Finnish Defence Research Agency

PHYSIOLOGICAL CHANGES DURING A 20-DAY WINTER MILITARY TRAINING COURSE AND ITS SUBSEQUENT 10-DAY RECOVERY PERIOD AMONG FINNISH PARATROOPERS

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HFM-349 Symposium, Washington DC, USA
18.10.2022

Puolustusvoimat
Försvarsmakten • The Finnish Defence Forces

INTRODUCTION

- Military operations are performed in climatic environments ranging from extreme hot (40°C) to extreme cold (-40 °C) conditions.
  - Todays battlefield requires soldiers to have appropriate strength and anaerobic capacity to fulfil the occupational requirements of high intensity movements with heavy load carriage
- Operations in arctic environment place soldiers even higher psychological and physiological stressors and can include also drastic energy deficit and sleep restriction as well as extreme weather conditions

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Nindl et al. 2018, Drain et al. 2016, Friedl et al. 2015, Szivak & Kraemer 2015, Mala et al 2015, Kraemer & Szivak 2012, Knapik et al. 2012, Treloar et al. 2011, Lester et al. 2010, Sharp et al. 2008, Nindl et al. 2007

RESPONSES TO MFT

PHYSIOLOGICAL

Prolonged physical exertion

Body mass, muscle mass ↓

Decrated neuromuscular performance

Strength, power and VO_2 ↓

Increased susceptibility to infections

Immune function ↓

Anabolic hormones ↓

Catabolic hormones ↑

PSYCHOLOGICAL

Extented recovery times

Cognitive fatigue ↑

Mental stress ↑

DECREASED READINESS

MISSION

Sleep deprivation

Cognitive performance ↓

Injury risk ↑

Insufficient energy and fluid intake

Absolute work capacity ↓

Mood state ↓

Prevalence of illnesses ↑

ENVIRONMENTAL

Environmental stress

Cold / Heat ↑

Different terrain ↑

Altitude ↑

Pollution ↑

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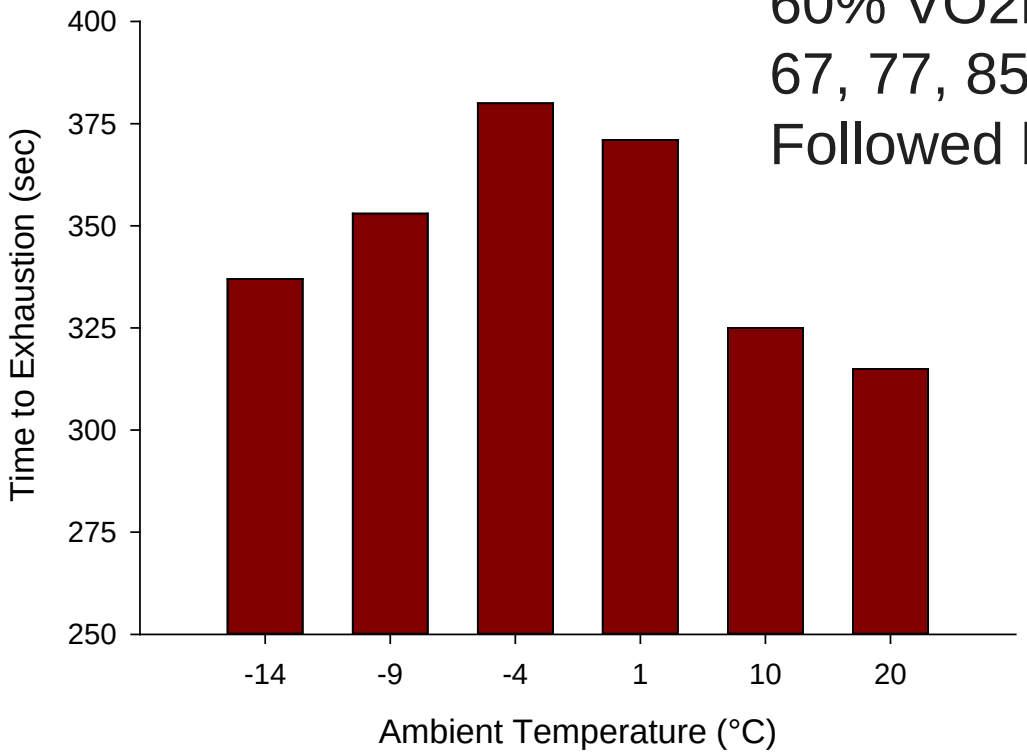
modified from Church et al. 2019, Henning et al. 2011, Nindl et al.. 2013, Pihlainen 2021

Impact of cold
- Aerobic Performance

TTE highest at -4 and 1°C
60% VO2max warm-up, Then ramp for 5 min each at 67, 77, 85, 91% VO_{2max}
Followed by run to exhaustion



Sandsund et al., Eur. J. Appl. Physiol., 2012

OTHER STUDIES

- TTE decreased 38% from 20 to -20°C, 75-80% VO2max

Patton & Vogel 1984

- TTE highest at 11°C (4, 11, 21, 31°C), 70% VO2max

Galloway and Maughan 1999

- TTE highest at 3°C (3, 20, 40°C), 70% VO2max

Parkin et al. 1999

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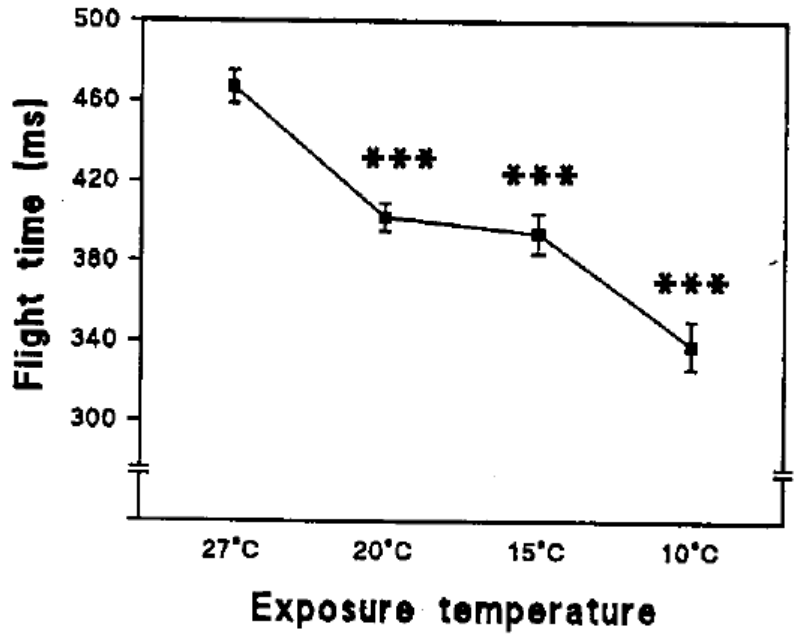
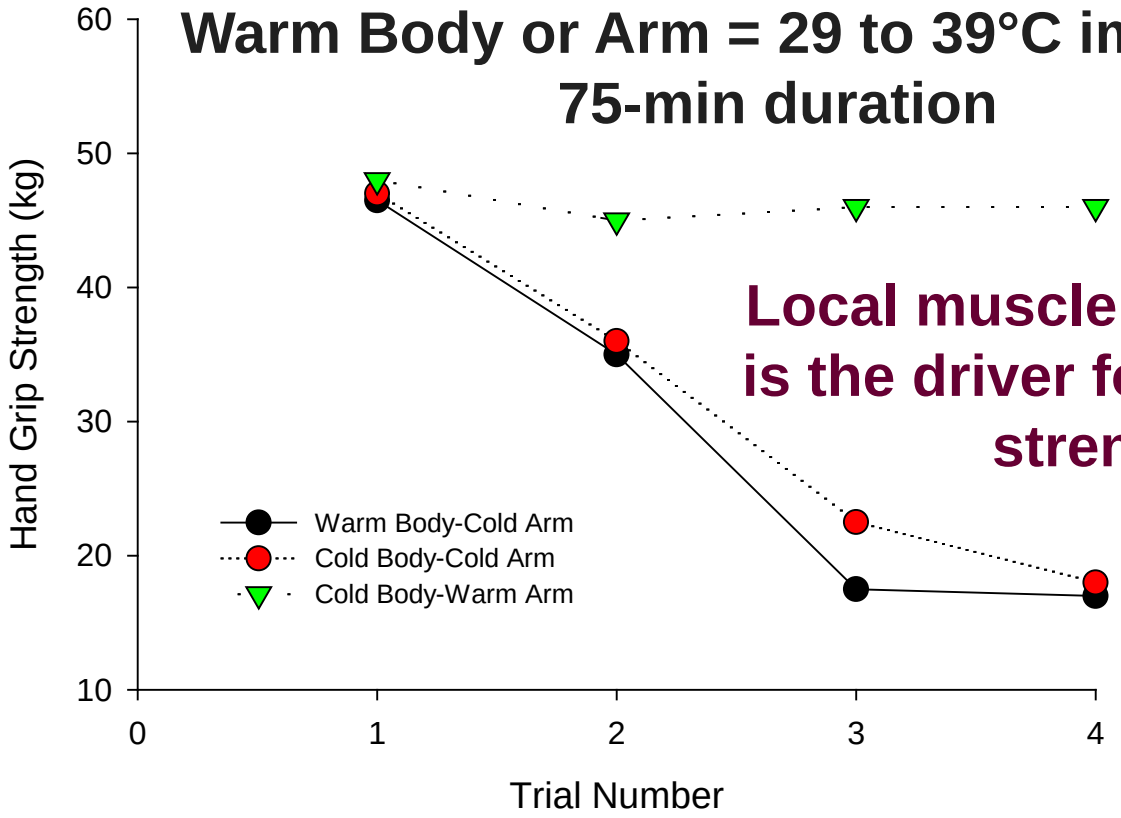
Impact of cold
- Anaerobic, Strength, Power Performance

Exposure for 60-min
Shorts and shoes
Rebound Jump



Oksa et al., Eur. J. Appl. Physiol., 1997

Cold Body or Arm = 8°C immersion
Warm Body or Arm = 29 to 39°C immersion
75-min duration



Local muscle temperature is the driver for decreased strength

Giesbrecht et al., Aviat. Space Environ. Med., 1995

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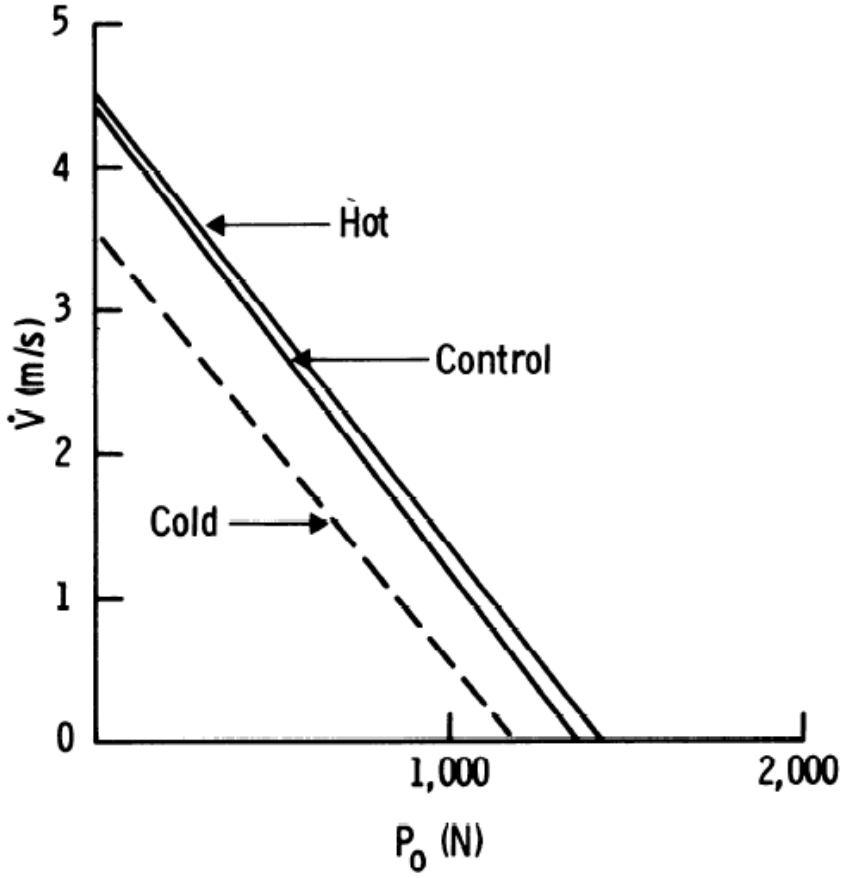
Impact of cold
- Anaerobic, Strength, Power Performance



Davies and Young, J. Appl. Physiol., 1983

Effects of cold exposure

- Decreased strength
- Decreased contraction speed
- Decrease nerve conduction velocity
- Increased joint viscosity
- Increased co-activation of agonist-antagonist muscle pairs
- Increased EMG activity
- Enhanced fatigue

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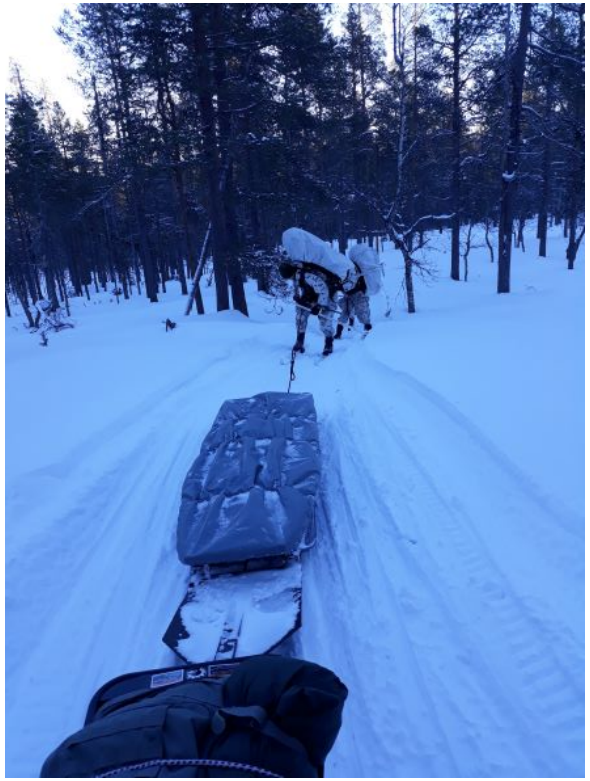
PURPOSE

- To investigate physiological changes in Finnish paratroopers during a 20-day winter military training course
- Recovery of physiological markers after a 10-day recovery period



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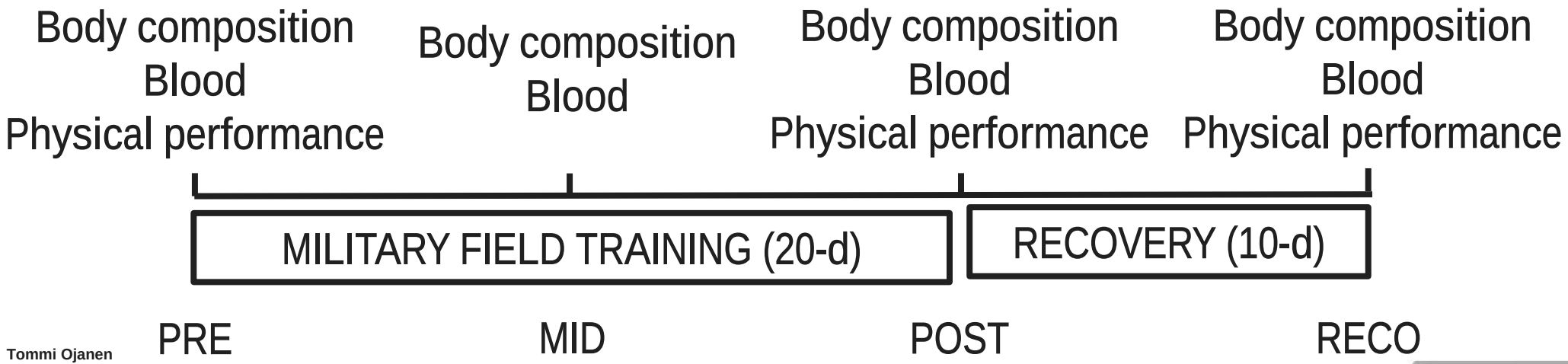
STUDIES AND SUBJECTS

- Study was a 20-day winter military field training
  - ➢ 58 male paratroop conscripts
  - ➢ 19±1 yrs; 182±6 cm; 78.5±7.2 kg

	0 - 10 d	11 - 20 d	0 - 20 d
Average snow depth (cm)	92	79	85
Average daily temp (°C)	-14.5	-5.2	-9.6
Average daily min temp (°C)	-6.5	-0.7	-3.5
Averarge daily max temp (°C)	-22.6	-12.8	-17.5



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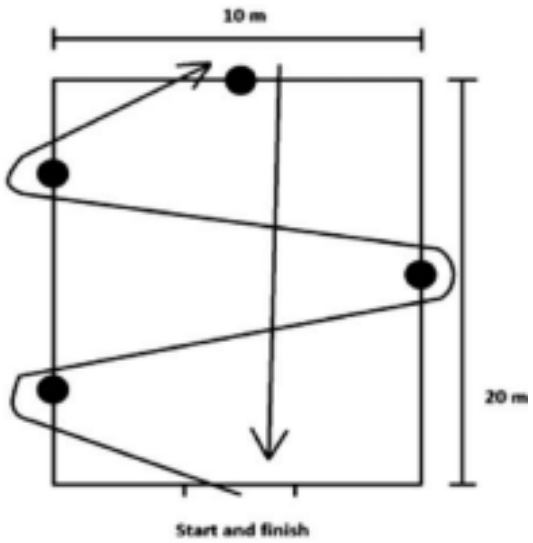
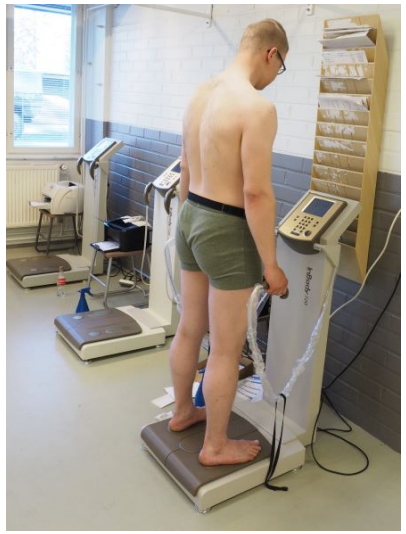
METHODS

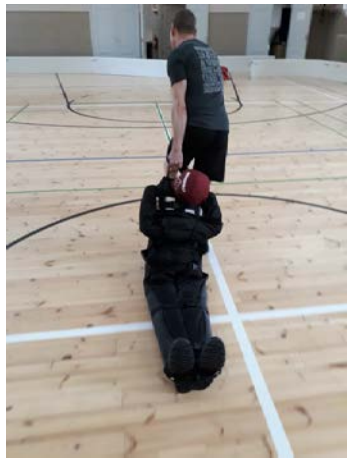
Measurements

- Body composition
- Blood samples
- Daily questionaires
  - Sleep, RPE, stress



- Evacuation test





Physical Measurements

- Physical performance
  - SLJ + CMJ
  - Medicine ball throw
  - Muscle endurance tests
    - Sit-ups
    - Pull-ups (+10kg)

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RESULTS

	PRE	MID	POST	RECO
Body mass (kg)	78.5±7.2	78.1±7.2	75.6±6.9***, ###	79.1±6.9§§§
Muscle mass (kg)	39.8±4.1	40.1±4.1	39.6±3.9	39.9±4.0
Fat mass (kg)	9.1±2.2	8.1±2.1***	6.2±1.9***, ###	9.4±2.1§§§
Fat %	11.6±2.7	10.5±2.6***	8.2±2.3***, ###	11.8±2.5§§§

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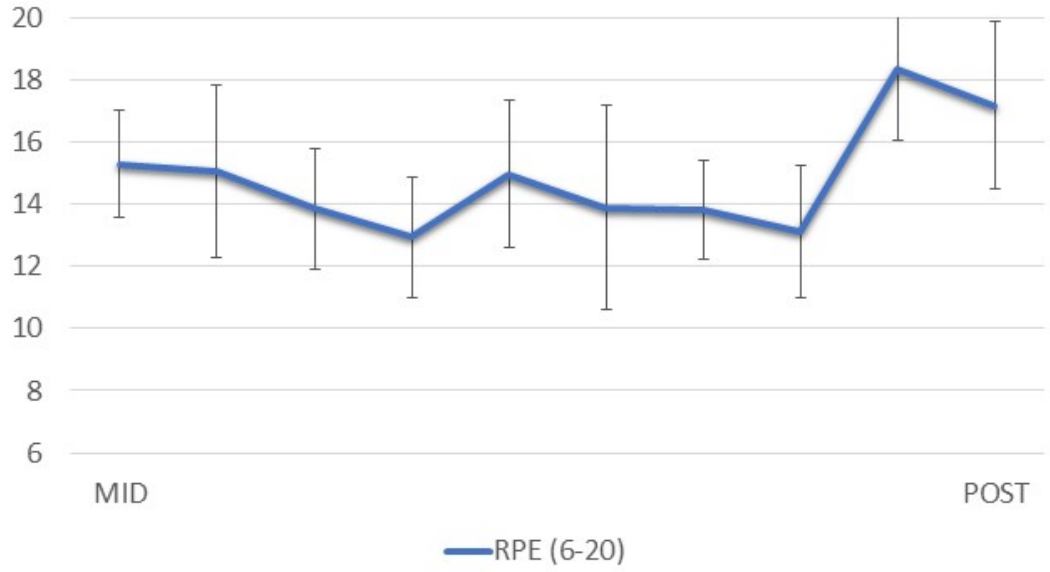
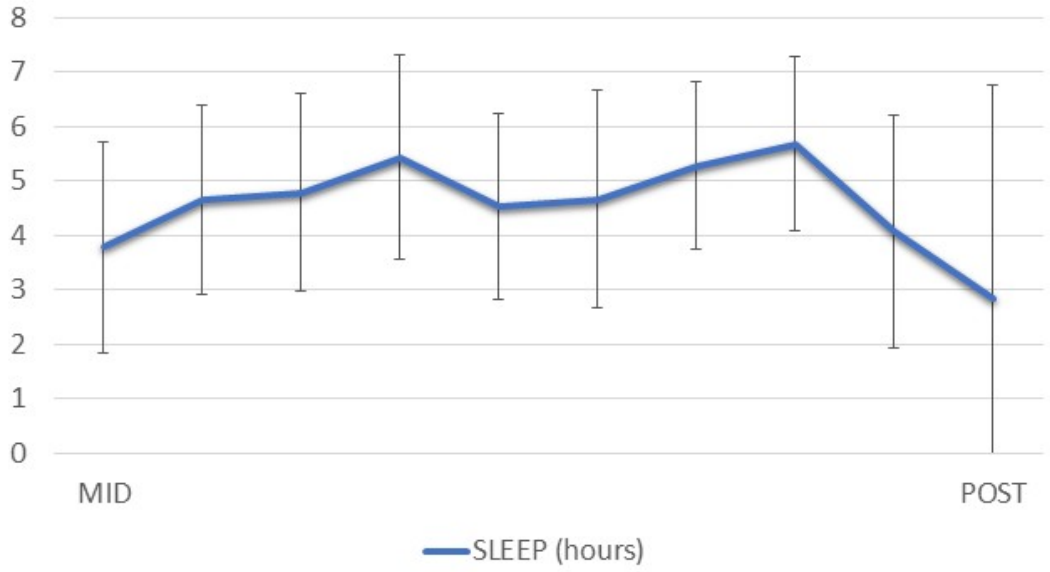
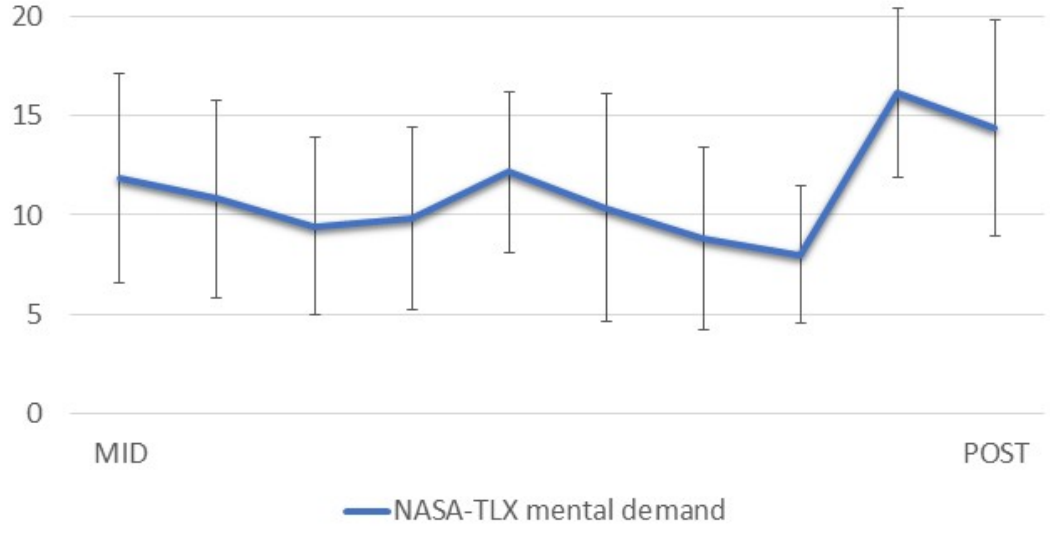
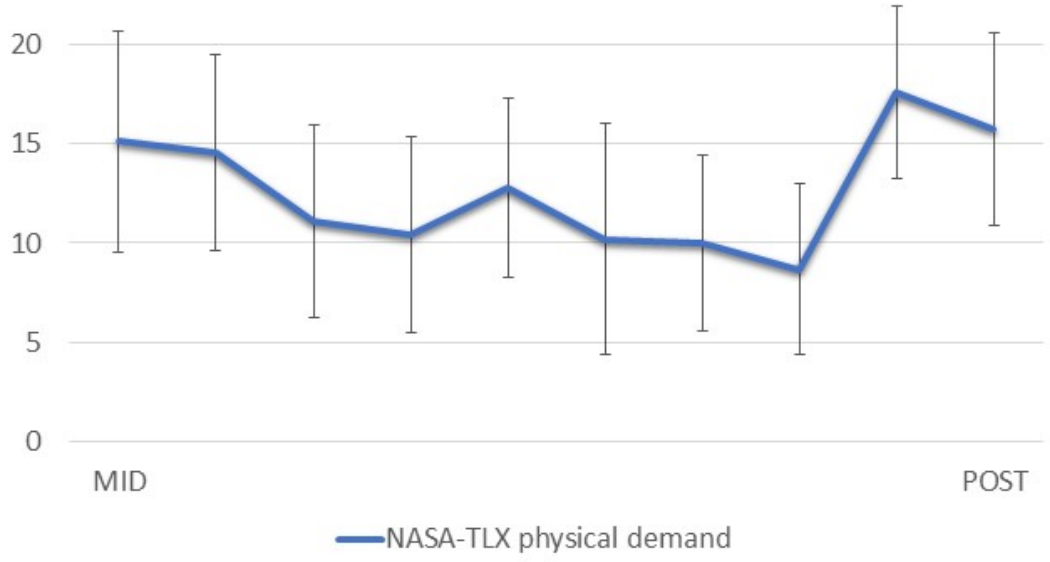
RESULTS


20
18
16
14
12
10
8
6
MID
POST
RPE (6-20)


8
7
6
5
4
3
2
1
0
MID
POST
SLEEP (hours)

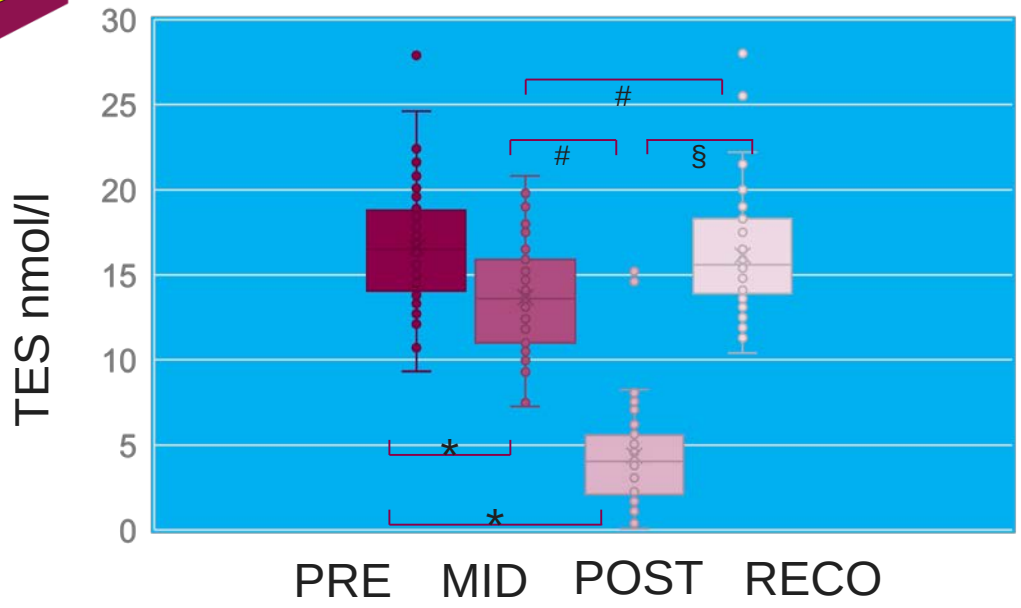

20
15
10
5
0
MID
POST
NASA-TLX mental demand

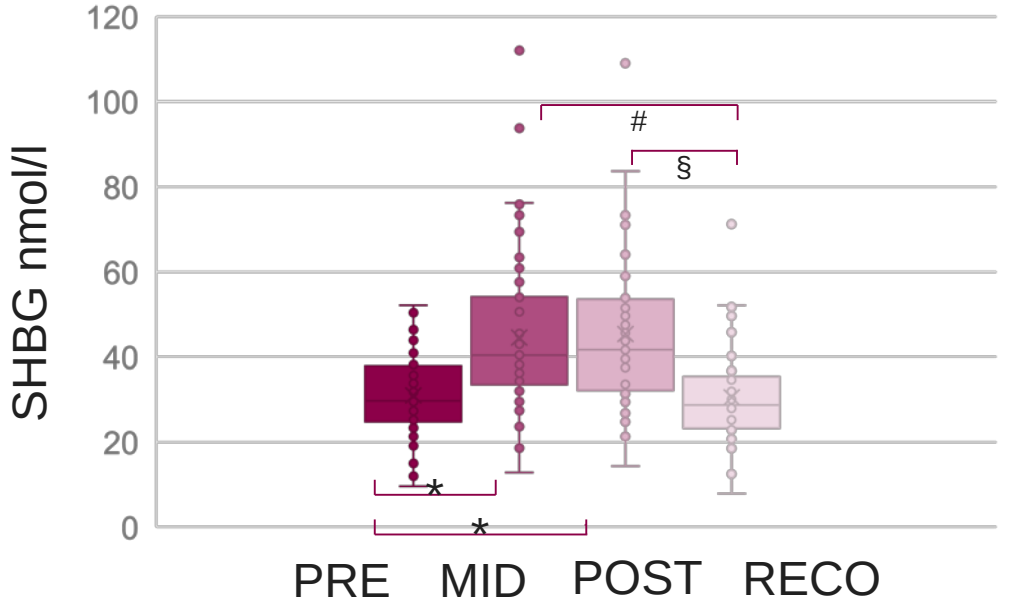

20
15
10
5
0
MID
POST
NASA-TLX physical demand

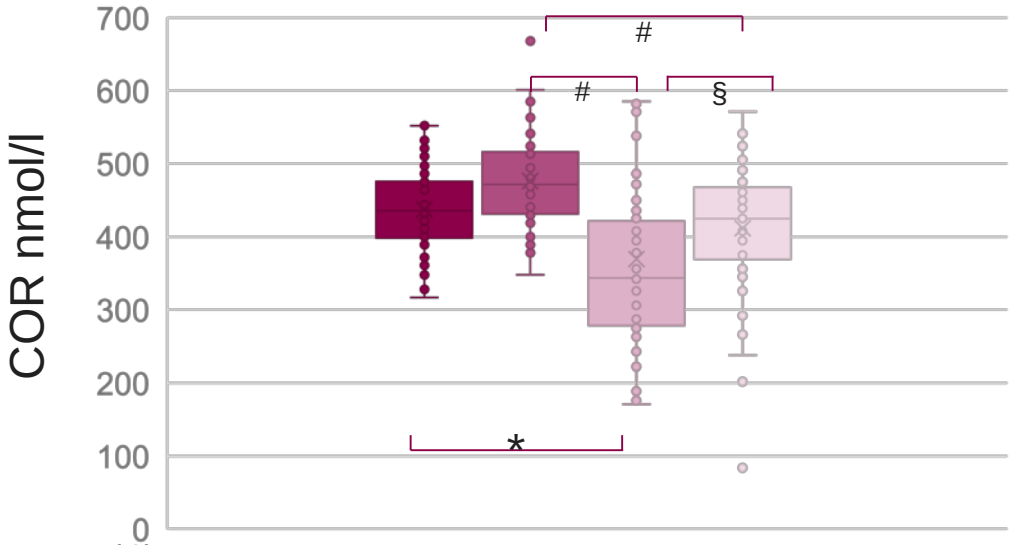
RESULTS

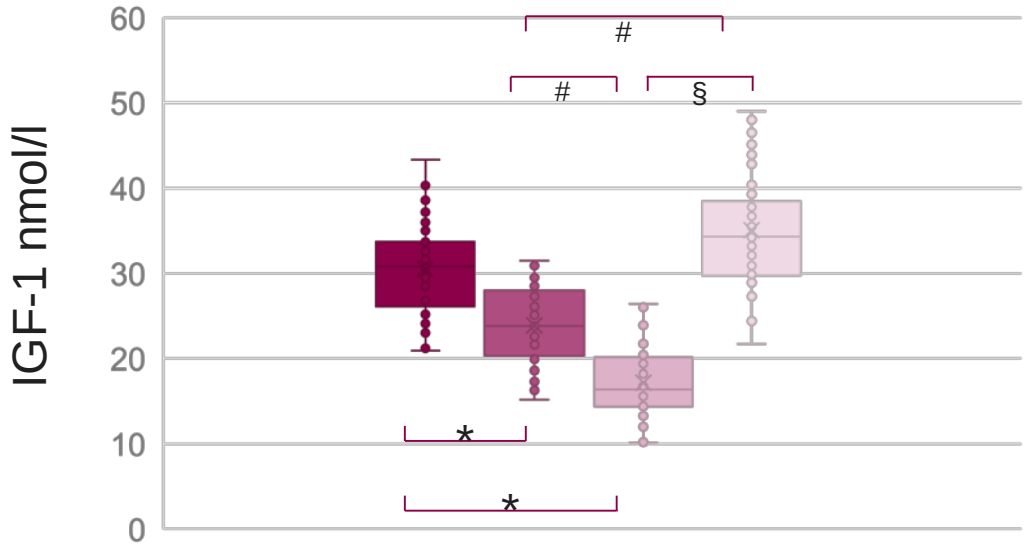
	PRE	POST	RECO
Standing long jump (cm)	240±16	211±23***	222±16***, ###
Counter movement jump (cm)	41±5	37±5***	36±5***
Medicine ball (2kg) throw (cm)	653±71	583±70***	596±66***
Weighted (10kg) pull-ups (reps)	9±3	8±3***	8±3***
2 min sit-ups (reps)	71±11	61±13***	68±12**, ###
Evacuation test (s)	49.9±5.5	60.1±10.0***	51.1±4.9**, ###

RESULTS









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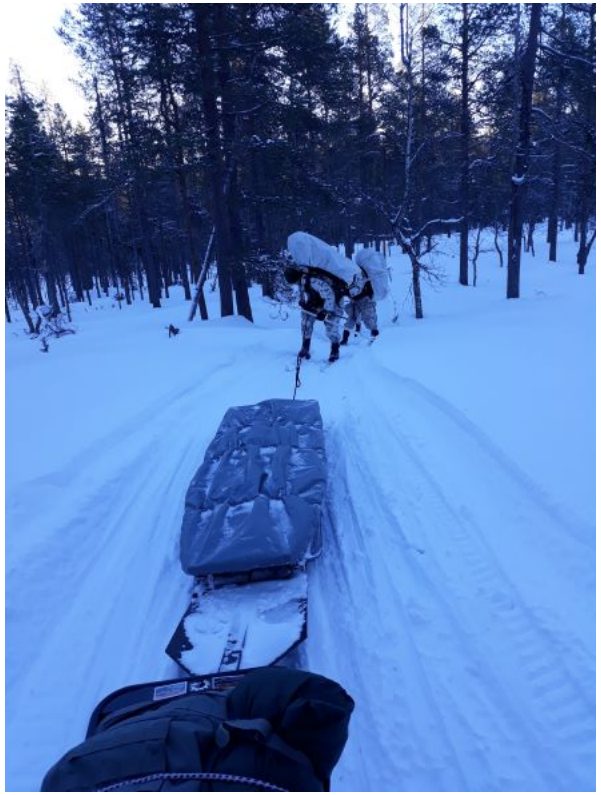
DISCUSSION

- The 20-day strenuous winter military training caused drastic decline in physical performance
  - even for highly physically fit soldiers
- The 10-day recovery period did not establish full recovery.
  - Explosive force production remained unrecovered
  - Hormone concentrations and body composition recovered fully.
  - No cold injuries were reported during the study



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OPERATIONAL RELEVANCE

- When planning field training exercises or operational missions, it is important to know how long it takes that the soldiers recover from different kinds of strain.
- Even though the body is fully recovered in terms of body composition or hormonal concentrations, physical performance can still be under recovered, especially the nervous system and the capability to produce power.
- If this trend continues, symptoms of overtraining and risk of injury may increase.

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THANK YOU!

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