Effect of including 30-s sprints in prolonged endurance exercise on muscular signaling and gross efficiency in highly trained cyclists

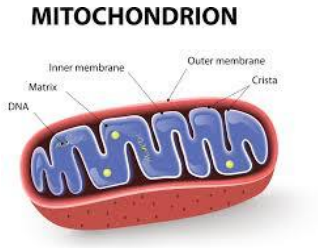
Nicki W. Almquist[1], Stian Ellefsen[1], Gertjan Ettema[2], Øyvind Sandbakk[2], Bent R. Rønnestad[1]

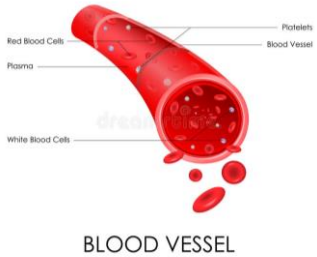
1: Inland Norway School of Sport Sciences, Lillehammer, NORWAY

2: Centre for Elite Sports Research, Norwegian University of Science and Technology, Trondheim, NORWAY

INLAND NORWAY UNIVERSITY OF APPLIED SCIENCES

Background



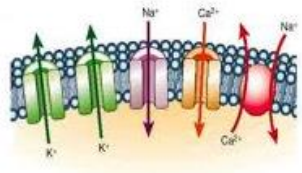


BLOOD VESSEL

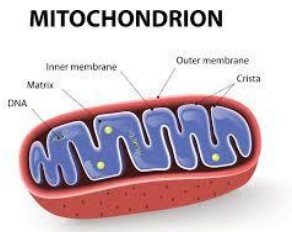
High volume of E ⇧ Markers of mitochondrial biogenesis and angiogenesis (Hoier et al. 2013)

Sprint training (S) ⇩⇧ Skeletal muscle ion-transport proteins (Iaia et al. 2008)

Ion Channels.



E+S ⇧ Superior increases in markers of mitochondrial biogenesis compared to E only (Skovgaard et al. 2016)



Aim: To investigate the effect of adding 9X30-s sprints to a 4-h low-intensity ride in highly trained cyclists on:

- Muscle signaling
- Gross efficiency
- Recovery of contractile function

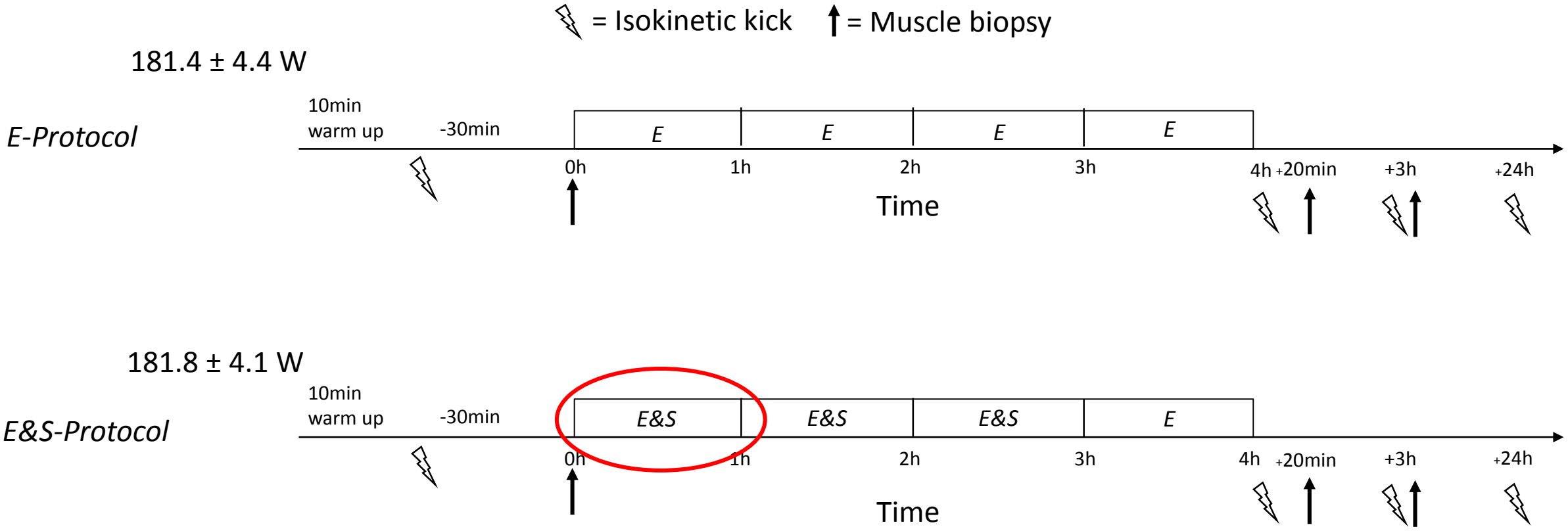
INLAND NORWAY UNIVERSITY OF APPLIED SCIENCES

Subjects

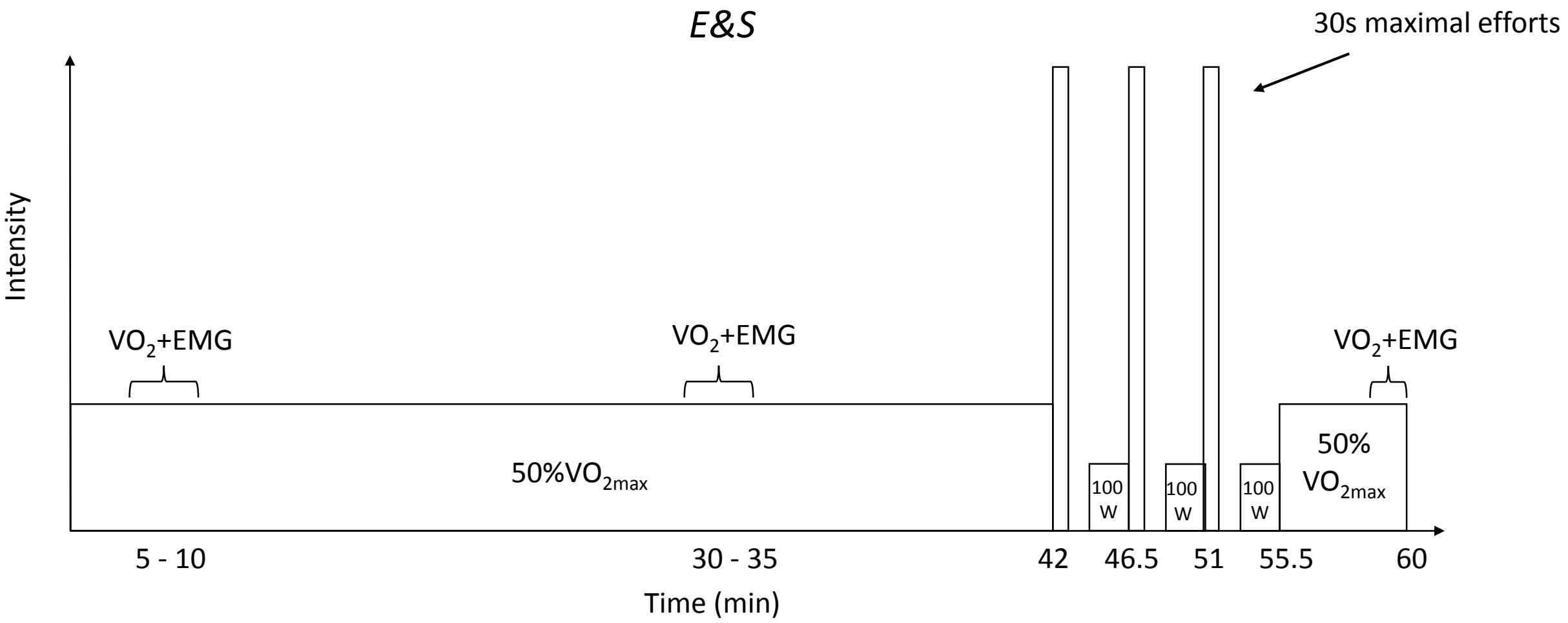
FP = 12	Absolute values	Relative values ($\bullet kg^{-1}$)
Age (years)	26.2 ± 6.3	
Body mass (kg)	76.1 ± 3.2	
Height (cm)	182.9 ± 5.4	
VO_{2max} ($L \bullet min^{-1}$)	5.6 ± 0,3	73.4 ± 4.0
W_{max} (W)	476.5 ± 28.6	6.3 ± 0.3
Training volume the last month (h)	54.9 ± 34.6	

INLAND NORWAY UNIVERSITY OF APPLIED SCIENCES

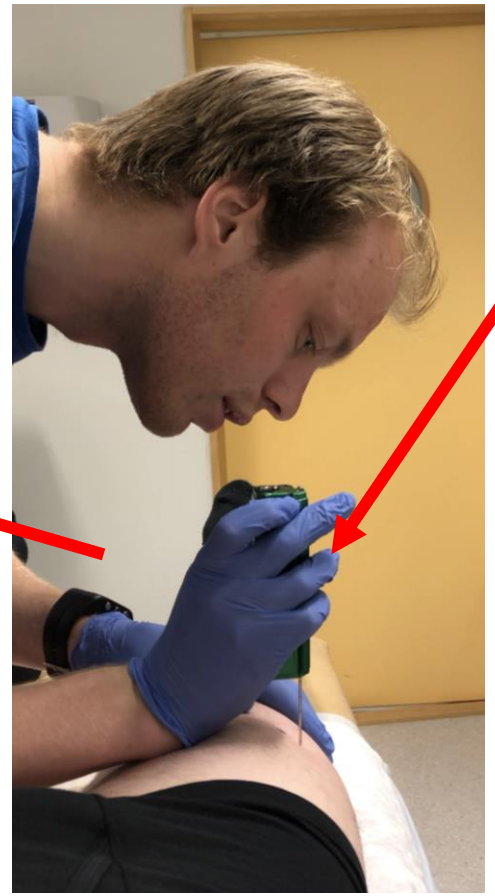
Design

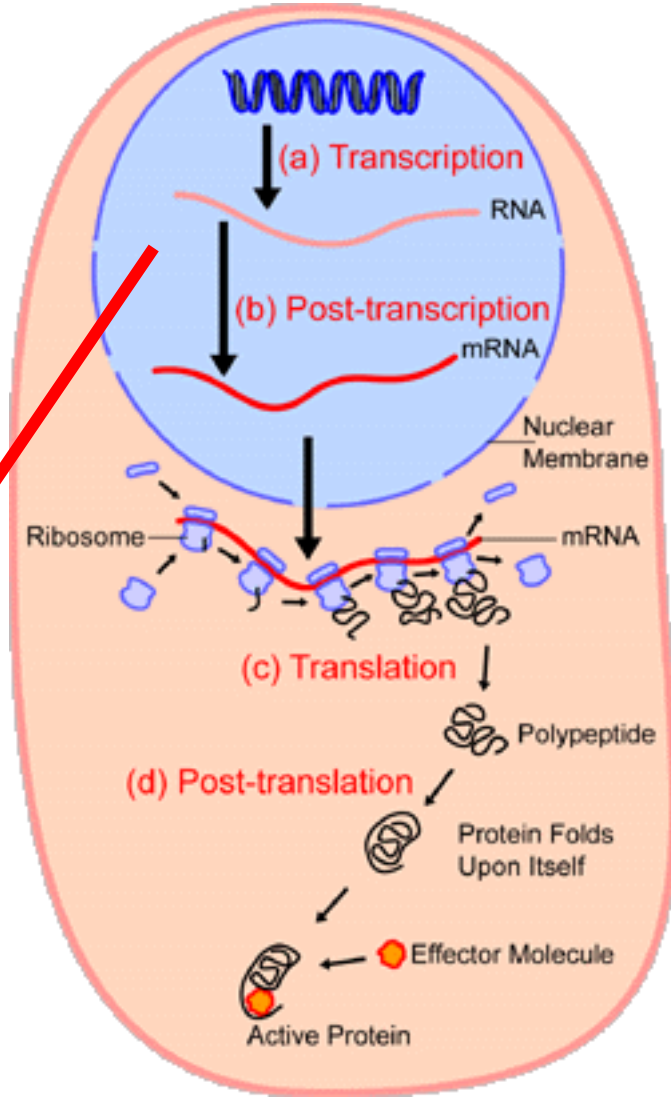


INLAND NORWAY UNIVERSITY OF APPLIED SCIENCES


E&S
30s maximal efforts
Intensity
VO2+EMG
VO2+EMG
VO2+EMG
50%VO2max
100 W
100 W
100 W
50% VO2max
5 - 10
30 - 35
42
46.5
51
55.5
60
Time (min)

Muscle signaling

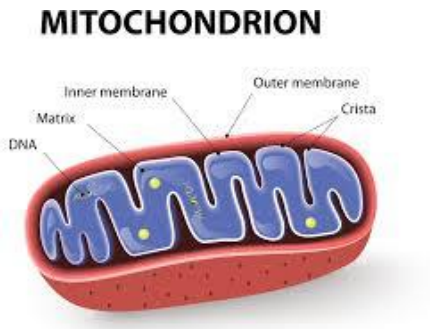




INLAND NORWAY UNIVERSITY OF APPLIED SCIENCES

Results - mRNA

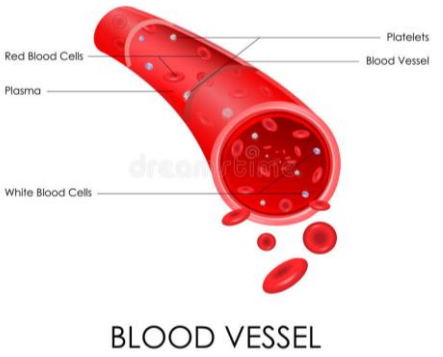
Mitochondrial biogenesis



INLAND NORWAY UNIVERSITY OF APPLIED SCIENCES

Results - mRNA

Angiogenesis



Log2 fold-changes Pre to Post and 3h Post (AU)

5
4
3
2
1
0
-1
-2

E
E&S

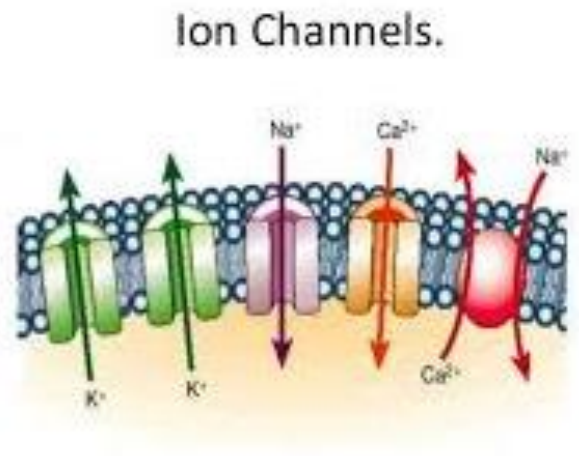
Post
3h post
HIF-1α

Post
3h post
VEGFA-stim

Post
3h post
Thrombospondin

INLAND NORWAY UNIVERSITY OF APPLIED SCIENCES

Results - mRNA



Skeletal muscle ion-transport proteins

Log2 fold-changes Pre to Post and 3h Post (AU)

5
4
3
2
1
0
-1
-2

§ * * § * § * § * § *

E
E&S

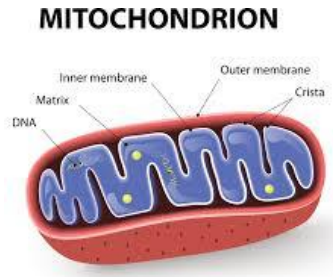
Post 3h post | Post 3h post | Post 3h post | Post 3h post | Post 3h post

Na+/K+ α1 | Na+/K+ α2 | Na+/K+ β1 | ClC1 | NHE1

INLAND NORWAY UNIVERSITY OF APPLIED SCIENCES

Results - mRNA

⇧ PGC-1α splice 1 E ≠ E&S PDK4 ⇧



Improved aerobic performance?

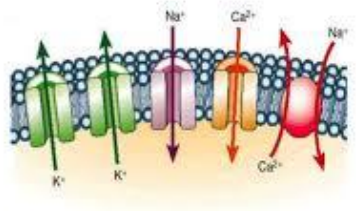
⇧ E = E&S ⇧

BLOOD VESSEL

Improved repeated sprintability and all-out efforts?

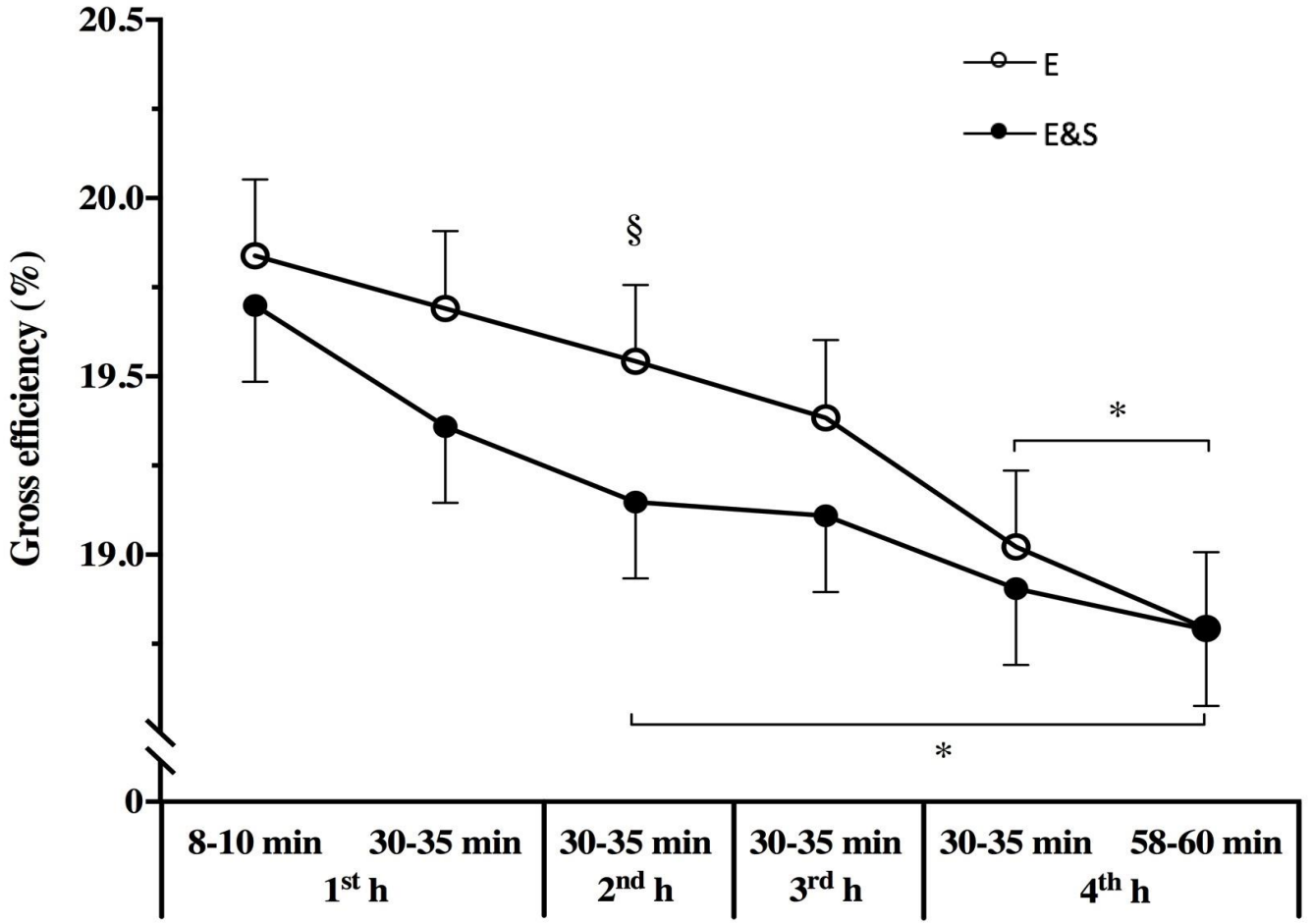
Ion Channels.

⇧ $Na^+/K^+\alpha 1$ E ≠ E&S ClC1 and NHE1 ⇩



INLAND NORWAY UNIVERSITY OF APPLIED SCIENCES

Results – Gross efficiency



Gross efficiency during steady-state periods. Filled markers represent E&S; endurance exercise with repeated 30 s sprints, open markers represent E; work-matched endurance exercise. Mean ± SE, *n* = 12, * indicates significantly different (P<0.05) from Baseline, § indicates significant difference (P<0.05) between conditions.

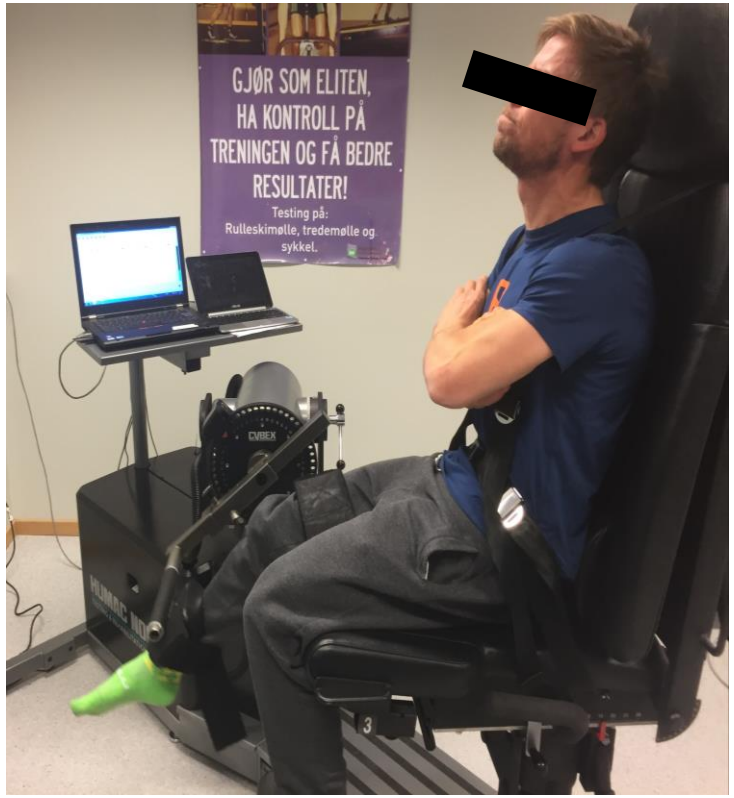
INLAND NORWAY UNIVERSITY OF APPLIED SCIENCES

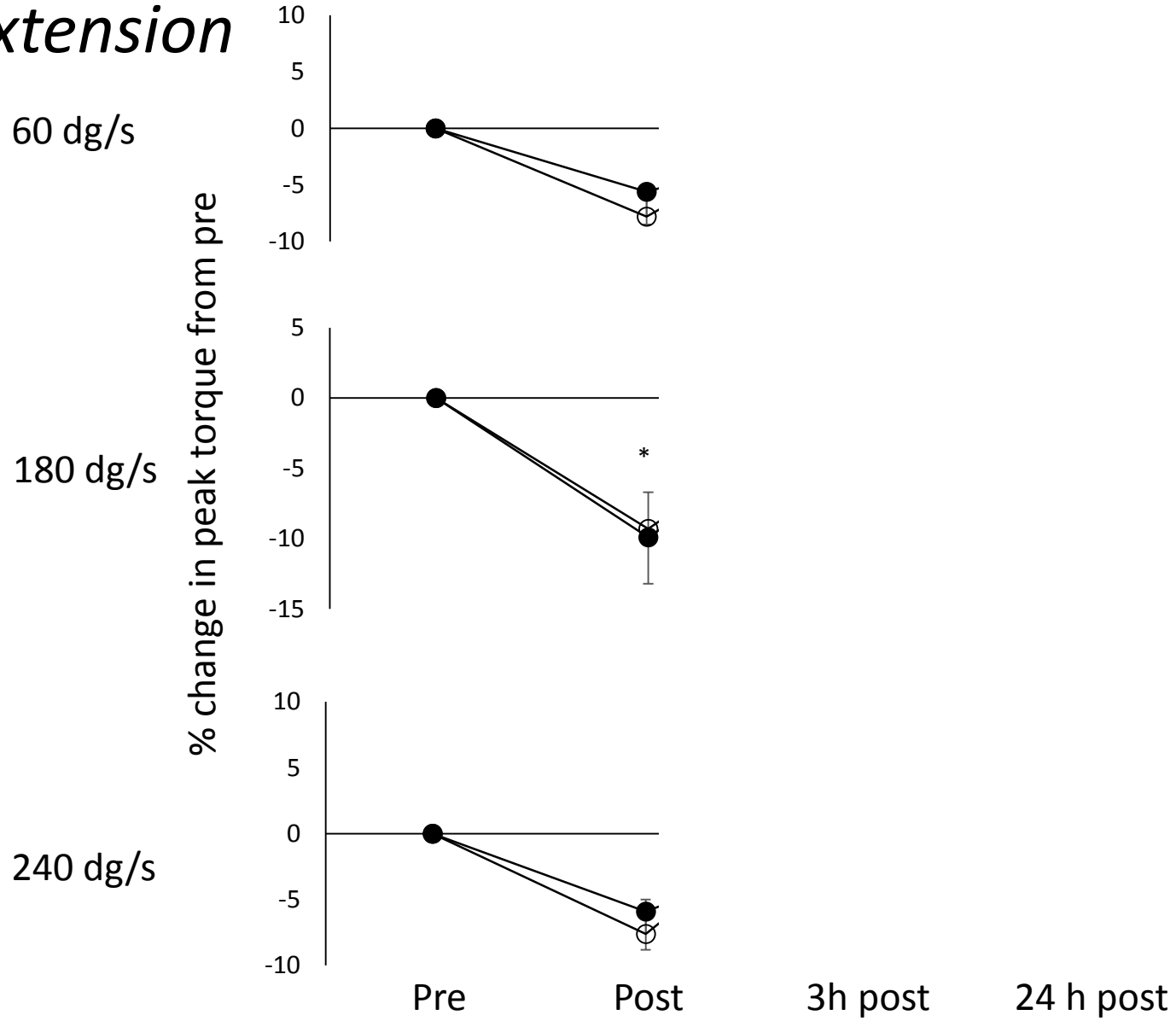
Results

		1st h		2nd h	3rd h	4th h	
		5-10 min	30-35 min	30-35 min	30-35 min	30-35 min	58-60 min
E&S	V'E (L·min^{-1})	63.8 ± 1.9	65.3 ± 1.7 §	69.3 ± 1.9 *§	70.4 ± 1.8*§	70.3 ± 1.8 *§	69.8 ± 1.8 *§
	RER	0.89 ± 0.01	0.89 ± 0.01	0.89 ± 0.01	0.88 ± 0.01	0.89 ± 0.01	0.88 ± 0.01
	Angle at peak torque (degrees)	91.9 ± 1.2	92.1 ± 1.2	91.5 ± 1.2	91.9 ± 1.1	91.6 ± 1.0	91.3 ± 0.9
	Cadence (RPM)	86 ± 1	85 ± 2	86 ± 1	85 ± 1	86 ± 1	85 ± 2
	Delta iEMG (mV)	-	1.8 ± 3.3	3.9 ± 3.4	7.1 ± 3.4	8.5 ± 3.3	8.6 ± 3.3
E	V'E (L·min^{-1})	61.6 ± 1.8	63.0 ± 1.9	64.6 ± 1.8	64.9 ± 1.8	65.3 ± 1.8 *	65.9 ± 1.9 *
	RER	0.91 ± 0.01	0.89 ± 0.01	0.91 ± 0.01	0.89 ± 0.01	0.90 ± 0.01	0.90 ± 0.01
	Angle at peak torque(degrees)	93.1 ± 1.2	93.1 ± 1.1	92.7 ± 1.1	92.7 ± 1.0	93.1 ± 1.3	92.2 ± 1.3
	Cadence (RPM)	86 ± 1	86 ± 1	86 ± 1	86 ± 1	86 ± 1	86 ± 1
	Delta iEMG (mV)	-	3.7 ± 3.4	8.4 ± 3.3	10.8 ± 3.3	17.7 ± 3.3 *§	16.7 ± 3.3 *§

Ventilation, respiratory exchange ratio, angle at which peak power is attained during a revolution, cadence and delta intramuscular EMG from M. Vastus Medialis. *: different (P<0.05) from 5-10min. §: different (P<0.05) from E, Mean ± SD, n = 12.

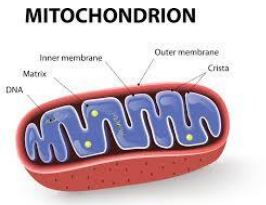
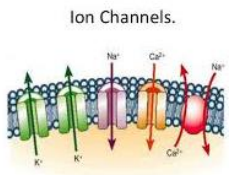
Results – Isokinetic knee-extension





Isokinetic knee- extension. * ; different (P<0.05) from Pre, §: different (P<0.05) from E, Mean ± SD, n = 12.

Summary - Effect of including 30-s sprints in prolonged endurance exercise

Acute effect	Difference between conditions
 ⬆	• Different signalling on mitochondrial markers
 ⬆	• Same response on markers of angiogenesis
 ⬆	• Different signalling on markers of ion handling -> improved repeated sprint ability?
 ⬇	• Gross efficiency was negatively affected by sprints but was similarly decreased <u>during</u> 4-h exercise
 ⬇	• Recovery of contractile function was similar 24 h post exercises

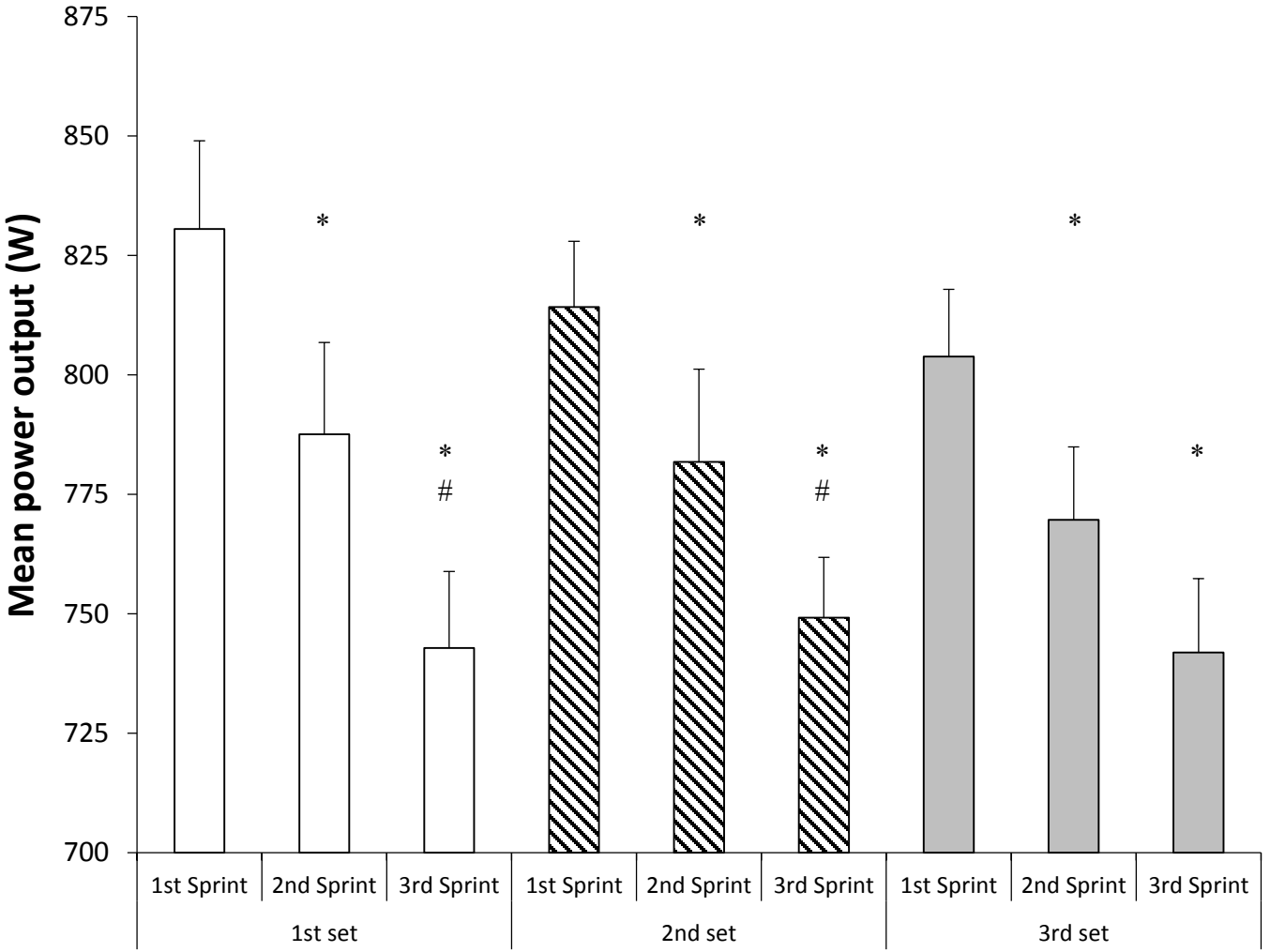
INLAND NORWAY UNIVERSITY OF APPLIED SCIENCES

Thank you for your attention!

Questions?

Nicki Winfield Almquist

INLAND NORWAY UNIVERSITY OF APPLIED SCIENCES



Mean power output during three sets of three sprints in *E&S*. Mean ± SE, n = 12, * indicates significantly different P<0.05 from the first sprint in the same set, # indicates significantly different P<0.05 from the second sprint in the same set.

		1st h			2nd h		3rd h		4th h
		10 min	40 min	3 min after sprints	40 min	3 min after sprints	40 min	3 min after sprints	54.5 min
E&S	RPE	9.8 ± 0.4	10.0 ± 0.2	13.3 ± 0.6 *§	11.1 ± 0.3 *	13.5 ± 0.5 *§	11.4 ± 0.3 *§	13.1 ± 0.5 *§	11.8 ± 0.4 *
	Blood lactate [la-]	0.9 ± 0.1	1.2 ± 0.1	17.2 ± 0.7 *§	1.8 ± 0.1 *§	16.7 ± 0.1 *§	2.0 ± 0.2 *§	16.0 ± 0.7 *§	2.6 ± 1.1
	HR (% of max)	65.5 ± 0.9	66.2 ± 1.5 §	68.0 ± 1.1 *§	68.0 ± 0.9 *§	68.3 ± 1.0 *§	70.6 ± 1.3 *§	67.8 ± 1.1 *	68.7 ± 1.0 *
E	RPE	10.0 ± 0.3	10.2 ± 0.2	10.3 ± 0.2	10.6 ± 0.2	10.7 ± 0.2	10.8 ± 0.2	11.0 ± 0.2	11.5 ± 0.3 *
	Blood lactate [la-]	0.9 ± 0.1	0.9 ± 0.1	0.9 ± 0.1	1.0 ± 0.1	0.9 ± 0.1	0.9 ± 0.1	0.9 ± 0.1	0.8 ± 0.1
	HR (% of max)	64.2 ± 1.0	63.4 ± 1.2	62.8 ± 1.1	63.3 ± 1.2	63.3 ± 1.1	65.7 ± 1.4	66.4 ± 1.4 *	67.4 ± 1.6 *