a†}	0.874 ± 0.021^{a}	0.809 ± 0.024^{b}	0.755 ± 0.025^{b}
Shoulder press	0.807 ± 0.043	0.847 ± 0.041	0.917 ± 0.024†	0.902 ± 0.020	0.855 ± 0.025
Single-joint exercises					
Hip adduction	0.869 ± 0.021^{cd}	0.929 ± 0.012^{ab†}	0.922 ± 0.017^{ab}	0.885 ± 0.885^{bc}	0.827 ± 0.031^{d}
Hip abduction	0.884 ± 0.021	0.922 ± −0.016†	0.910 ± 0.019	0.870 ± 0.021	0.849 ± 0.024
Leg curl	0.840 ± 0.027	0.872 ± 0.027†	0.849 ± 0.024	0.865 ± 0.023	0.844 ± 0.024
Calf raise	0.698 ± 0.041^{c}	0.831 ± 0.039^{ab}	0.885 ± 0.032^{a†}	0.812 ± 0.030^{ab}	0.726 ± 0.036^{bc}
Biceps curl	0.711 ± 0.042^{c}	0.777 ± 0.038^{bc}	0.845 ± 0.034^{ab†}	0.842 ± 0.048^{ab}	0.837 ± .046^{ab}
Triceps extension	0.800 ± 0.029^{b}	0.887 ± 0.018^{a}	0.922 ± 0.015^{a†}	0.898 ± 0.019^{a}	0.891 ± 0.022^{a}

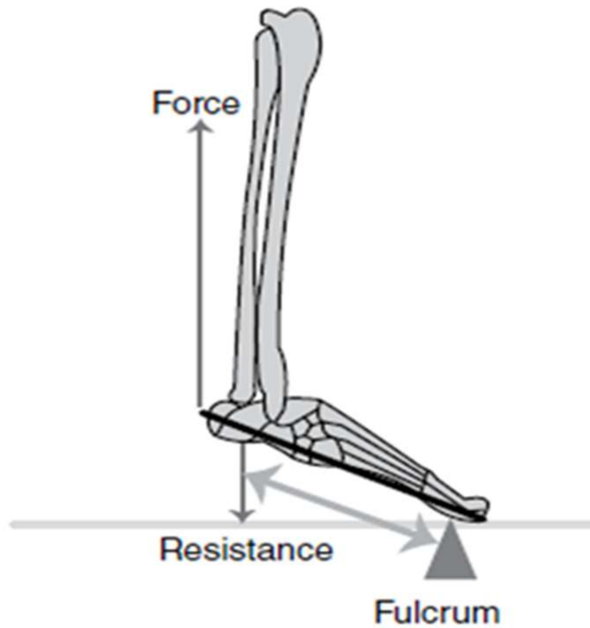
Values are mean ± SD. Loads are presented as a percentage of one-repetition maximum (1RM). † indicates load at which peak power was obtained. All values with similar letter are not significantly different from each other ($p < 0.05$).

Strand et al., Exp Gerontol, 2019

Biomechanical Considerations

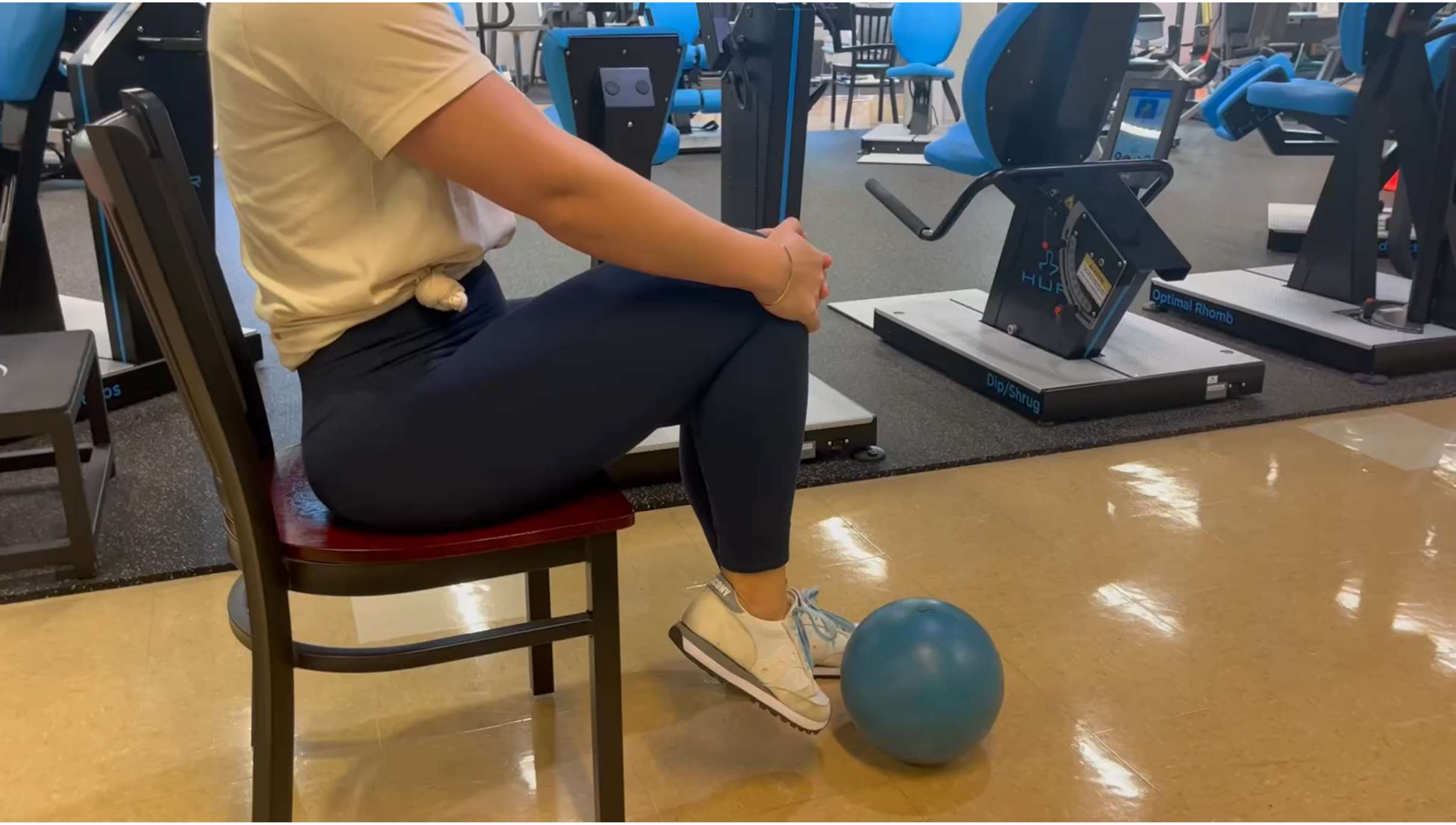


Long third class lever:
Favors movement velocity



Short second class lever:
Favors force production

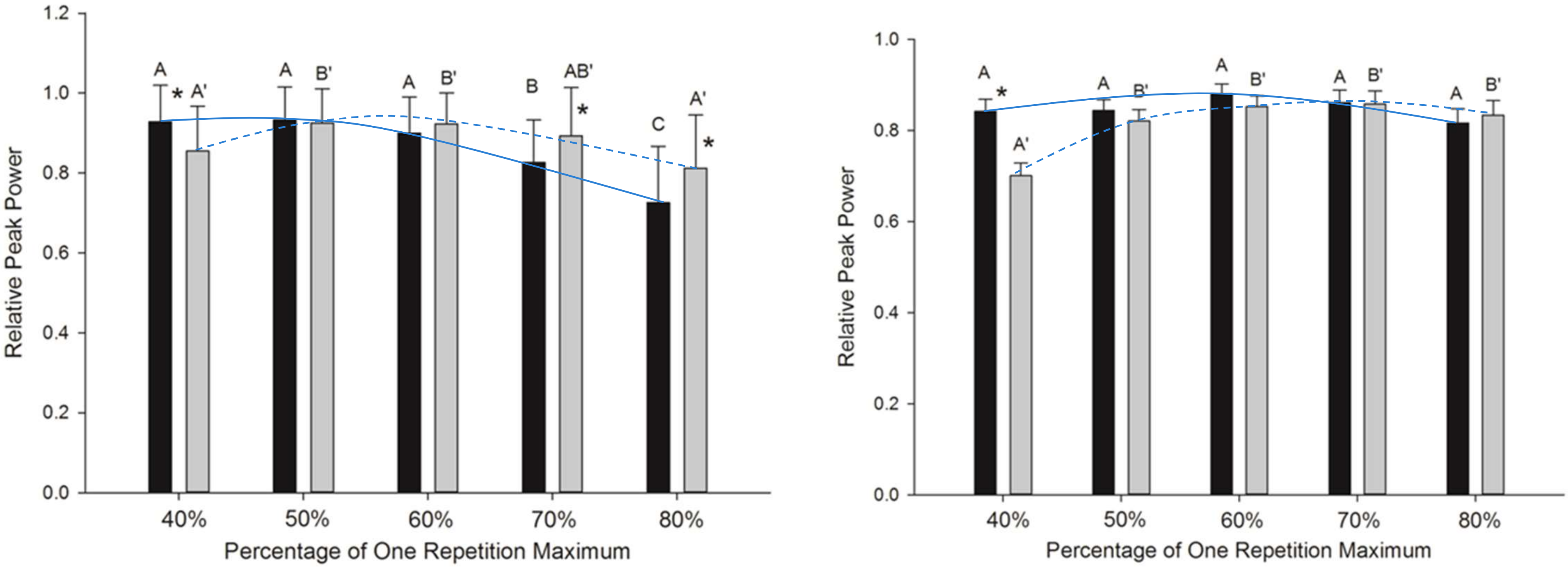
…and now a practical example


Optimal Rhomb
Dip/Shrug


Optimal Rhomb
Dip/Shrug

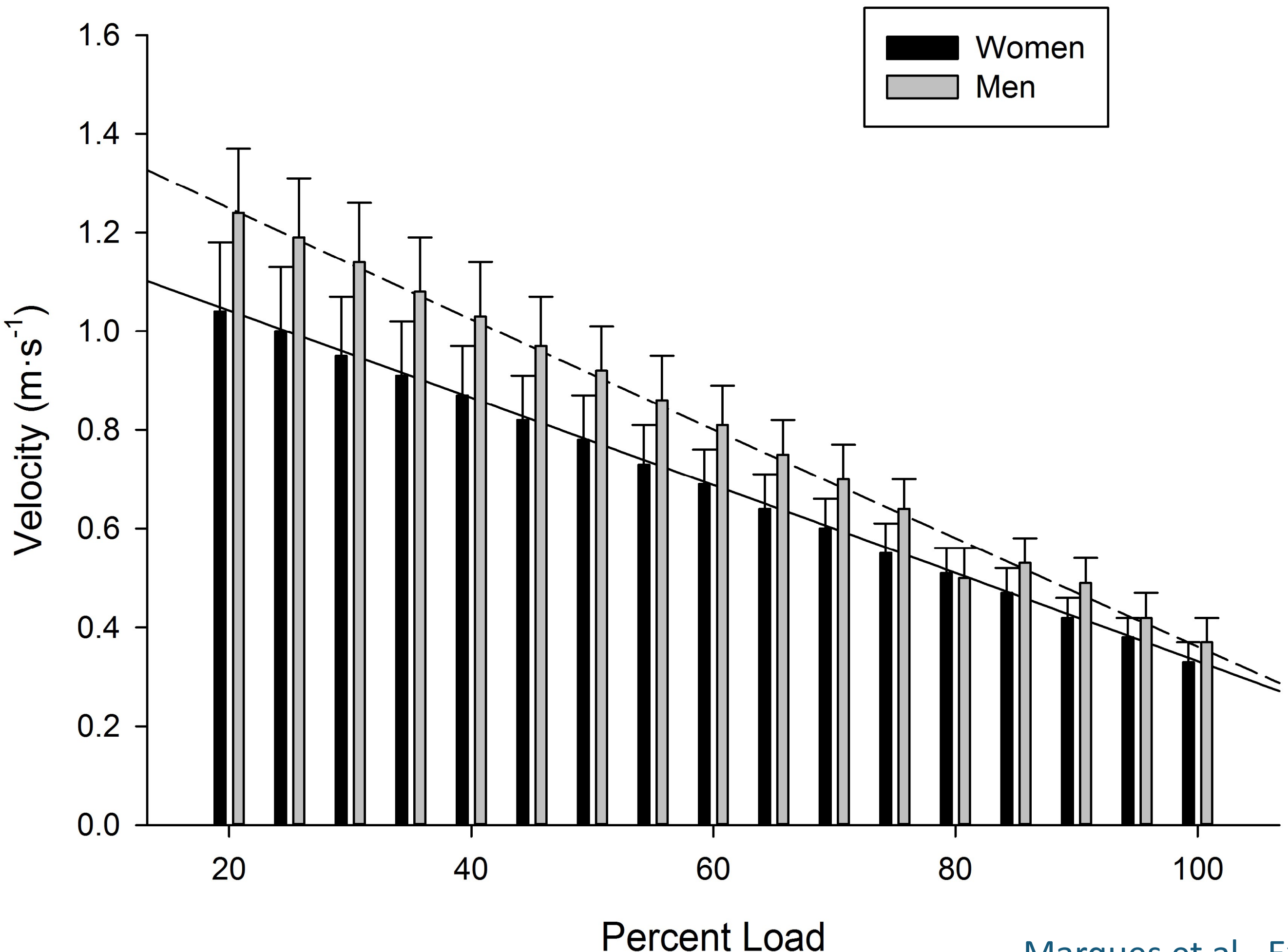
Sex differences

Sex differences



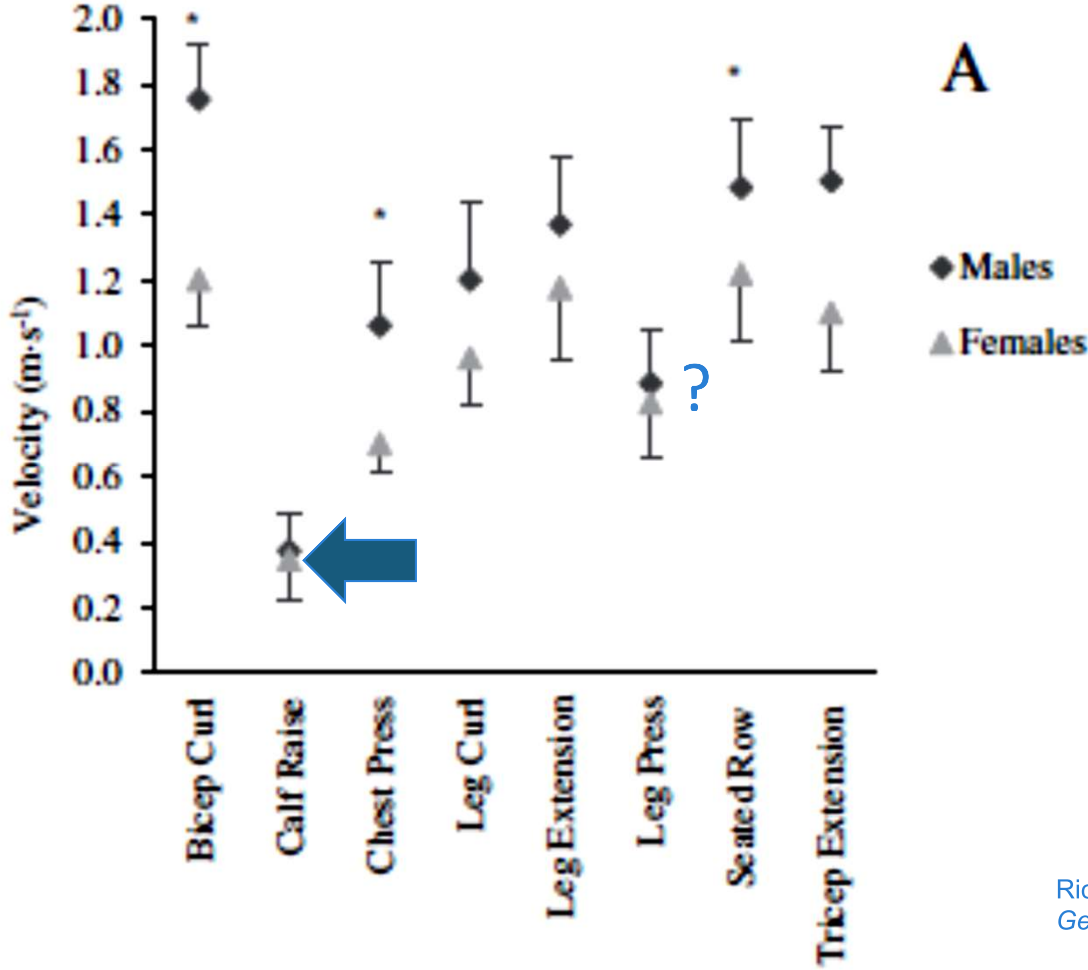
Strand et al., Exp Gerontol, 2019

Sex differences



Marques et al., Exp Gerontol., 2021

Sex differences

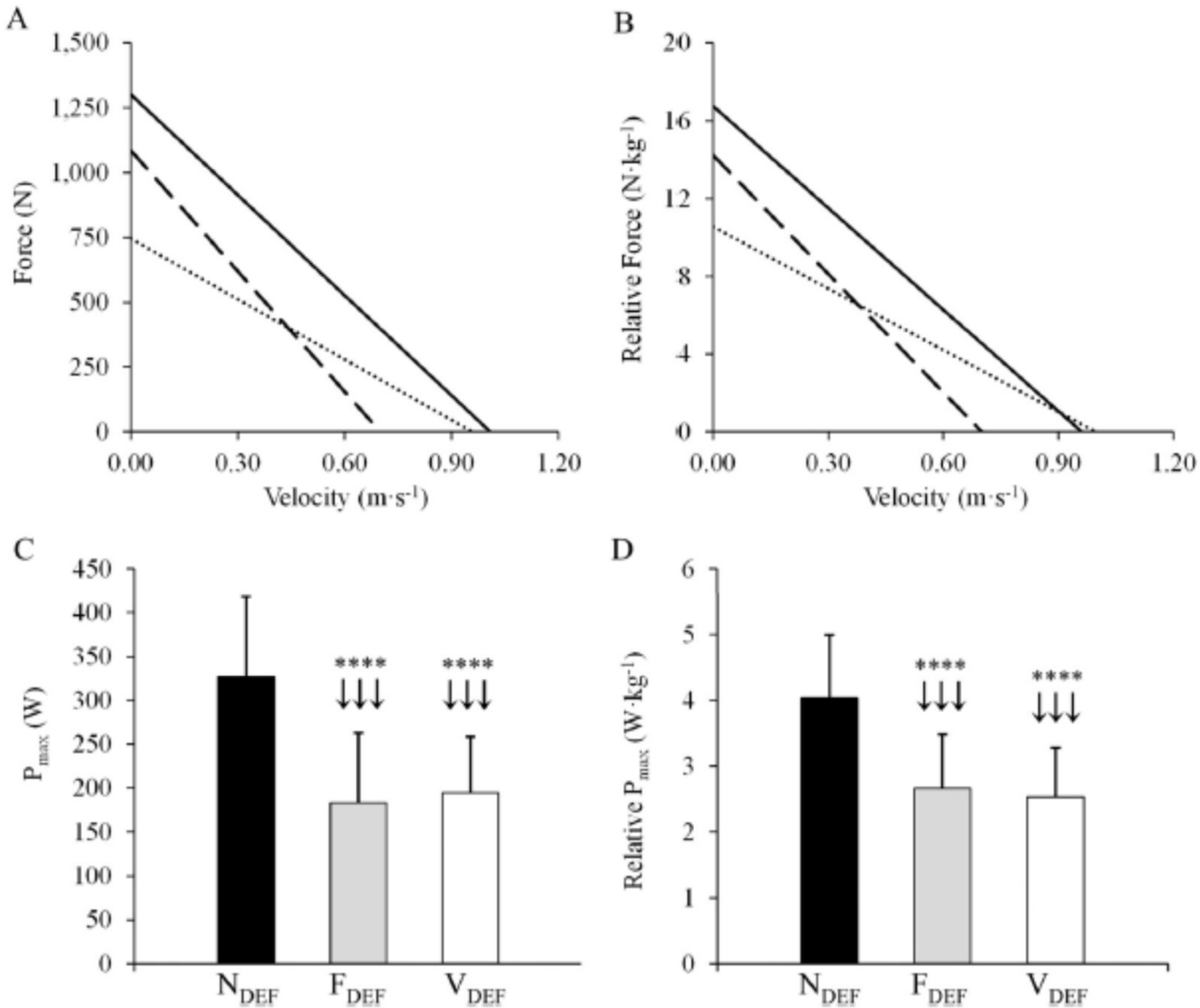


Richardson, D. L., et al., *Experimental Gerontology*, 2018

So what?

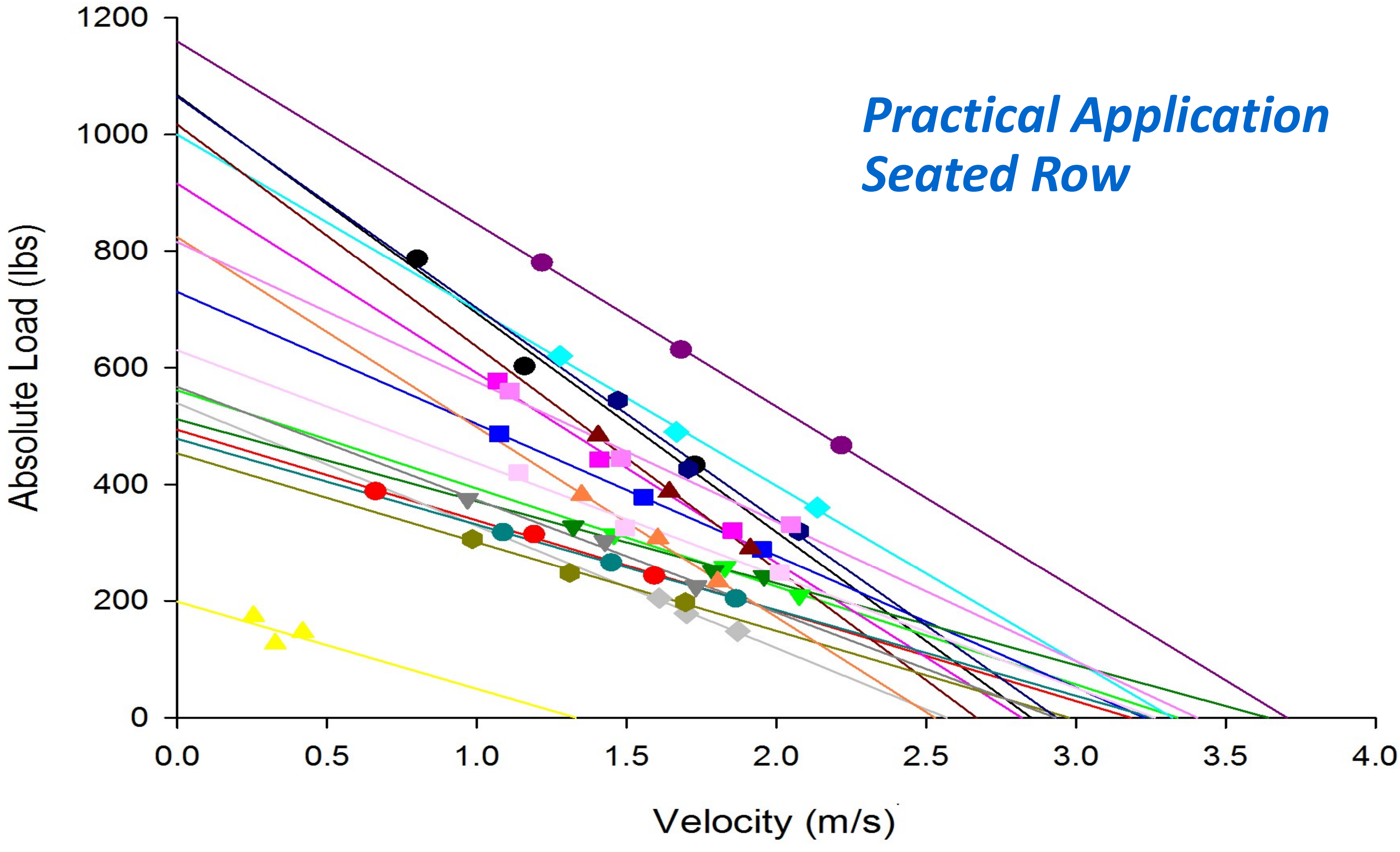
Can I manipulate loads to target my client's needs?

F-V profiling



Alcazar et al.,
Exp Gerontol., 2018

Practical Application
Seated Row



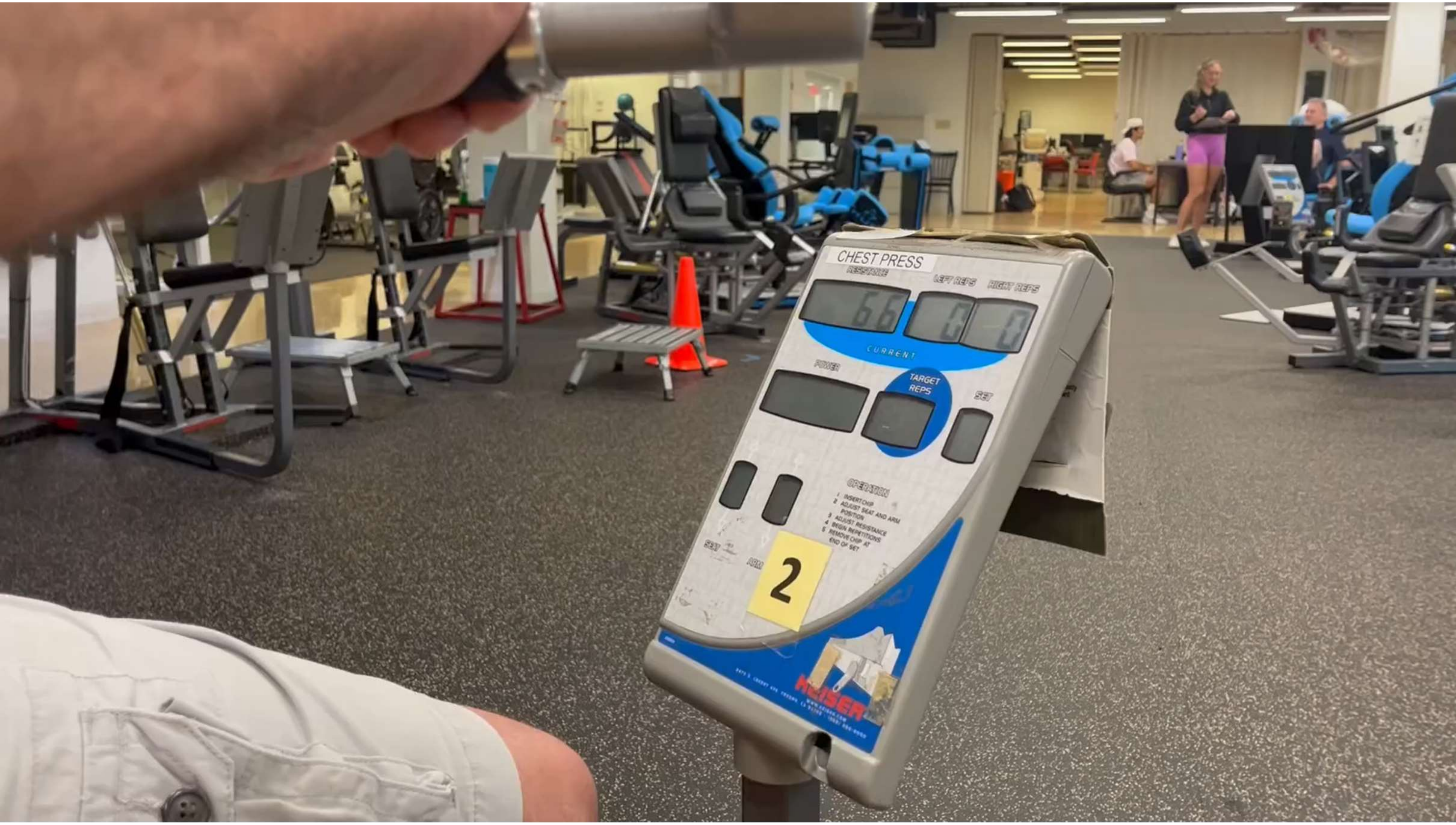
Velocity-based Training: Using Power Deficits

- To target velocity: 10% power deficit

- To target force: 30% power deficit

Velocity-based Training using Power Deficits:

Velocity Deficit

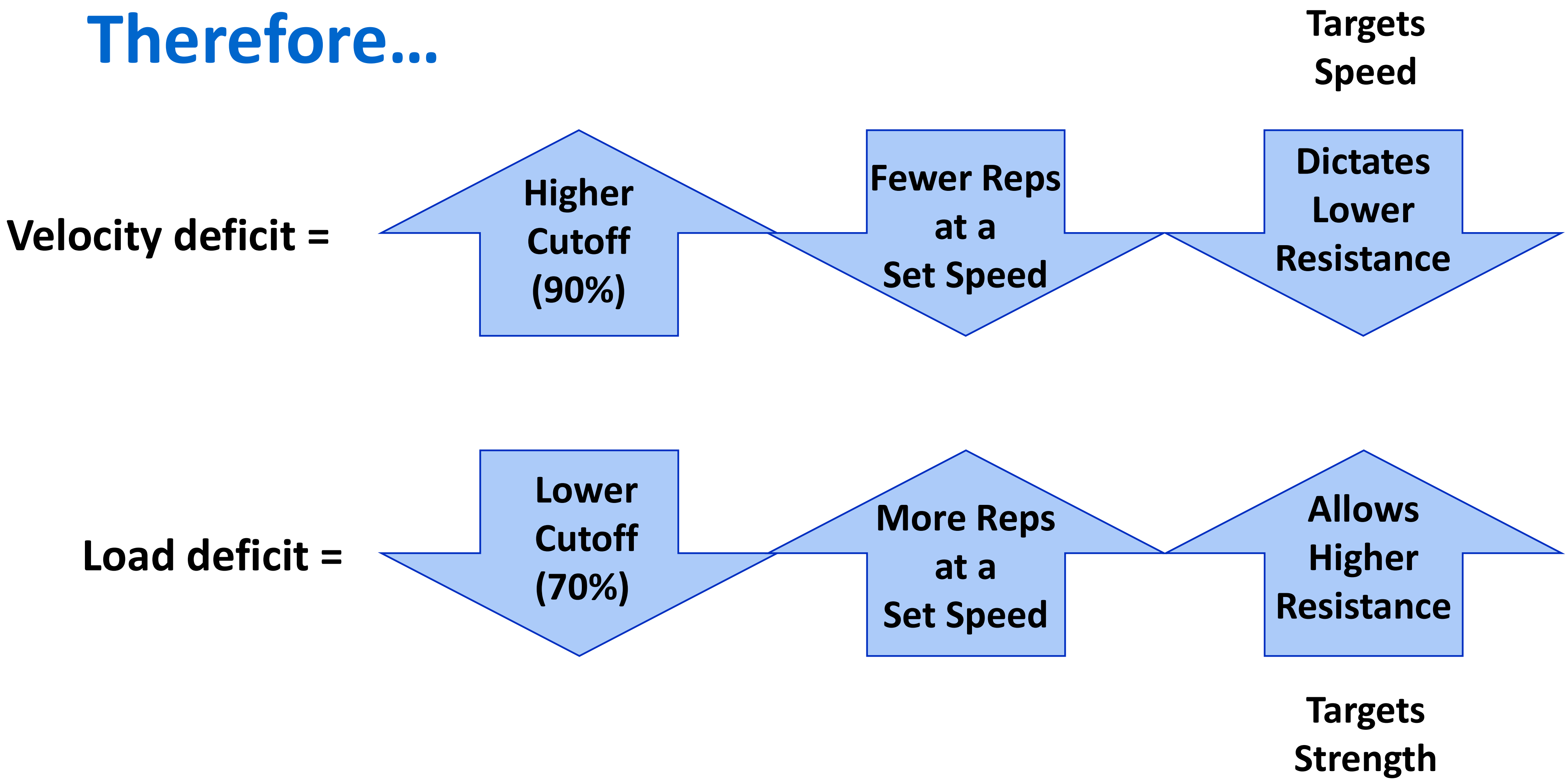

CHEST PRESS
RESISTANCE
LEFT REPS
RIGHT REPS
CURRENT
POWER
TARGET REPS
SET
OPERATION
1 INSERT CHIP
2 ADJUST SEAT AND ARM POSITION
3 ADJUST RESISTANCE
4 BEGIN REPETITIONS
5 REMOVE CHIP AT END OF SET
2
KEISER

Velocity-based Training using Power Deficits:

Force Deficit


CHEST PRESS
LEFT REPS
RIGHT REPS
CURRENT
POWER
TARGET REPS
SET
OPERATION
1 INSERT CHIP
2 ADJUST SEAT AND ARM POSITION
3 ADJUST RESISTANCE
4 BEGIN REPETITIONS
5 REMOVE CHIP AT END OF SET
2
KEISER

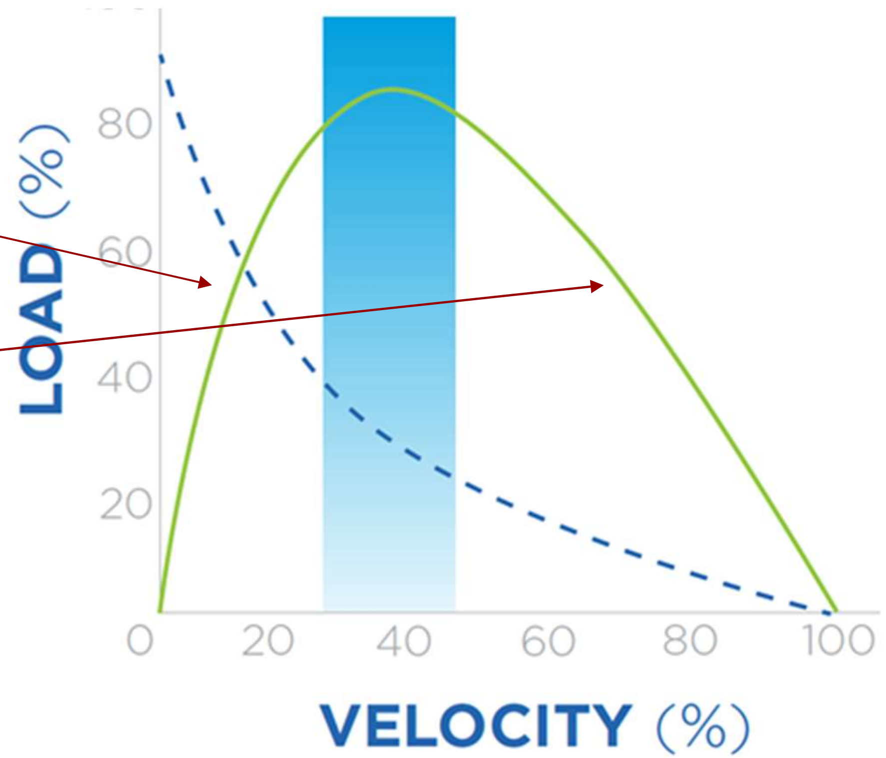
Therefore…


Targets Speed
Velocity deficit =
Higher Cutoff (90%)
Fewer Reps at a Set Speed
Dictates Lower Resistance
Load deficit =
Lower Cutoff (70%)
More Reps at a Set Speed
Allows Higher Resistance
Targets Strength

Velocity-Based Training

While this does allow us to target specific deficits along the force-velocity curve…

- Training targeting velocity deficit.
- Training targeting load deficit.



Velocity-Based Training

…we are still determining the relationships between these deficits and activities of daily living.

Theoretically, is one of these tests more velocity-based and one more load based…and why?

Set Structures

Background

Traditional Set Structure (TS)
The completion of a training set occurs without any rest being taken between repetitions.

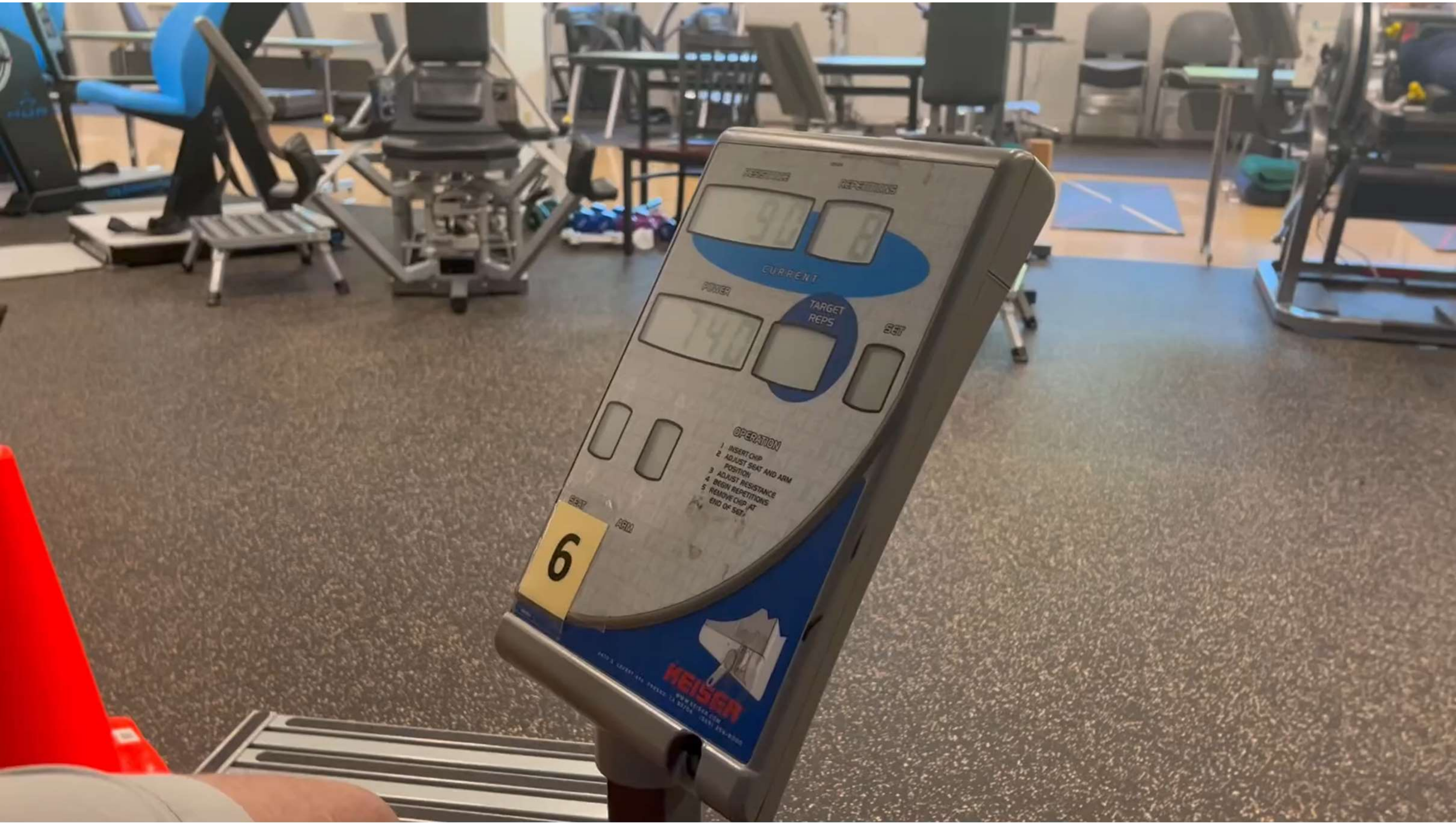
Cluster Set Structure (CS)
Adding pre-planned rest intervals within a set alongside normal interset rest periods, thereby breaking sets into small clusters of repetitions.

Rest Redistribution Set Structure (RR)
The addition of shorter, more frequent rests intervals within the set structure.

Traditional Set Structure


RESISTANCE
REPETITIONS
CURRENT
POWER
TARGET REPS
SET
OPERATION
1 INSERT CHIP
2 ADJUST SEAT AND ARM POSITION
3 ADJUST RESISTANCE
4 BEGIN REPETITIONS
5 REMOVE CHIP AT END OF SET
SEAT
ARM
6
KEISER

Cluster Set Structure


REPETITIONS
98
8
CURRENT
POWER
740
TARGET
REPS
SET
OPERATION
1 INSERT CHIP
2 ADJUST SEAT AND ARM
POSITION
3 ADJUST RESISTANCE
4 BEGIN REPETITIONS
5 REMOVE CHIP AT
END OF SET
SEAT
ARM
6
KEISER

Rest Redistribution Set Structure


RESISTANCE
REPETITIONS
CURRENT
POWER
TARGET REPS
SET
OPERATION
1 INSERT CHIP
2 ADJUST SEAT AND ARM POSITION
3 ADJUST RESISTANCE
4 BEGIN REPETITIONS
5 REMOVE CHIP AT END OF SET
SEAT
ARM
6
KEISER

What equipment is optimal?

High-speed training and modalities

Although free weights and stack-loaded machines are common modalities used to develop power; however, they have three inherent problems.

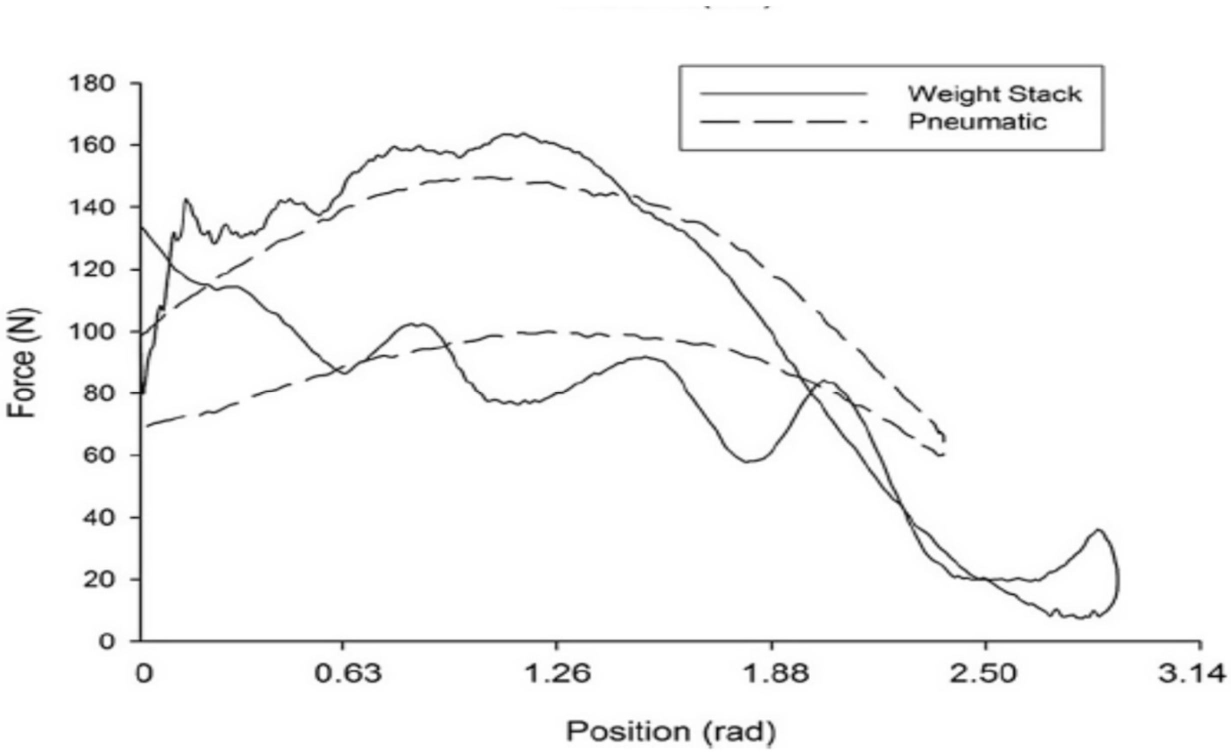
- Deceleration
- Momentum
- Safety

High-speed training and modalities

Deceleration

- During explosive movements, the bar, dumbbell or weight-stack must be decelerated at the end of the movement (Gambetta V., 1998)
- In fact, it has been estimated that during a 7RM (81% max) lift, over half the duration of the lift is spent slowing the weight down as you approach your endpoint (Elliot et al., 1989; Wilson et al., 1993; Wolfe et al., 1982).
- The time necessary to slow down the weight would increase as the load is decreased and velocity increases, causing a reduction in maximal power improvements (Schmidtbleicher, D., 1982; Schmidtbleicher et al., 1988).

Momentum



Napoli et al., Human Movement Science, 2015

High-speed training and modalities

Injury Potential

- The highest injury risks occur at the extreme end ranges of motion of a resistance-based exercise (Kumar S., 2001. This may be acerbated by momentum during the use of stack- or plate-loaded machines or free weights Elliot et al., 1989; Wilson et al., 1993; Wolfe et al., 1982).

Plate-Loaded Power Training


12
12.5
25
37.5
50
62.5
6
L.B.

Pneumatic-Loaded Power Training


HUR
Pull Down
62.5

Thank you for attending!
We appreciate your support.

Joseph Signorile, PhD
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