



**«Physical performance and muscle activity during a 3 hour high speed boat transit»**



Foto: Thorbjørn Kjosvold

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# The worlds most stressful job (Forbes, 2013 and 2014)





# Background



Foto: Norwegian Navy

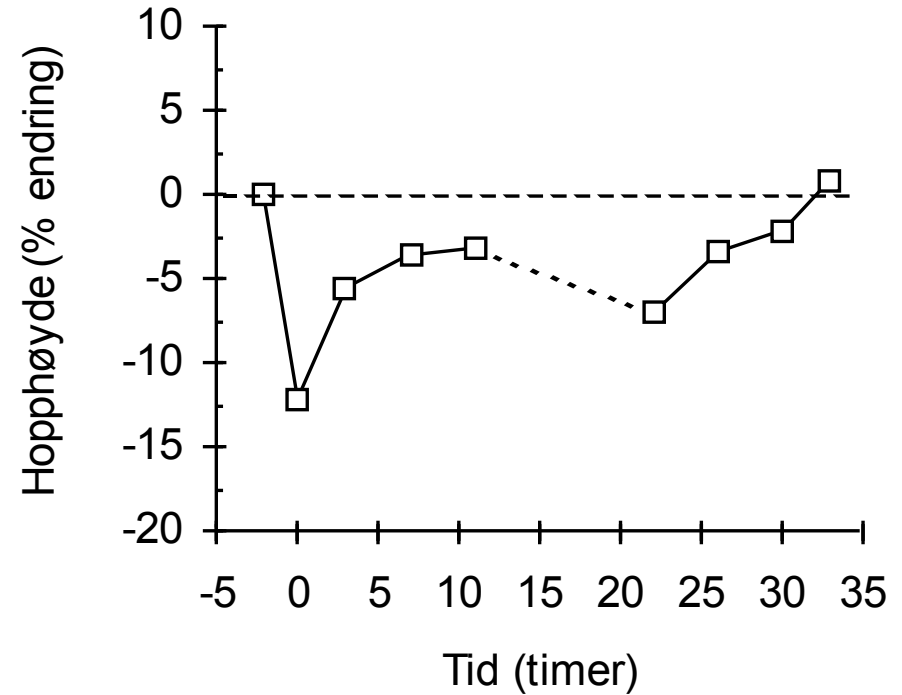
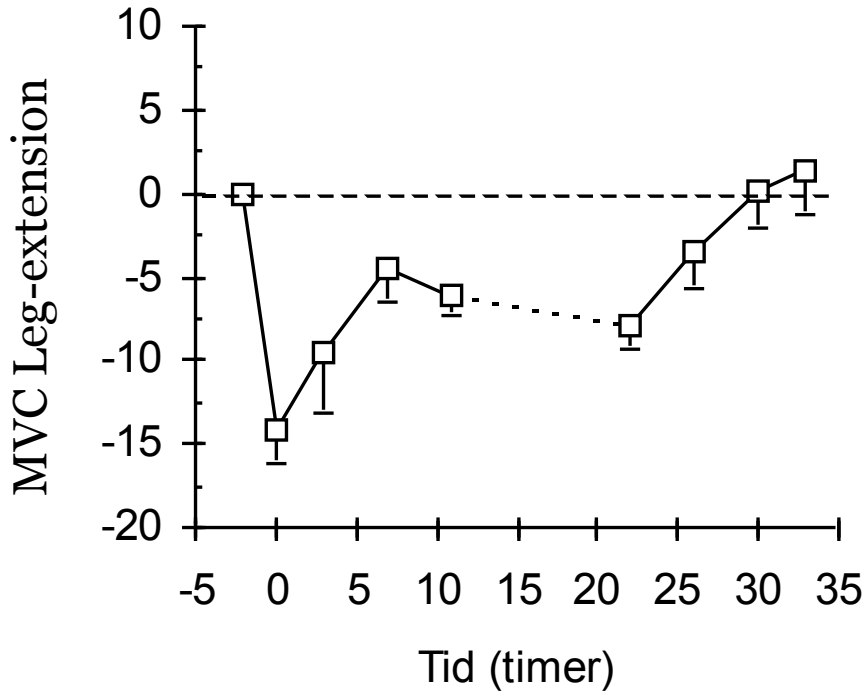


# Background

- Crucial to be able to perform at high level after long transits, either as passenger or driver
- Few known studies on boat personnel
- Fatigue & Decreased performance with fixed seats, - no fatigue and maintained performance with suspension seats (Myers et al. (2011):
- Experience suggests that knees and lower back are exposed to risk
- US SBO's report problems in lower back (33,6%), knees (21,5%) and shoulders (14,2%) (Ensign et al., 2004)



## Restitution after strength training



Raastad & Hallén (2000)



# Research questions

- 1) What is the effect of a 3 hour transit on physical performance?
- 2) How is the muscle activity during transit?



Foto: O.G.H. Nordlie



## Participants and Design

Two groups:

- Transit group: 4 SBO operators (188 cm, 89 kg)
- Control group: 4 staff officers (180 cm, 90 kg)
- Two boats (HP-RHIB, 11 m)
- 3 hour trial with pre- and post-testing





# Physical tests

## Strength

- **1 RM legpress**
- *Static lower back*
- *“Brutalbench” (abdominals)*
- *Grip-strength*

## Power

- Counter Movement Jump (CMJ)

## Endurance

- 20m Beep test (Ramsbottom, Brewer & Williams, 1988)

## Body Composition

- Body weight (kg), fat % and SMM (%) measured with DXA







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# Electromyography (EMG)

- 2 Bioplux Wireless EMG Systems
  - Plux Wireless Biosignals SA (Lisbon, PT)
  - Sample frequency: 1000 Hz
  - Muscles:
    - M. Rectus abdominis (R)
    - M. Erector spinae (R)
    - M. Rectus femoris (R)
    - M. Biceps femoris (R)
  - Full wave rectification – Low pass filtering – Averaging
  - Synchronization with accelerometers @ knee (data not presented, here)



# EMG and MVC

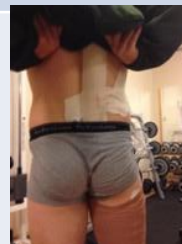
## Maximum Voluntary Contraction (MVC)

## EMG Attachment

### Rectus abdominis



### Erector spinae



### Rectus femoris (extension)



### Biceps femoris (flexion)





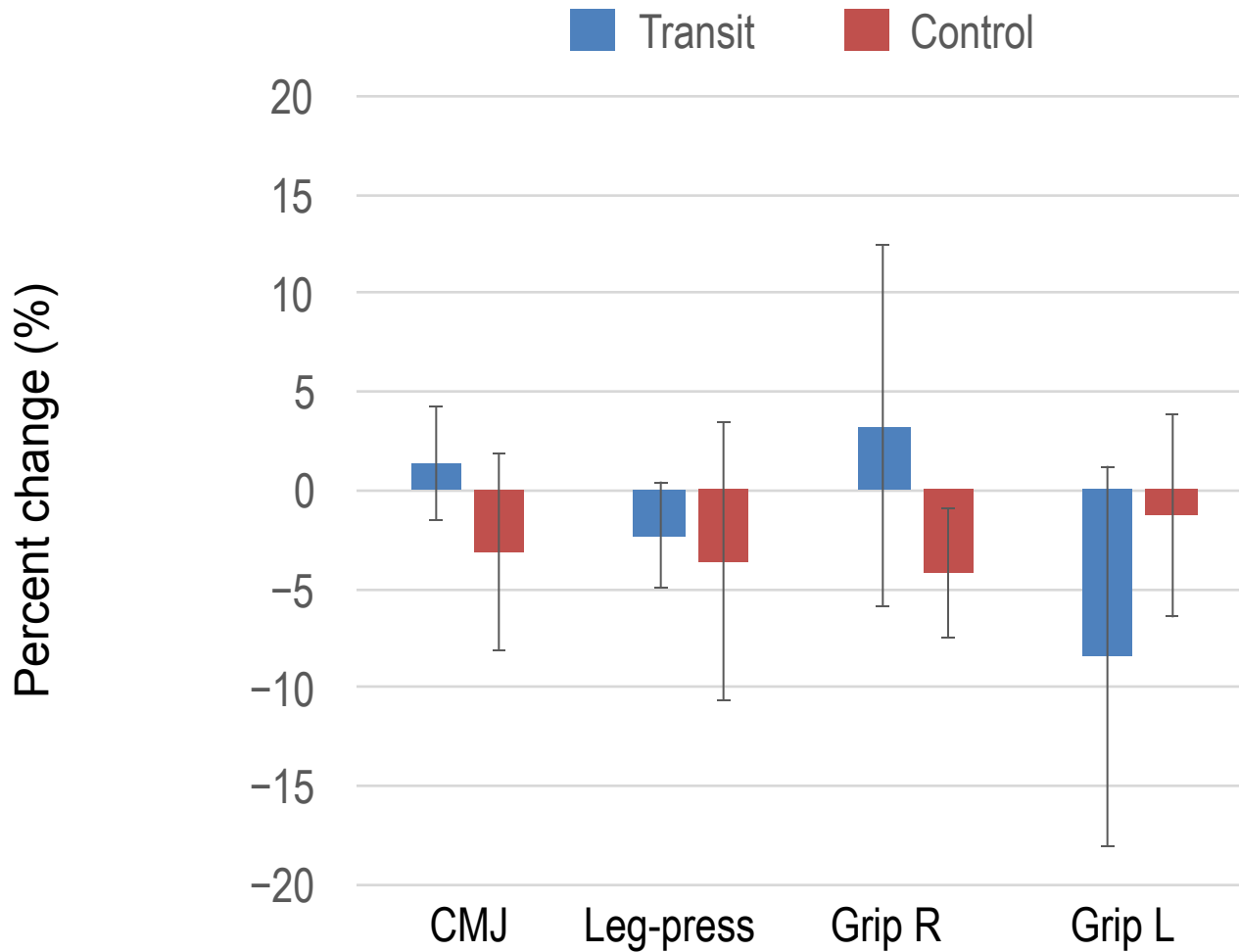
## RESULTS - Seastate

- WMO seastate: **2 to 4** (Between 0.1 and 2.5 m wave height)
- Wind conditions: Level 3 (Beaufort scale: 3.4 to 5.4 m/s)
- Temperature: -2 to -6 C<sup>0</sup>
- Average speed: 42 knots





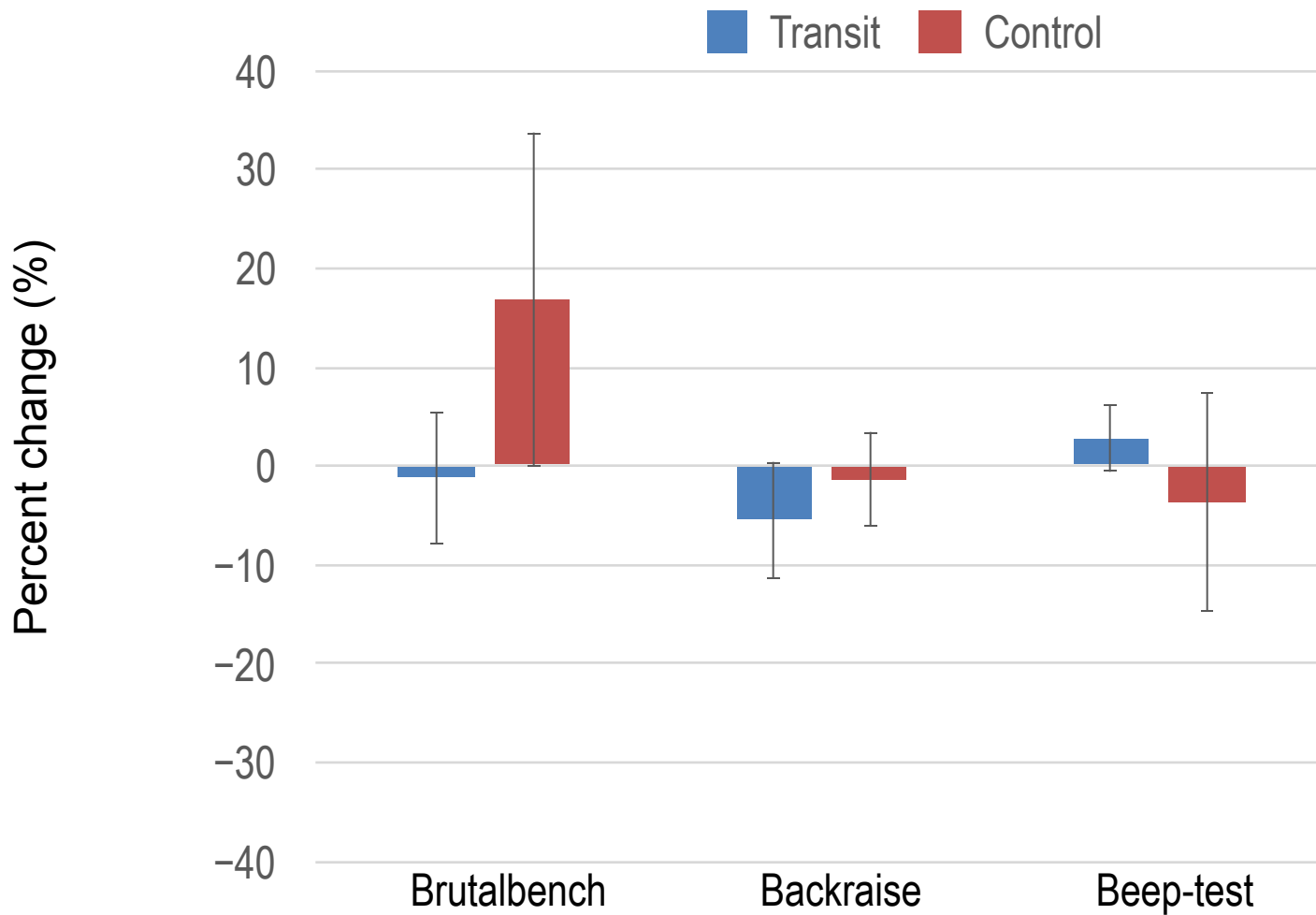
# RESULTS – Change in power and strength





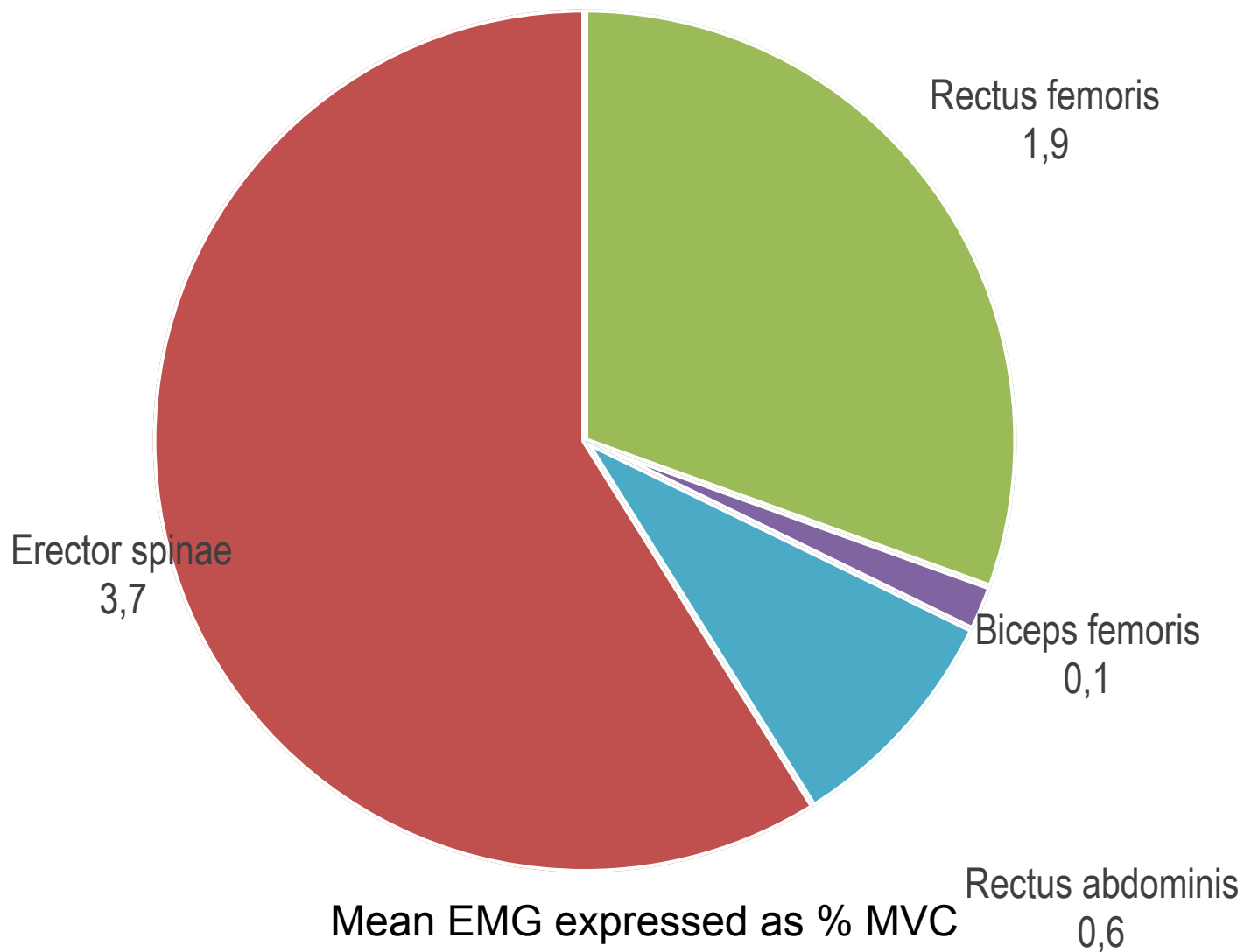


# RESULTS – Change in endurance and stability



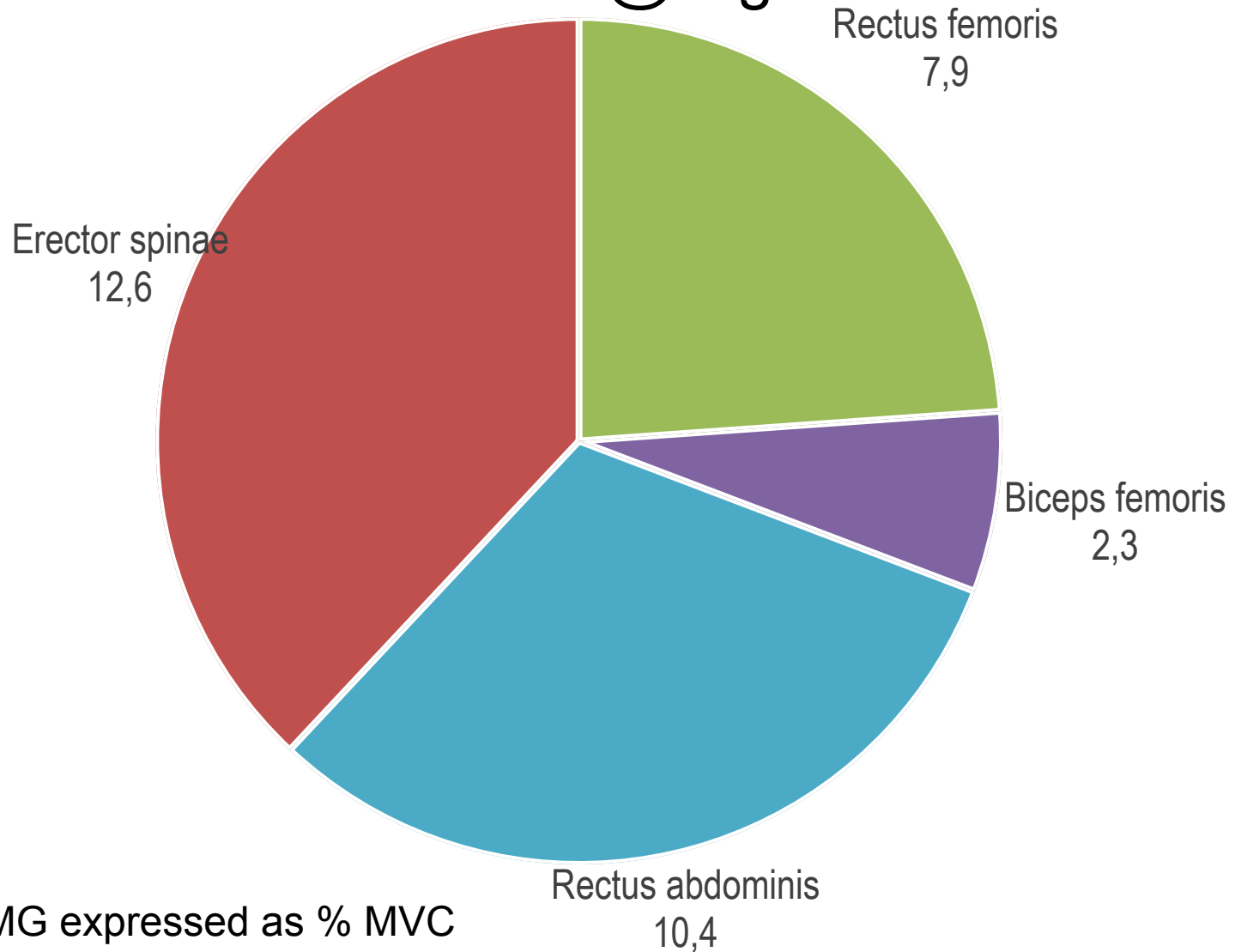


## Mean EMG @ low sea





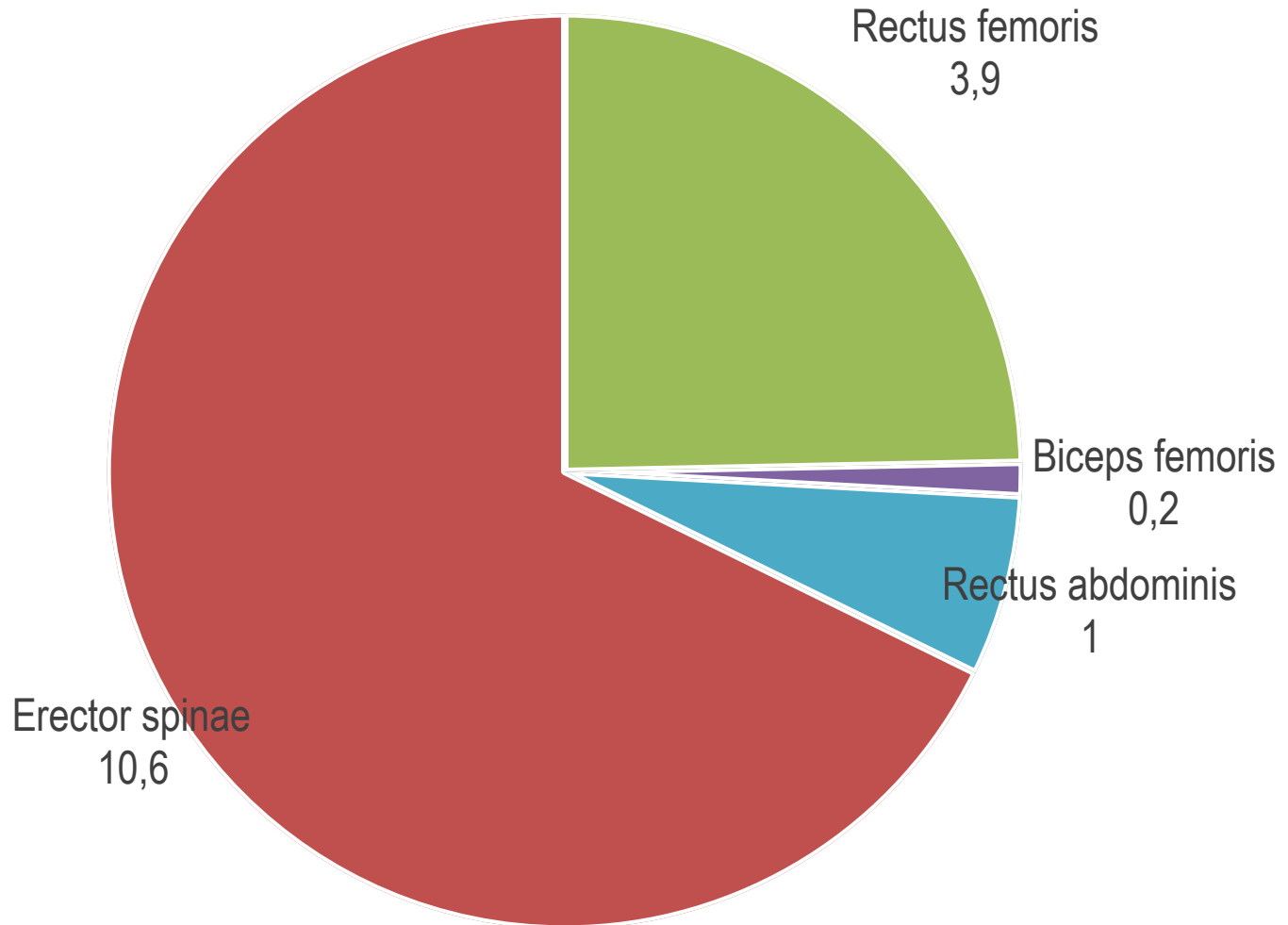
## Mean EMG @ high sea



Mean EMG expressed as % MVC



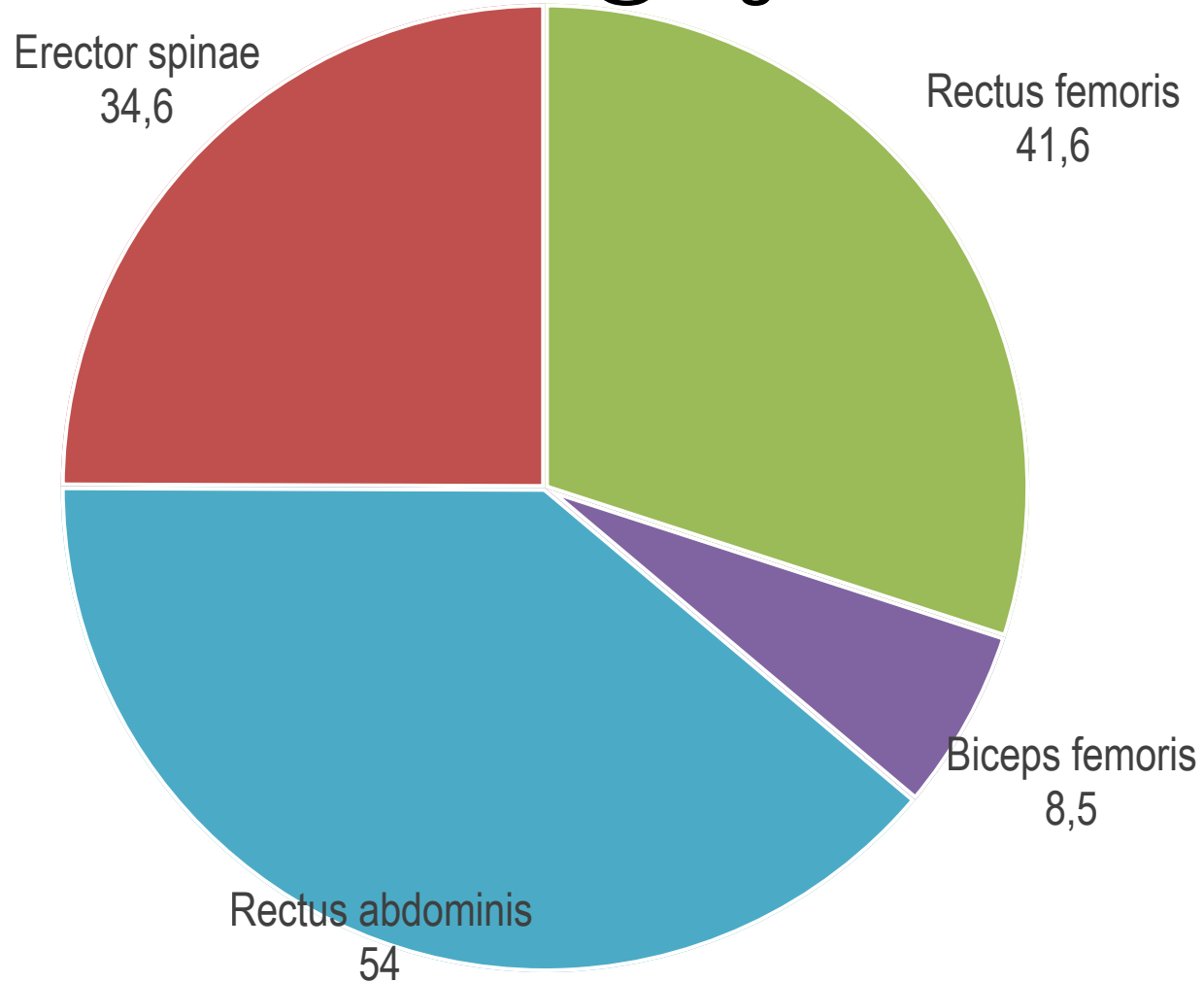
## Peak EMG @ low sea



Peak EMG expressed as % MVC



## Peak EMG @ high sea



Peak EMG expressed as % MVC



## Discussion/conclusion

- No significant changes or differences in physical performance after a 3 hours transit with suspension seats
- Well-trained and selected NORNAVSOC personnel
- Different muscles in use with different intensities at different sea states



Foto: Forsvaret



# Limitations and future directions

## Limitations:

- Sea state
- Small sample
- Changed boat: accelerometer data lost

## Future directions:

- Investigate passengers (without suspension seats)
- M. Trapezius, M. Gluteus and M. Vastus Lateralis
- Longer transit
- Identify "time to exhaustion"





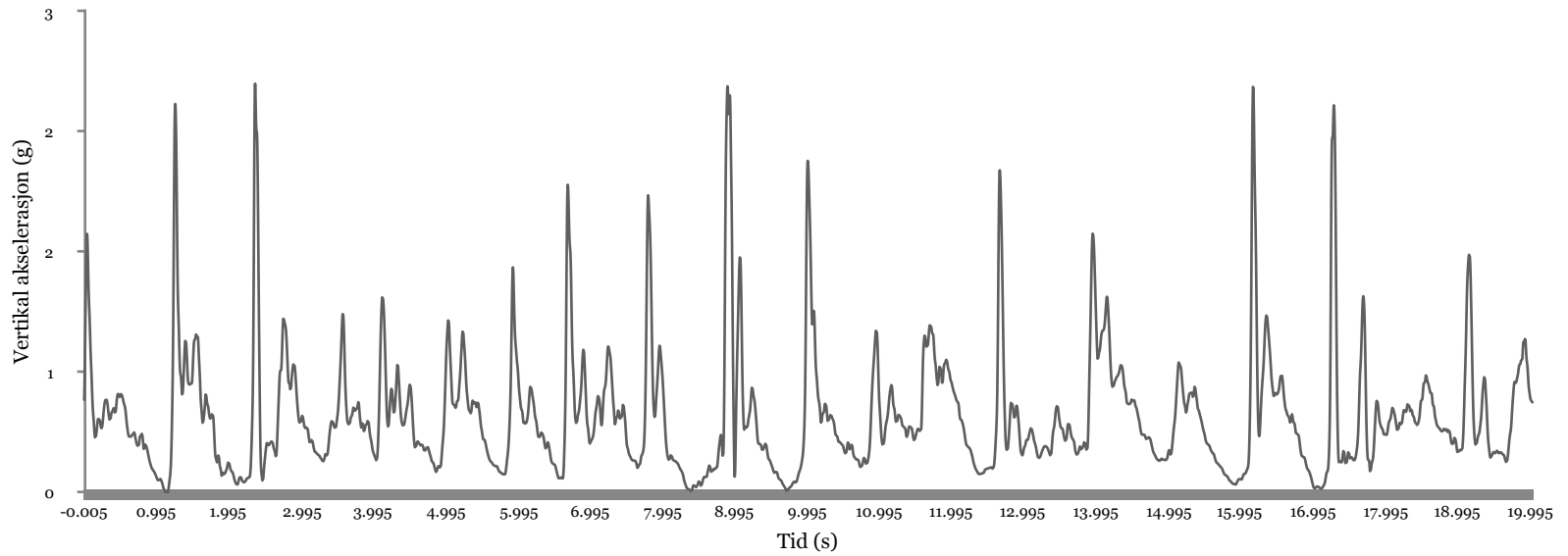
# Acknowledgements

- The Echo Squadron (NORNAVSOC)
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- The Zulu Squadron (NAFSOC)
- The Coastal Ranger Command (CRCDO)
- Norwegian School of Sport Sciences



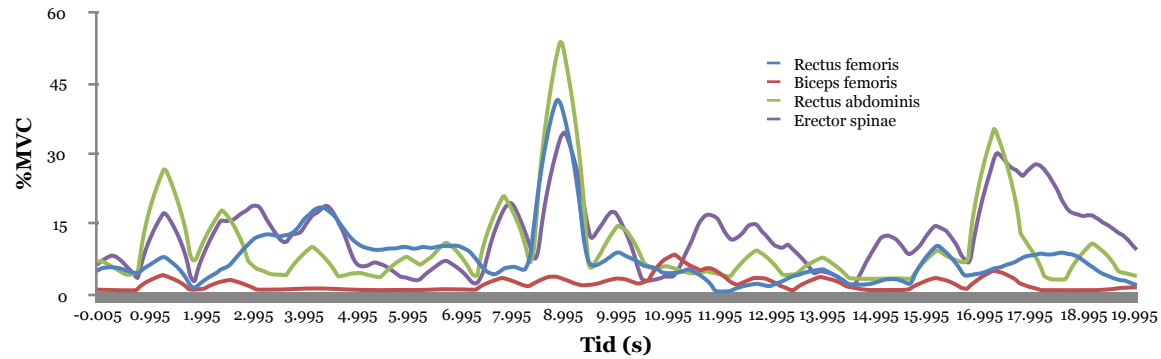


# Accelerometer on knee (20 sec)





# % EMG high sea





# %MVC low sea

