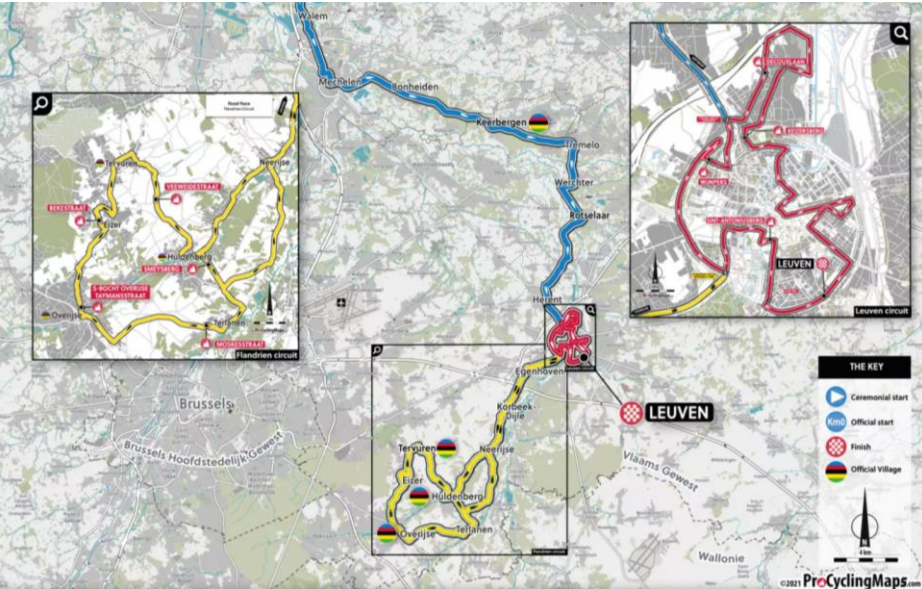




The effect of road bike damping on short term cycling performance

Josef Viellehner

*Department of Biomechanics and Orthopaedics
German Sport University Cologne*



Vibration

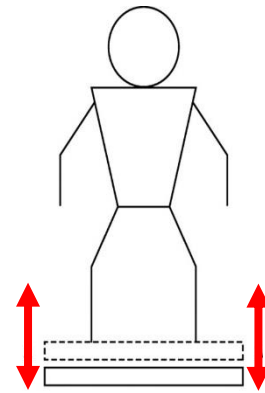
- Discomfort, pain, traumatism (Schwellnus & Derman, 2005)
- Muscular activity (Munera et al. 2018, Viellehner & Potthast, 2021)
- Respiratory response (Sperlich et al. 2009, Viellehner & Potthast, 2020)

Damping

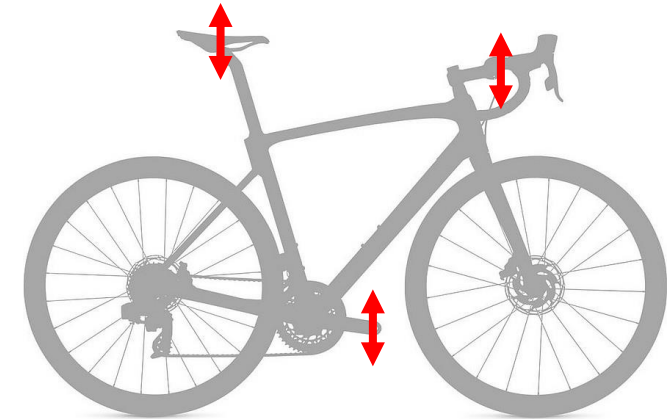
- Vibration stimulus modulates muscle activity and respiratory demand (Lienhard et al. 2014, Pollock et al. 2010)

Vibration

- Frequency
- Amplitude
- Magnitude



Cardinale et al. 2005



Influencing factors

- Type of vibration (Rittweger et al. 2001, Munera et al, 2018)
- Duration of exposure (Chiemetin, 2013)
- Direction of application (Jack & Eger, 2008, Nawayseh, 2019)
- Muscle specific sensitivity (Banks, 2006; Mildren et al., 2019)
- External loading (Ritzmann et al. 2013)
-

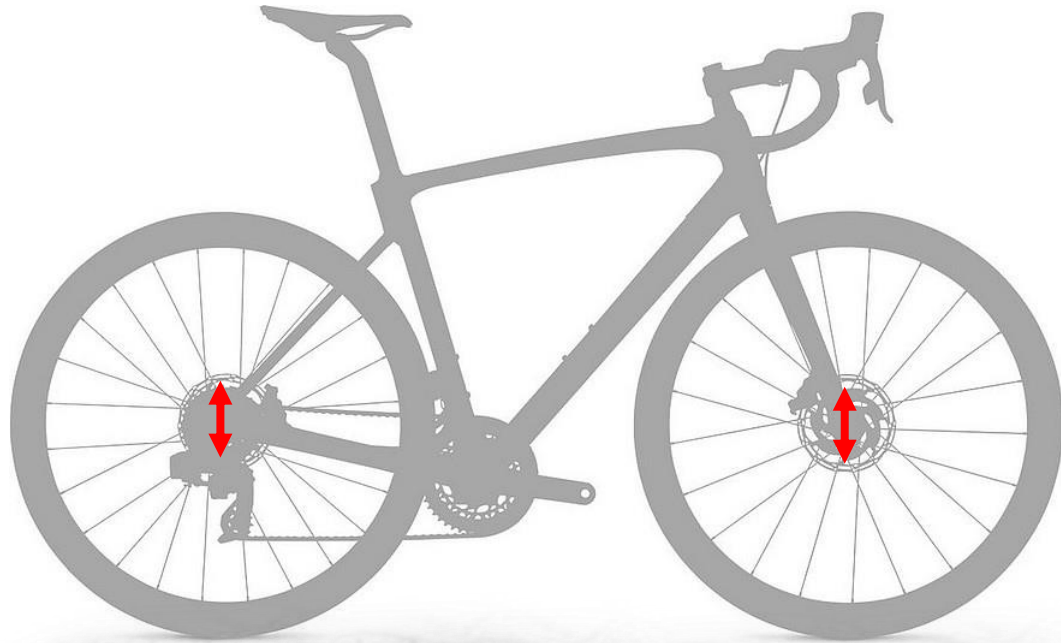
Understanding if and how vibration and road bike damping affect short time performance in cycling.

METHODS – Testrides on Cobblestones

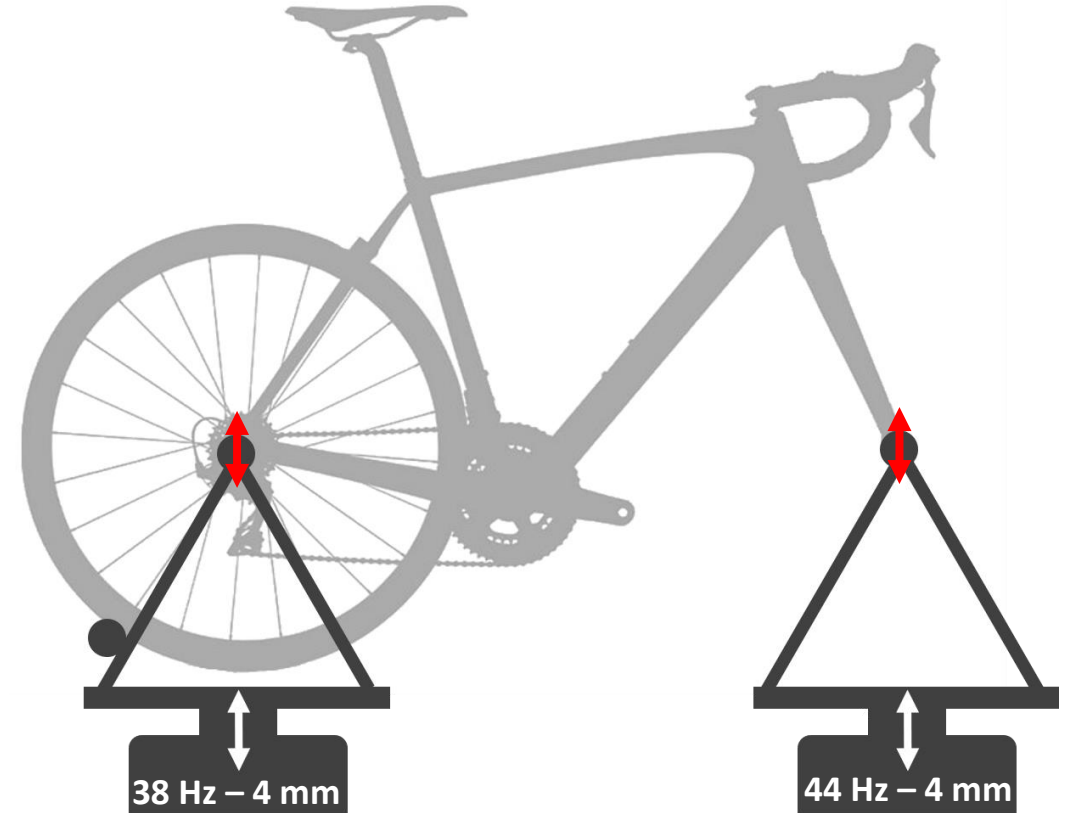


METHODS – Vibration application

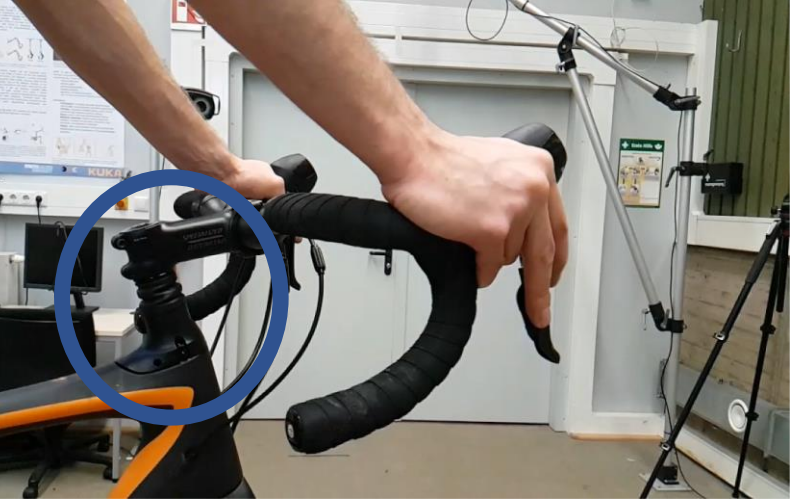
Field Test on Cobbles



Lab Intervention



Viellehner & Potthast, 2020



Participants:

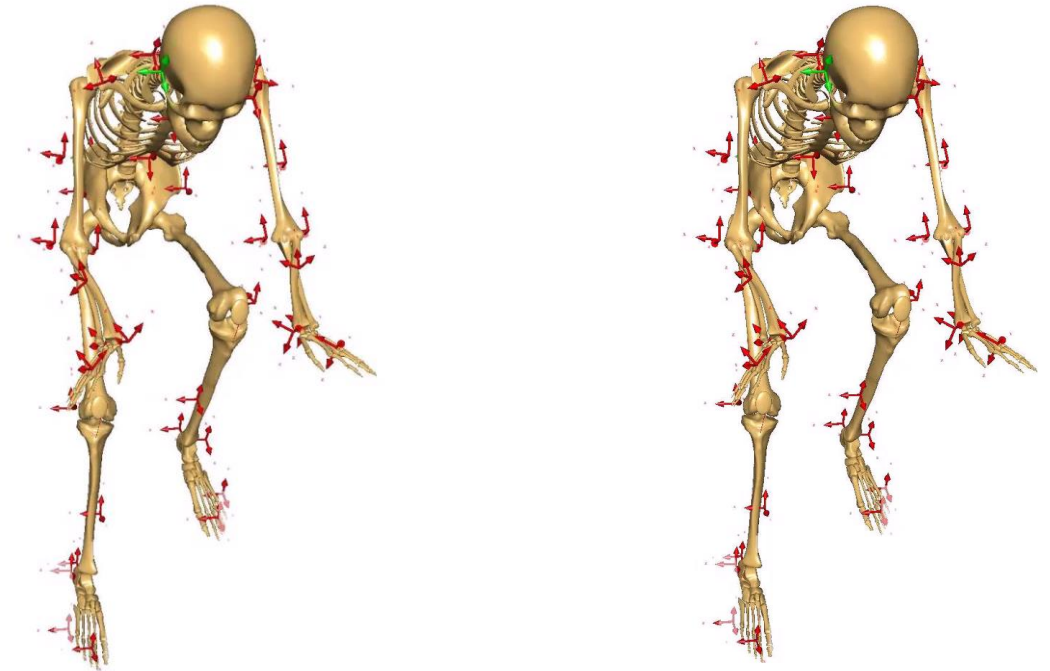
- 30 trained amateur cyclists (75 ± 8.9 kg / 1.82 ± 0.05 m / 63 ± 6.8 ml/min/kg)

Experimental Interventions:

- Vibration / No Vibration (Rear: 38 Hz – 4 mm / Front: 44 Hz – 4 mm)
- Bike: Damped / Non-Damped (Specialized: Roubaix 2016 / Tarmac SL 5)

Statistics:

- Two factor rmANOVA (Damping / Vibration)



Day 2	 NoVib		Vib 
Day 1	NoVib		Vib

Vibration Exposure

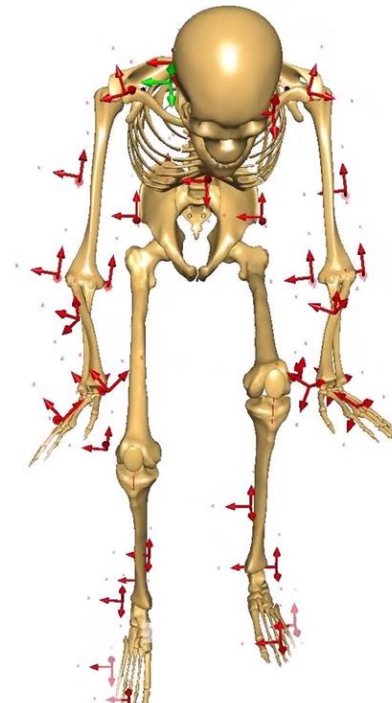
(Myon Aktos @ 275 Hz)

Muscle Activation

(Myon Aktos @ 1000 Hz)

Kinematics

(Vicon MX40 @ 200 Hz)



Heart rate

(Garmin, Edge @ 1 Hz)

Oxygen Consumption

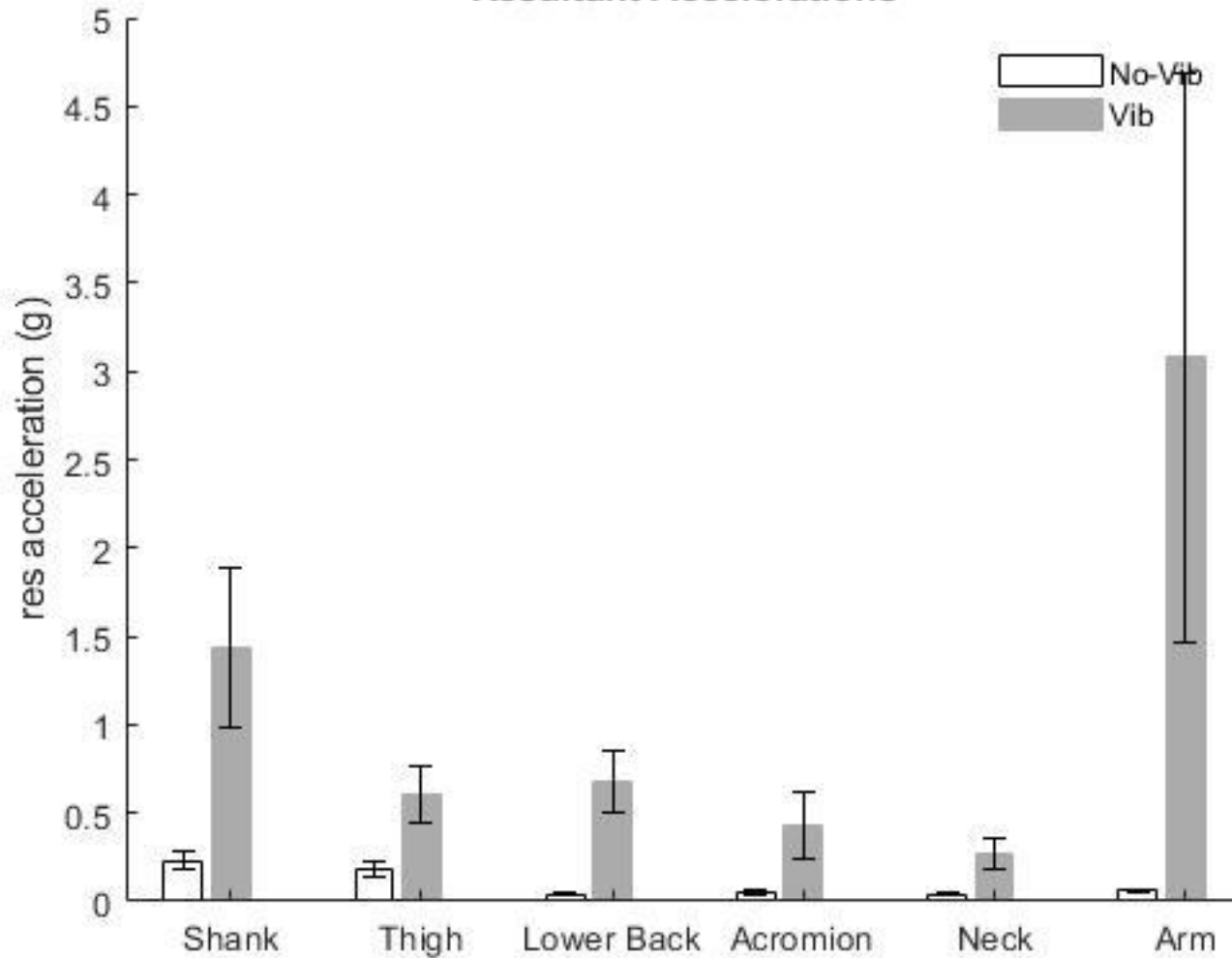
(nSpire, Zano600 USB)

Cranking Power

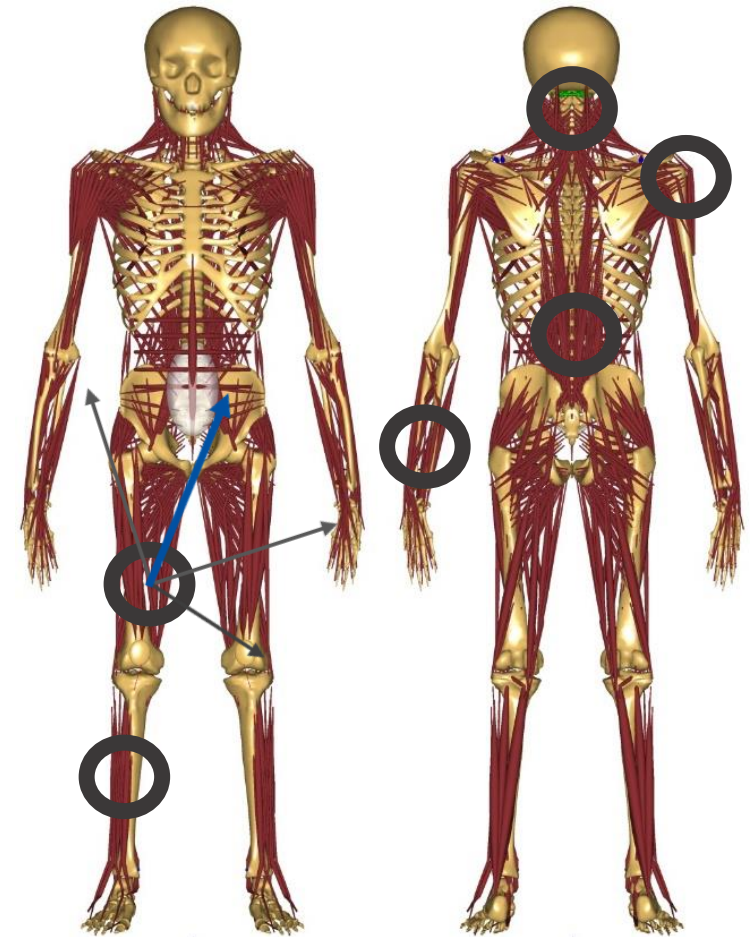
(SRM, 5th Gen)

RESULTS – Vibration Exposure

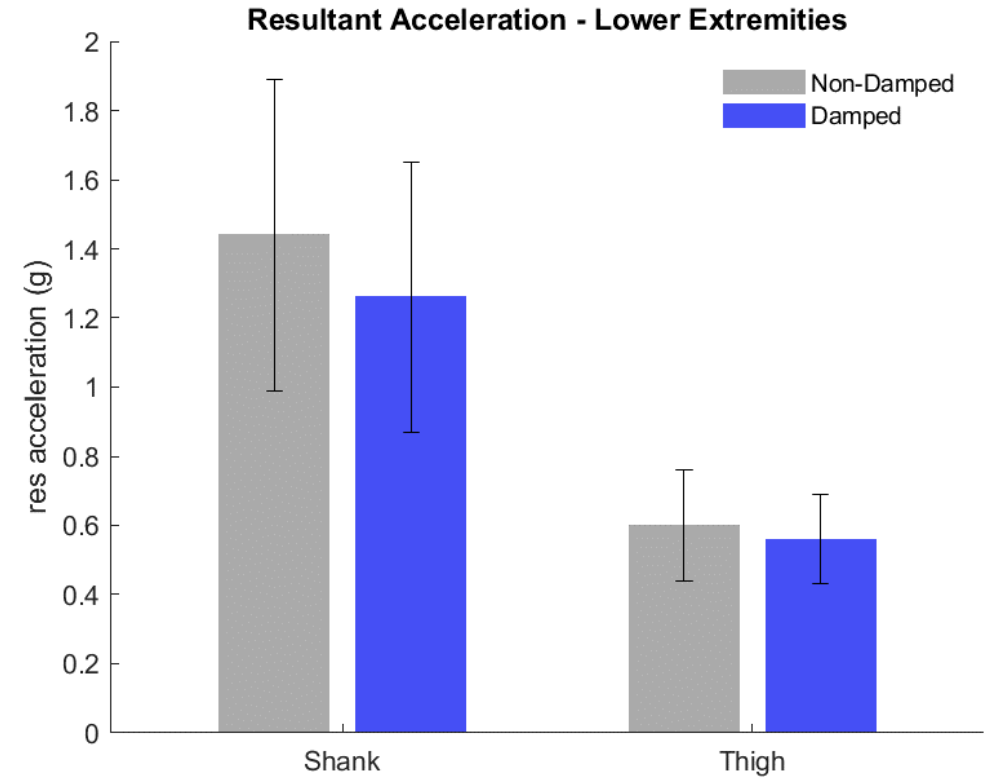
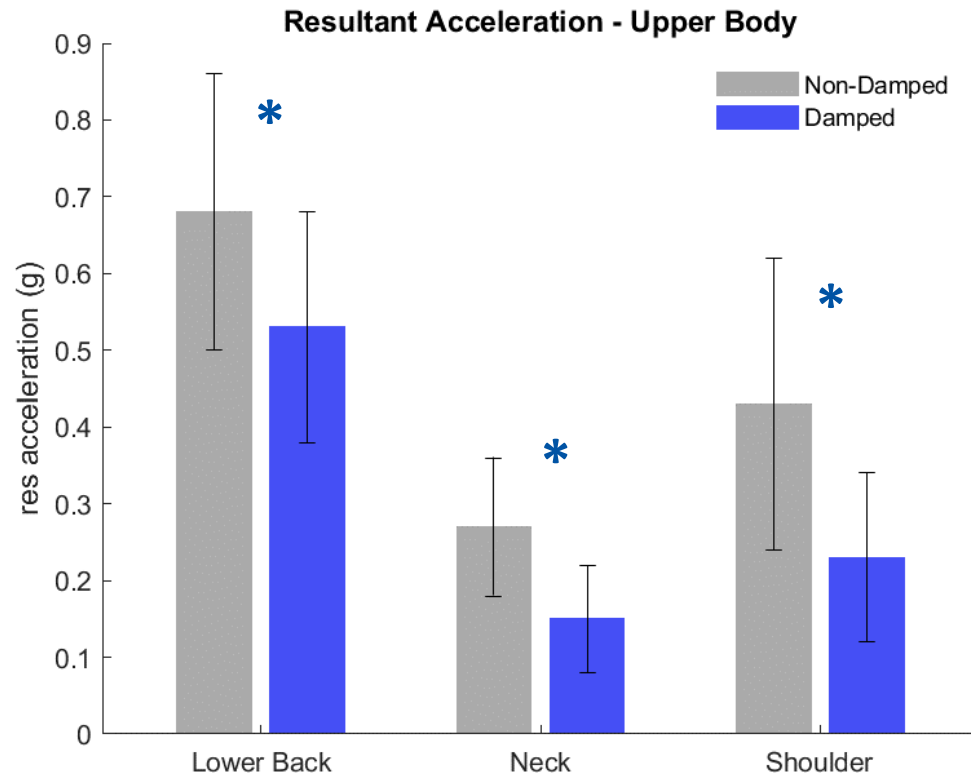
Resultant Accelerations



Viellehner & Potthast, 2021



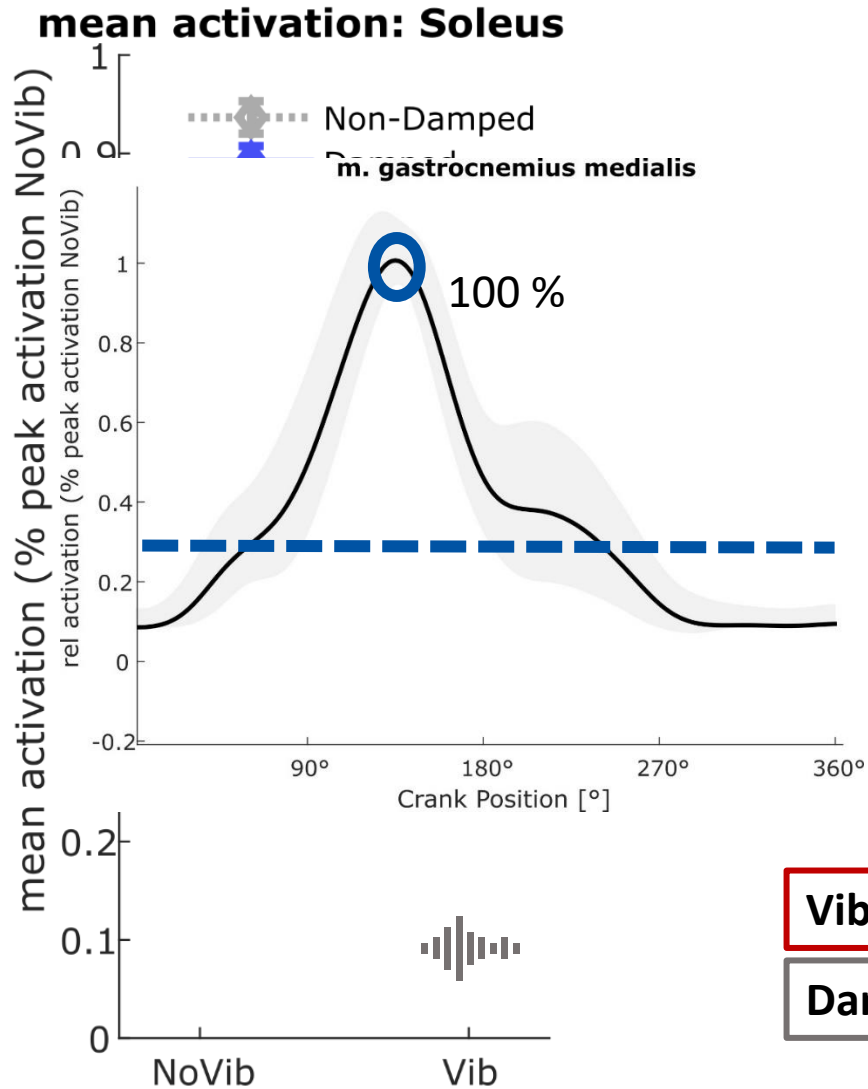
RESULTS – Vibration Exposure



Viellehner & Potthast, 2021

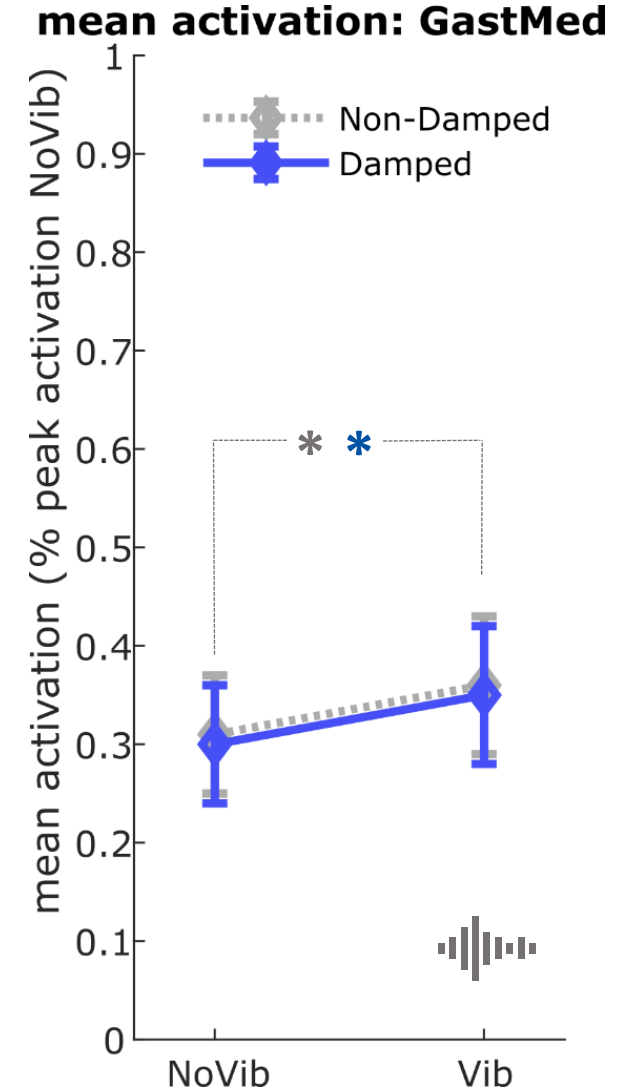
* = sig. diff. 'Damped' - 'Non-Damped' (p < 0.05)

RESULTS – Muscular Activation



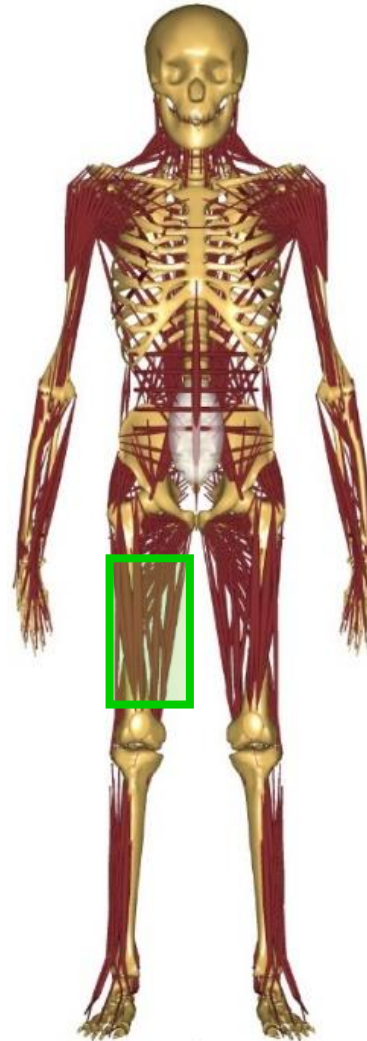
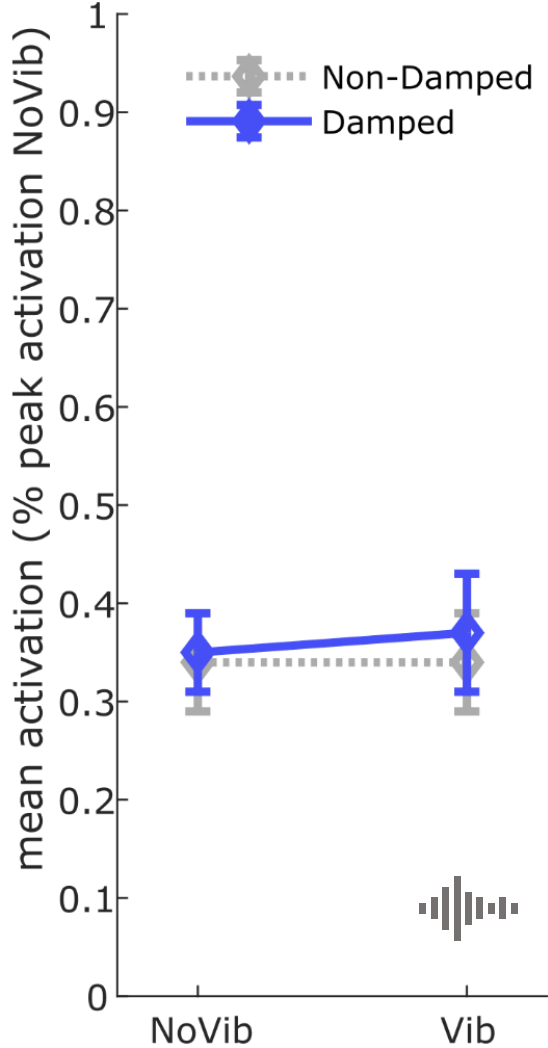
Vibration increases mean activation sig.

Damping has no sig. effect



RESULTS - Muscular Activation

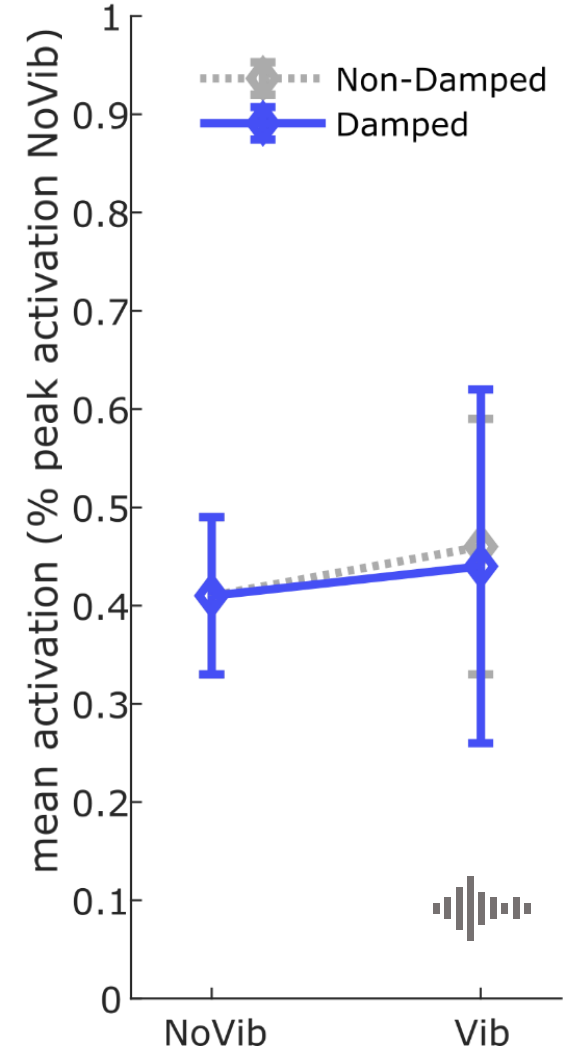
mean activation: VastMed



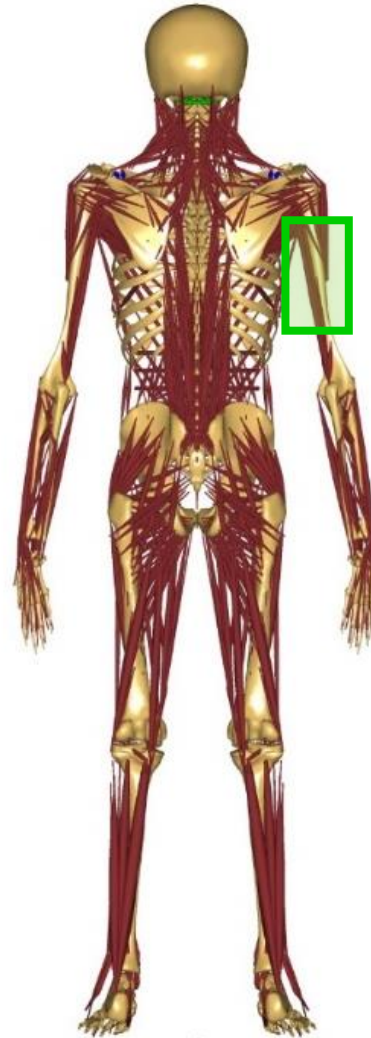
Vibration has no sig. effect

Damping has no sig. effect

mean activation: RecFem



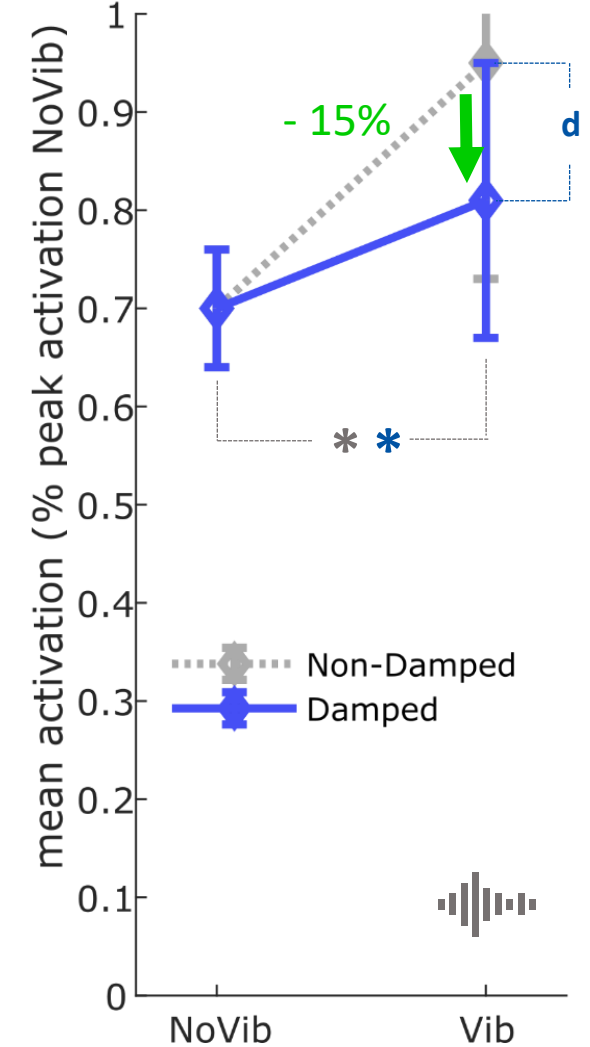
RESULTS - Muscular Activation



Vibration increases mean activation sig. ↗

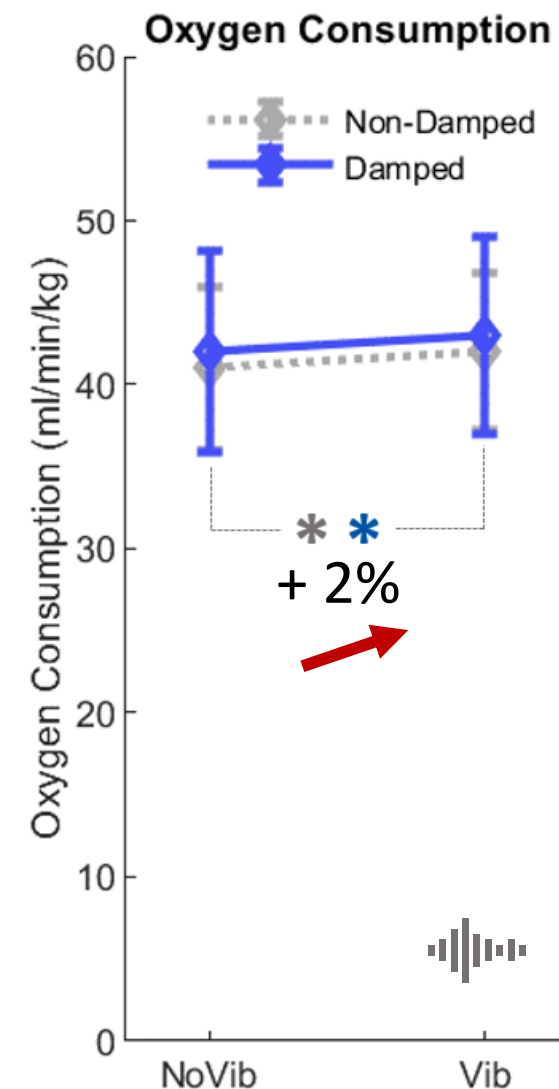
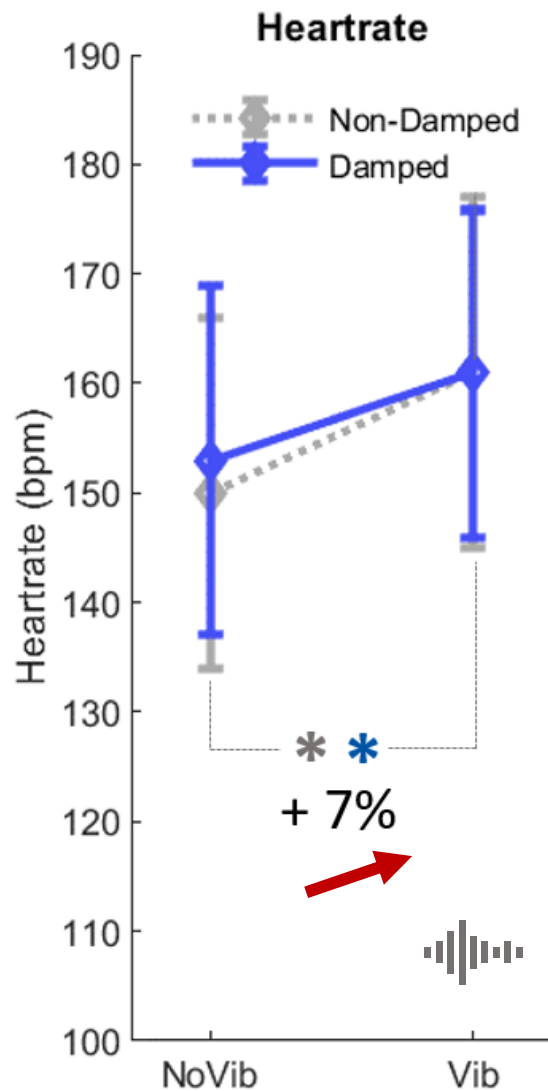
Damping has sig. effect ↘

mean activation: TricBrachii



Normalized to No-Vib peak activation * = sig. diff. 'NoVib' - 'Vib' ($p < 0.05$) d = sig. diff. 'NoVib' - 'Vib' ($p < 0.05$)

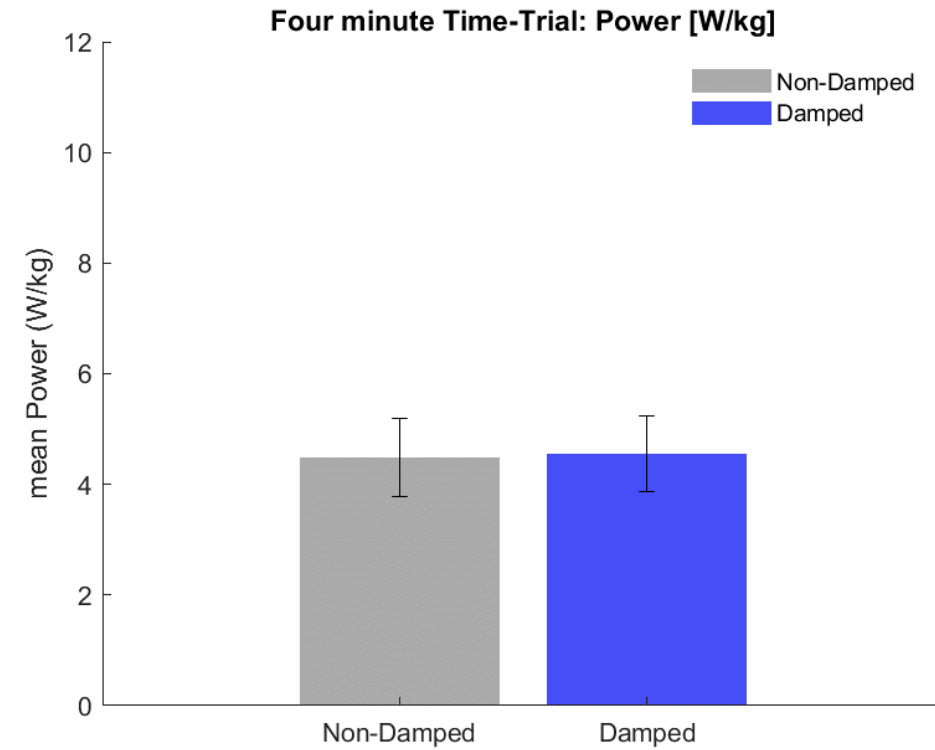
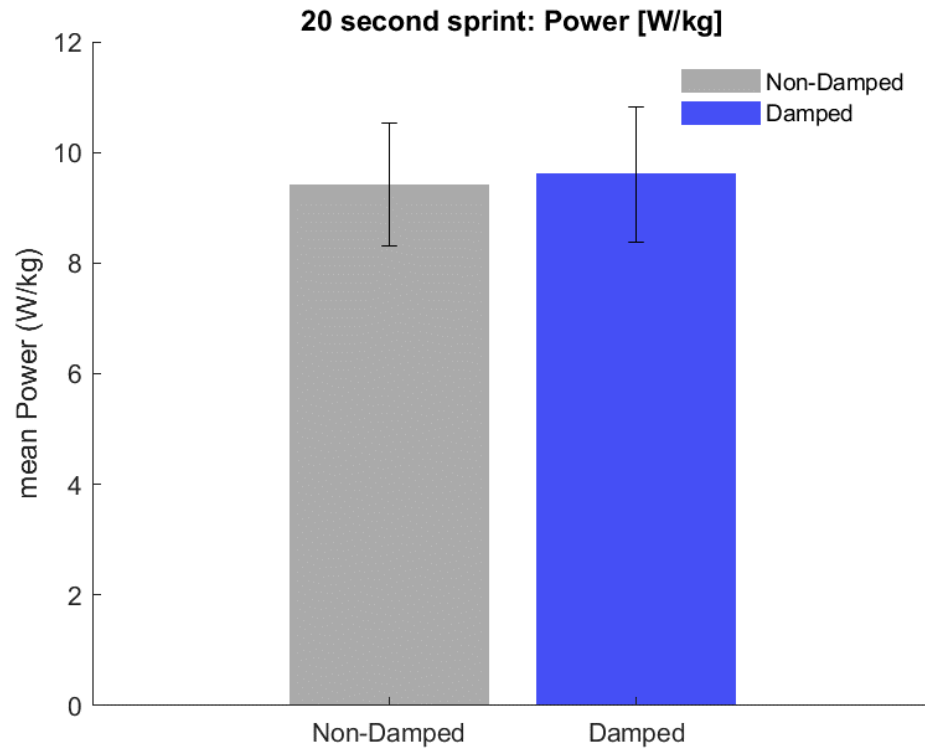
RESULTS – O₂ & Heartrate



Vibration increases HR and O₂ sig.

Damping has no sig. effect

RESULTS – Power Output

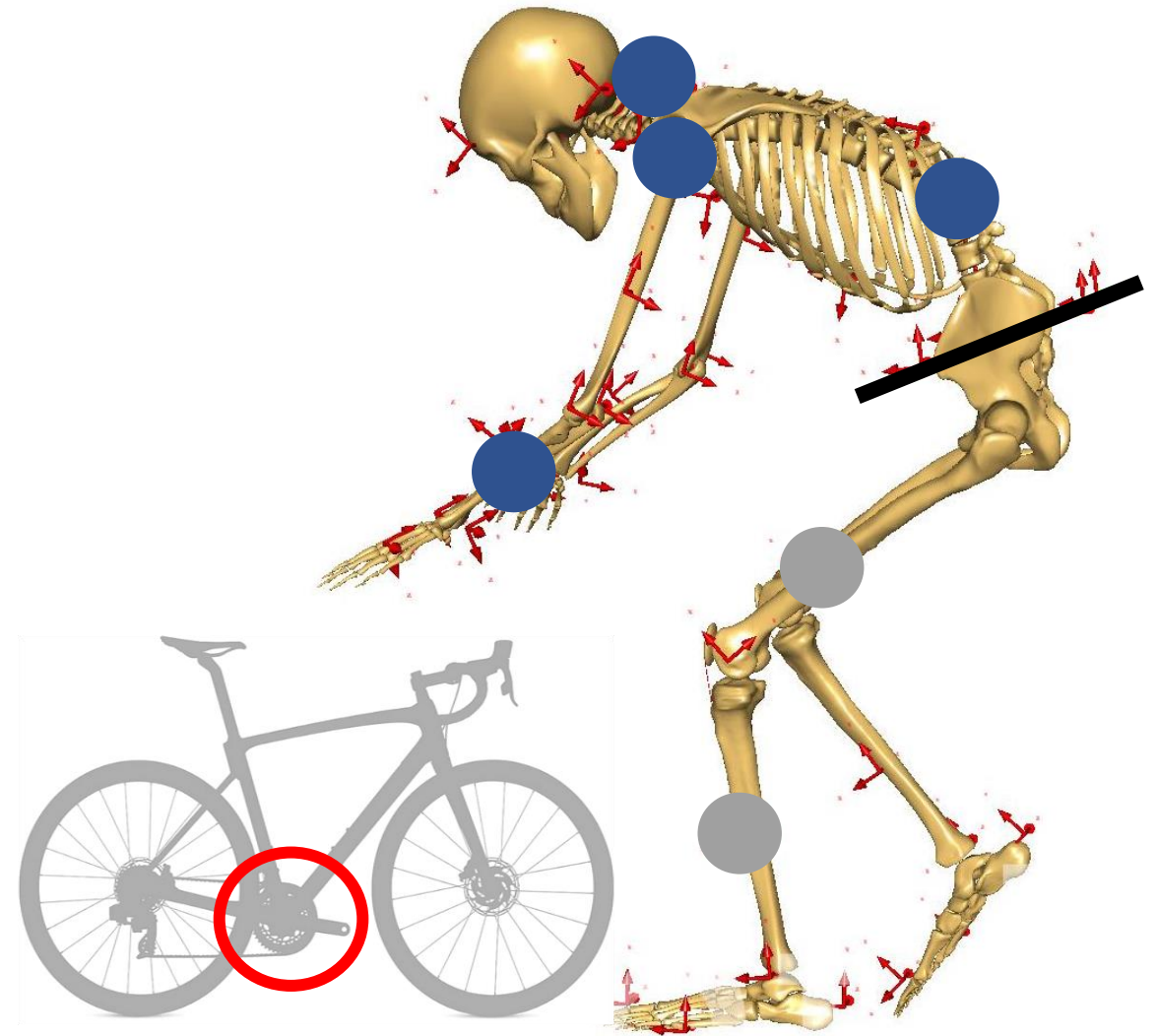


Damping has no sig. effect

I: Vibration is transmitted to the entire musculoskeletal system

II: Damping reduces effectively upper body vibrations

III: Damping does not effectively reduce vibrations transmitted to the lower extremities



(I) Vibration:

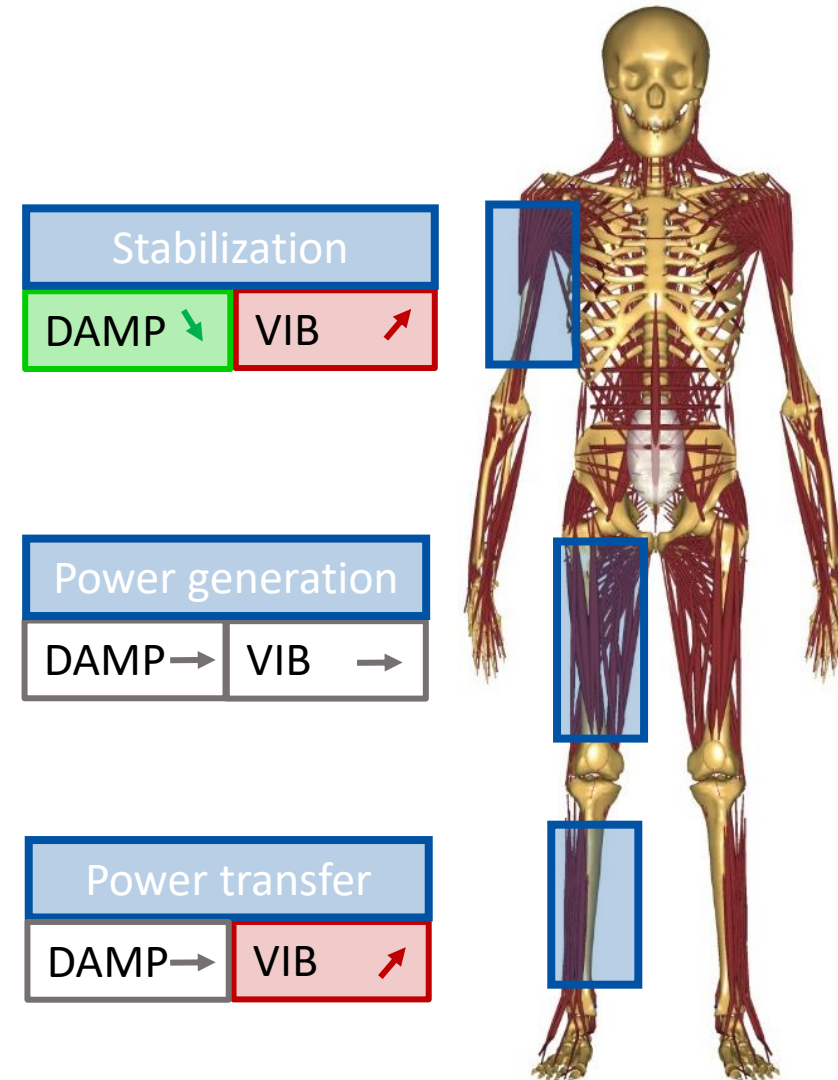
- Muscle specific reaction to vibration
(Viellehner & Potthast, 2021)
- Main power-producers knee- and hip-joint not affected by vibration
(Zajac et al. 2002; Mornieux et al. 2007)

➡ **Small relevance for propulsion**

(II) Damping:

- Upper body muscles activation decreased

➡ **Supports stabilization task**



(I) **Vibration** increases the respiratory and cardiopulmonal demands

(Viellehner & Potthast, 2021; Sperlich et al. 2009)

- Also upper body muscles contribute

(II) **Damping** does not increase net efficiency (Power/ VO_2)

(Viellehner & Potthast, 2020)

- Only small muscles affected by damping



(III) **Damping** does not enhance short time power production

LIMITATIONS – Application to racing

66 m
Compiègne

29 m
Roubaix

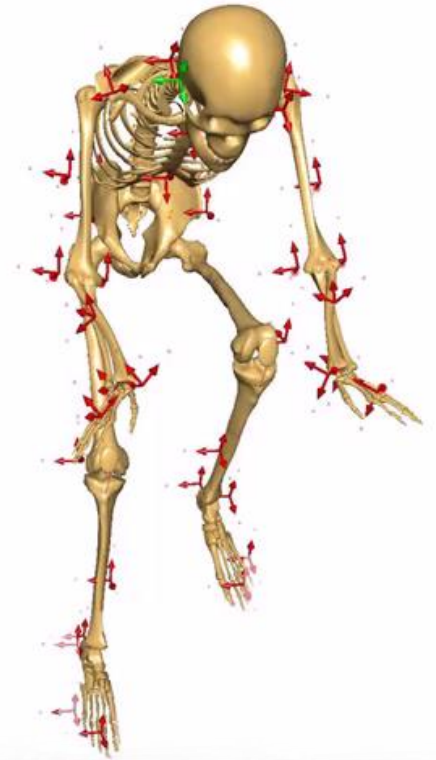


- Race duration
- Fatigue
- Nutrition/ Energy
- Mental Aspects

Race: 6 h

Lab Test: 4 min

Race with bike damping or not?



ACKNOWLEDGEMENT



Deutsche
Sporthochschule Köln
German Sport University Cologne



SPECIALIZED



Dr. Josef Viellehner

*Department of Biomechanics and Orthopaedics
German Sport University Cologne*

Contact: j.viellehner@dshs-koeln.de