An analysis of intrinsic factors, performance, comfort and economy in relation to static and dynamic whole body kinematics in recreational and elite cyclists

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An analysis of intrinsic factors, performance, comfort and economy in relation to static and dynamic whole body kinematics in recreational and elite cyclists

- How do cyclists sit on their bikes?
  - Why do they sit that way?
  - How can this be optimised?

An analysis of intrinsic factors, performance, comfort and economy in relation to static and dynamic whole body kinematics in recreational and elite cyclists

Wendy Holliday

Raymond Teo

Background

- Kinematic data in cycling
- Optimal knee flexion angle:
  - The Hamley and Holmes - only two documented static scientific methods for adjusting saddle height:
    - Hamley – 109% of inseam length – postulated to optimise power
    - Holmes – KFA of 25-35° with pedal horizontal at BDC.
  - Intervention studies by:
    - Peveler reduction of KFA to 25° improved economy, reduced RPE and improved power
    - Hamley method achieves range < 26% of time
    - Nordeen Snyder – 100% of TLL improved economy in comparison to 95% or 105%
    - Shennum – 103-104% of inseam maximises both power and economy

Background

- KFA – dynamic data:
  - Only 3 studies utilising freely chosen bike configuration
  - Bailey et al – 24 experienced subjects:
    - KFA not reported other than figures for 2D kinematics ~ 40°
  - Bini thesis – 30 recreationally competitive cyclists
    - KFA using 2D kinematics = 38°
  - Garcia Lopez - 11 professional and 23 amateur cyclists
    - KFA using 2D kinematics = 33.6° / 35.5° respectively

Background

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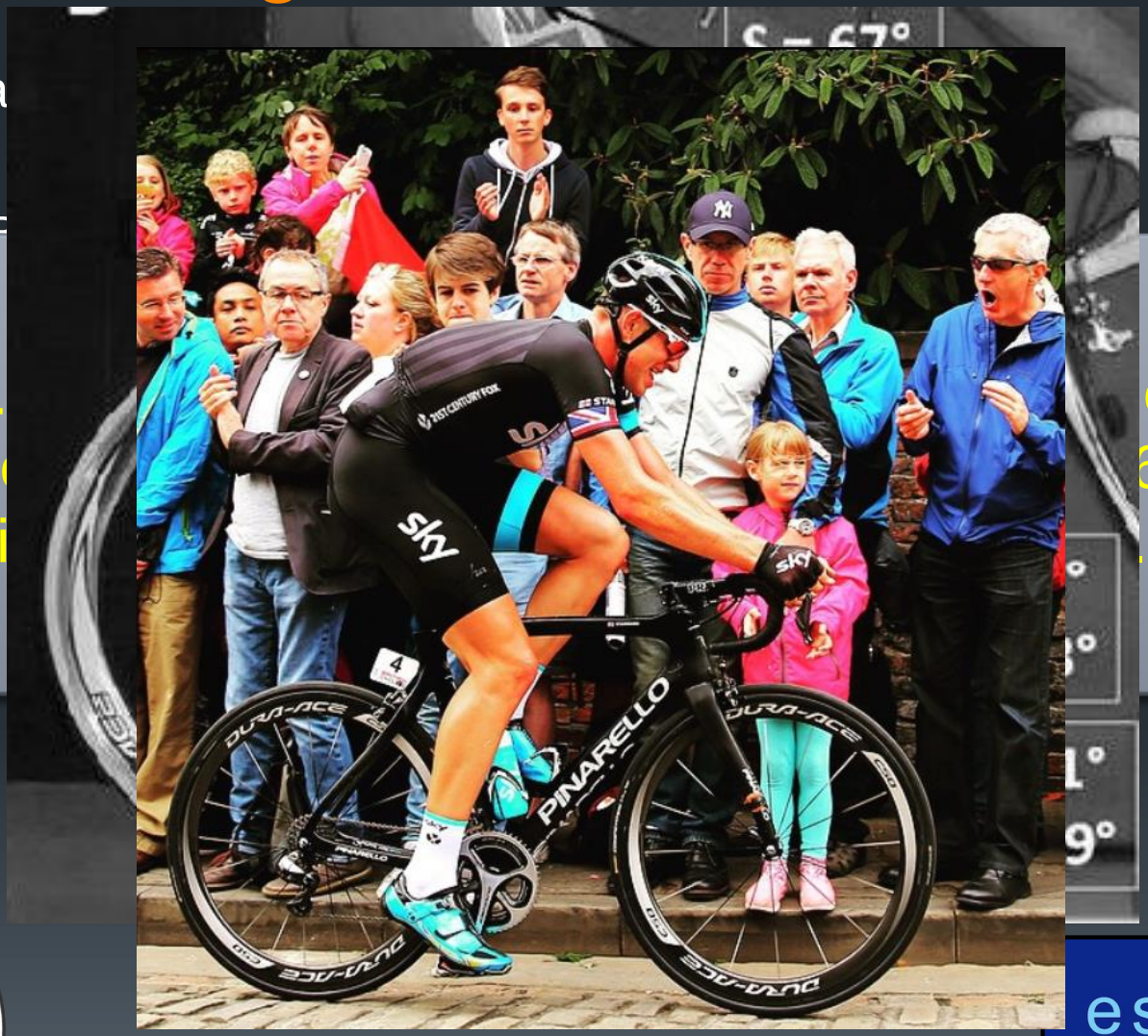
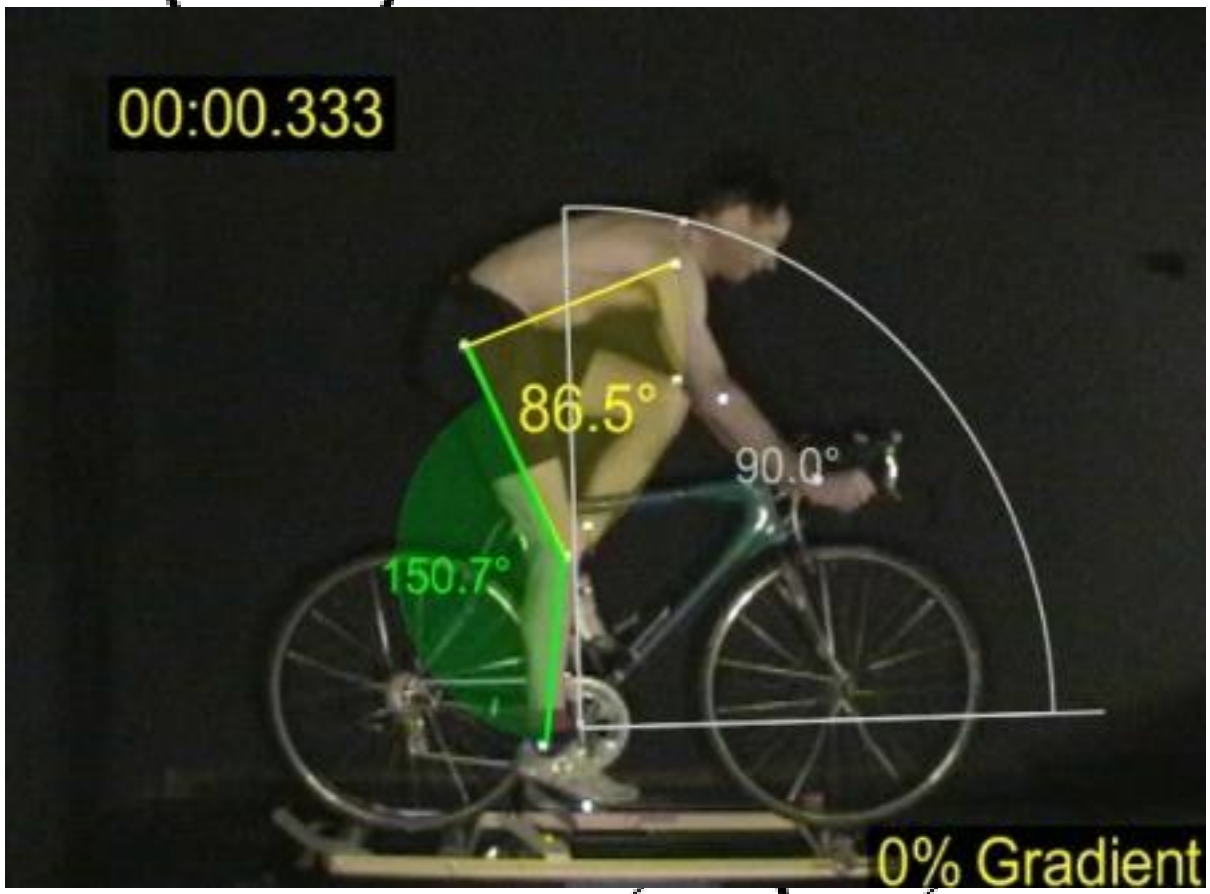


Summary

- Freely chosen KFA variably reported as:
  - 33.6 – 40°
- Change from static to dynamic:
  - 2.9° - 8°
- Inferred freely chosen KFA:
  - 25.6° – 32° (static position using Hamley method)



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Background

- There have been absolutely NO studies reporting normative data for static or dynamic hip, shoulder and elbow flexion angles
- How these joints interact with knee and ankle flexion angles.
- The effects of fatigue on these joint kinematics has also not been investigated.

Aim

- Freely chosen Static & Dynamic kinematics for:
  - Ankle FA
  - Knee FA
  - Hip FA
  - Shoulder FA
  - Elbow FA
- Reliability of static and dynamic measures

Aim

- Freely chosen bike fit parameters
  - Saddle height
  - Saddle setback
  - Reach
  - Drop
- Intrinsic factors which may influence the above:
  - Training history and volume
  - Flexibility
  - Training status

Aim

- Alterations in kinematics during a fatiguing exercise bout
- Common outcome variables:
  - Economy
  - RPE
  - Comfort scores
  - Cadence
  - Heart rate
  - EMG (GM, RF, VLO, VMO, BF, TA, MG)

Methods

- 25 Healthy males (18-45 y.o.)
- Recent Argus Cycle Tour of < 4.5hrs
- Minimum of 4hrs training per week.
- Minimum of 3.6W/kg during VO_2peak test
- No illness or injury
- No recent bike parameter alterations

Methods

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e, ankle, shoulder

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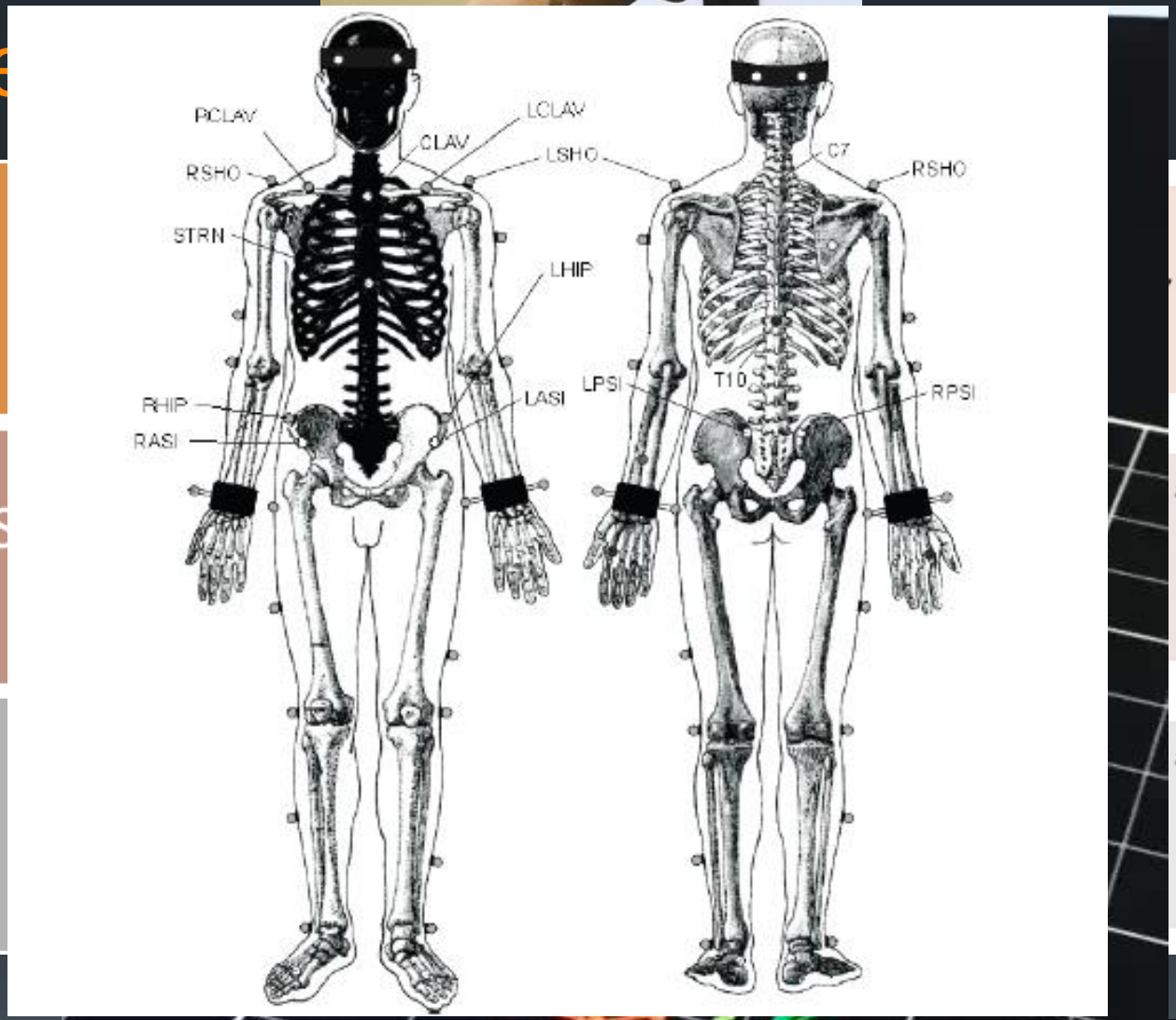

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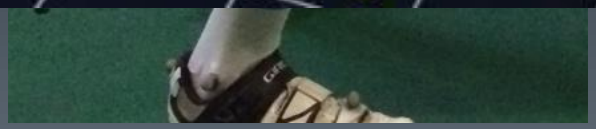
ankle, shoulder

ankle, shoulder



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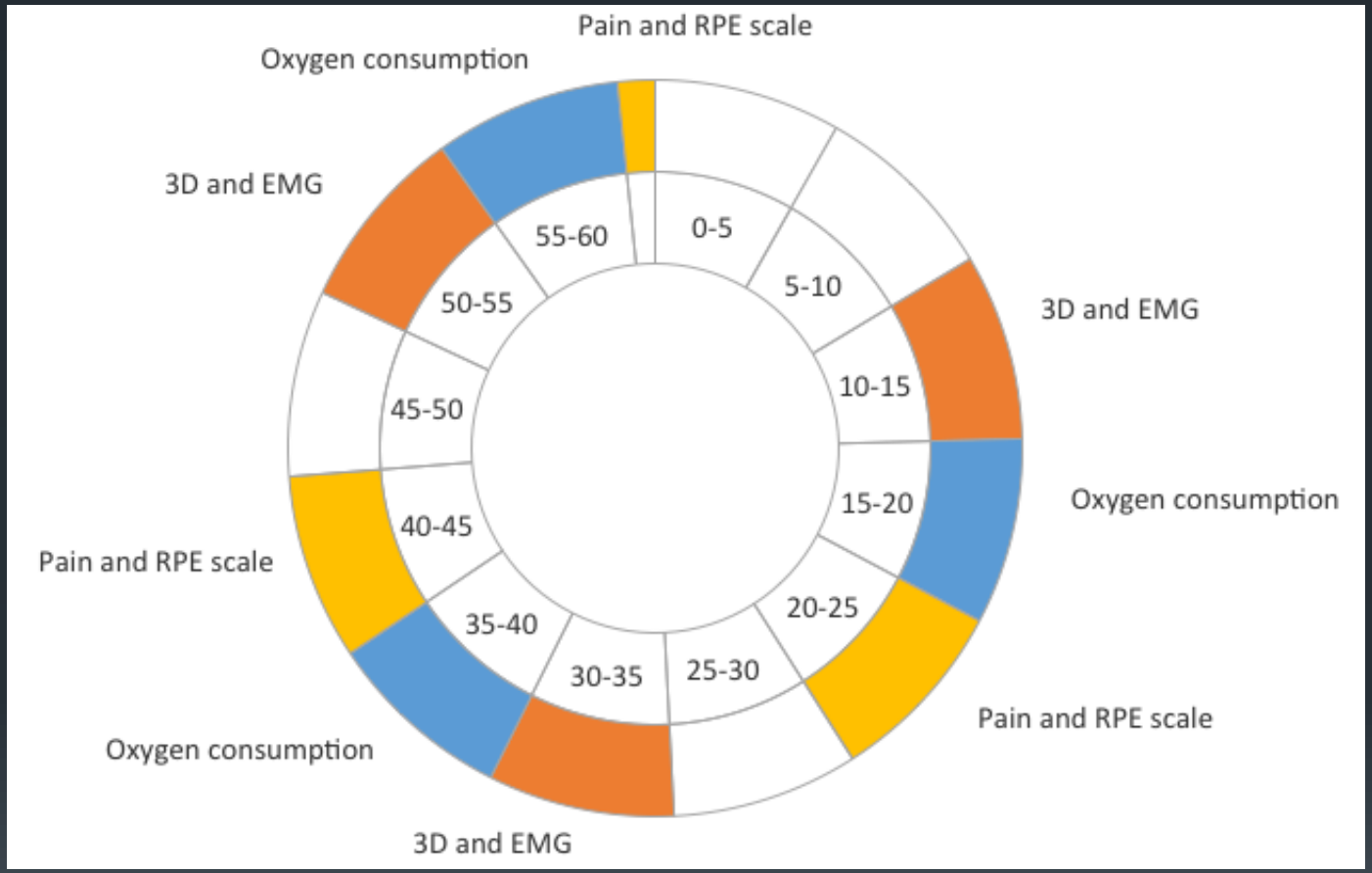
Methods


Pain and RPE scale
Oxygen consumption
3D and EMG
0-5
5-10
10-15
15-20
20-25
25-30
30-35
35-40
40-45
45-50
50-55
55-60
3D and EMG
Oxygen consumption
Pain and RPE scale
Pain and RPE scale
Oxygen consumption
3D and EMG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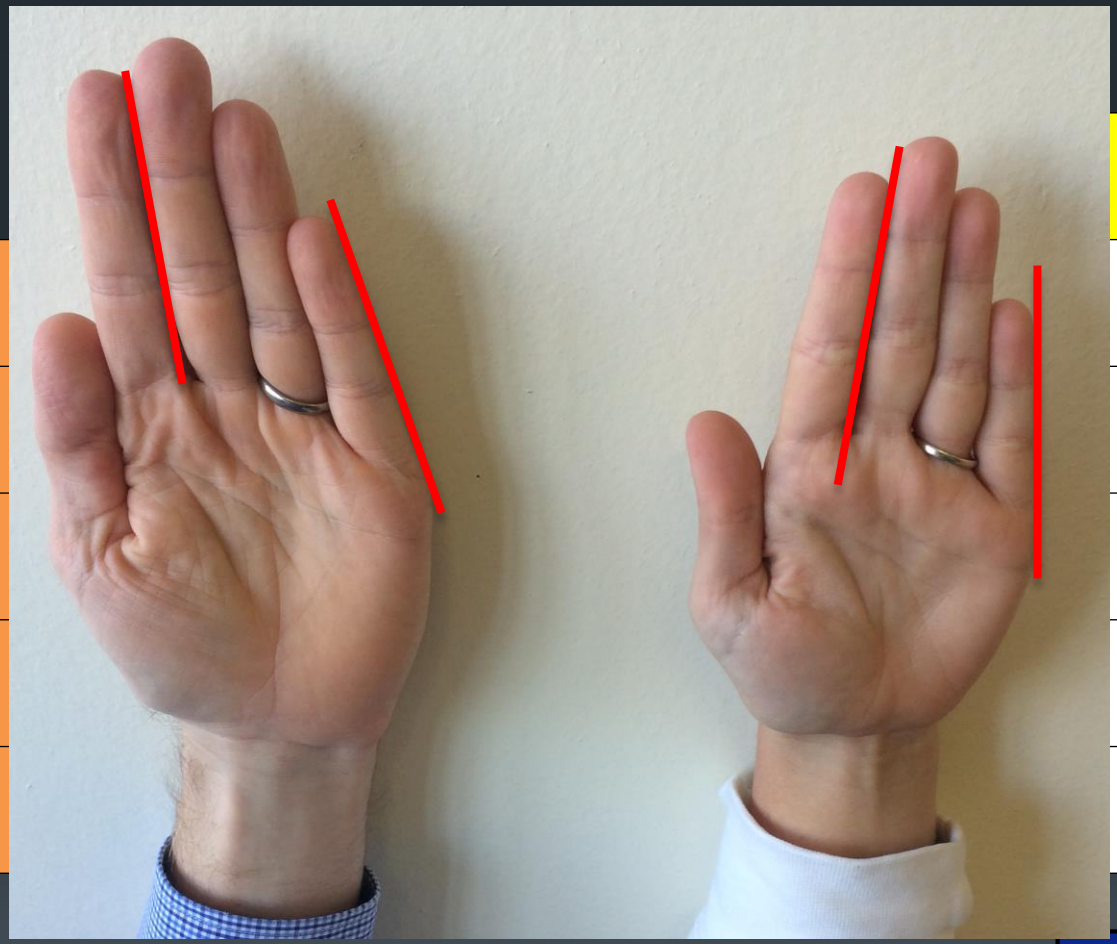
Results – Participants.

	Mean (SD)
Age (yrs)	33.4 (8.2
Stature (cm)	179.2 (4.8
Mass (kg)	77.1 (8.8
Training history (yrs)	7.1 (5.6)
Training load (hrs/wk)	8.0 (4.0)
PPO (W)	355.8 (37.6)
PPO (W/kg)	4.6 (0.4)

Results



VICON (°) (SD)
34.3 (7.0)
86.5 (7.4)
100.8 (4.2)
34.5 (8.3)
8.2 (5.8)

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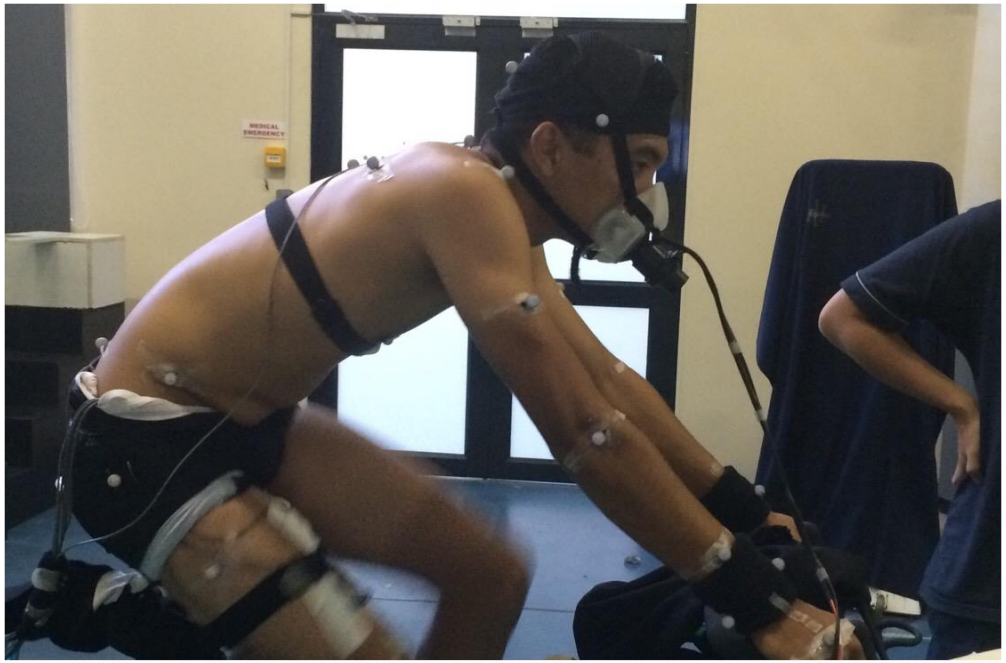


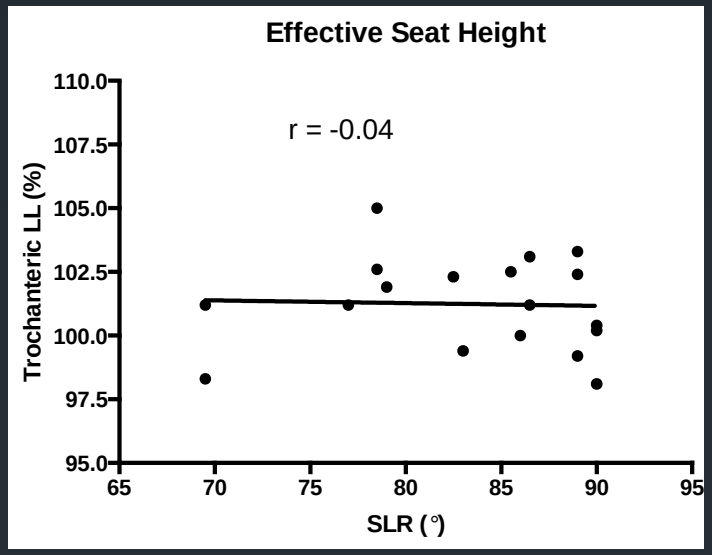
Results

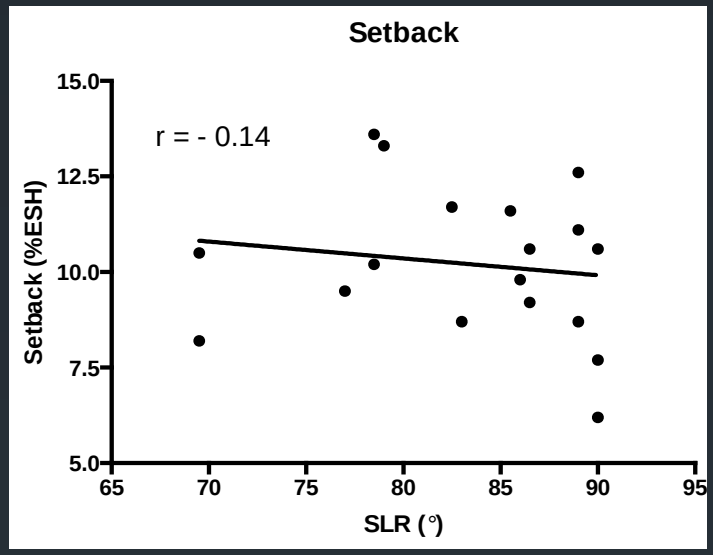
	Goniometer	Inclinometer	VICON
	TEM (°) (95% CI)	TEM (°) (95% CI)	TEM (°) (95% CI)
Knee	3.07 (2.54 - 4.12)	2.27 (1.88 - 3.05)	2.65 (2.10 - 3.89)
Hip	3.5 (2.90 - 4.70)	2.78 (2.33 - 3.73)	3.94 (3.11 - 5.78)
Shoulder	4.47 (3.70 - 6.01)	4.44 (3.68 - 5.97)	2.35 (1.86 - 3.45)
Elbow	3.68 (3.05 - 4.94)	3.63 (3.00 - 4.87)	4.50 (3.55 - 6.59)
Ankle	2.55 (2.11 - 3.42)	3.40 (2.82 - 4.57)	3.64 (2.87 - 5.33)

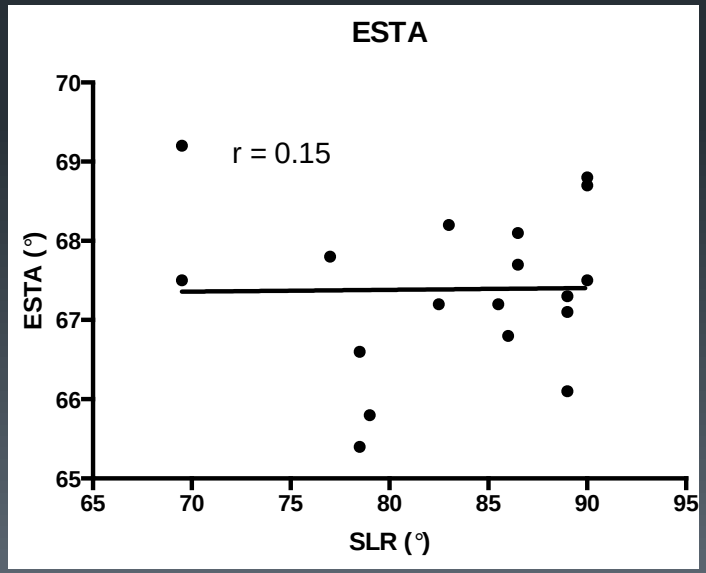
Results

- No relationships found between:
  - Flexibility and bike configuration
  - Training status and bike configuration
  - Training history and economy
  - Training load and economy
  - Training history and cadence
  - Training load and cadence
  - Training status and cadence
  - Training history and RPE
  - Training load and RPE
  - Training status and RPE

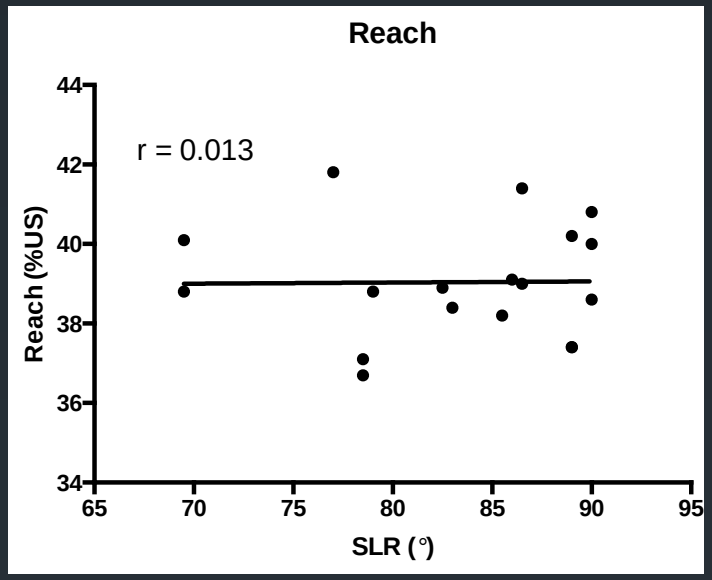
Results – Flexibility vs Seat position

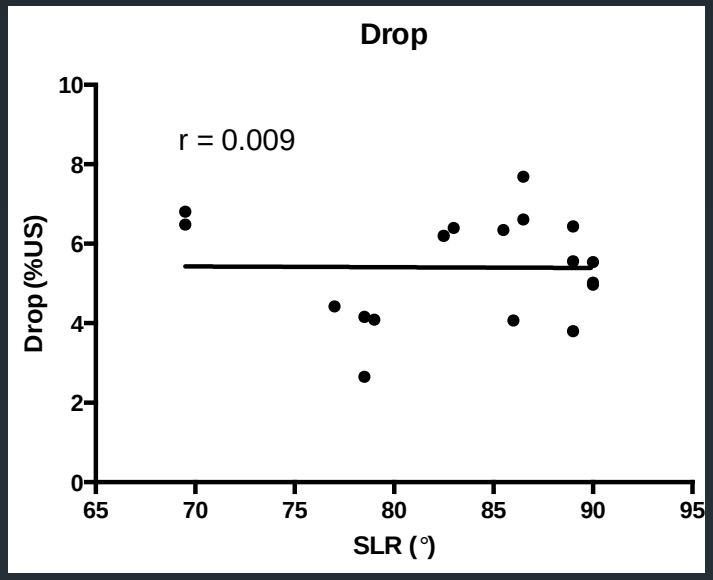


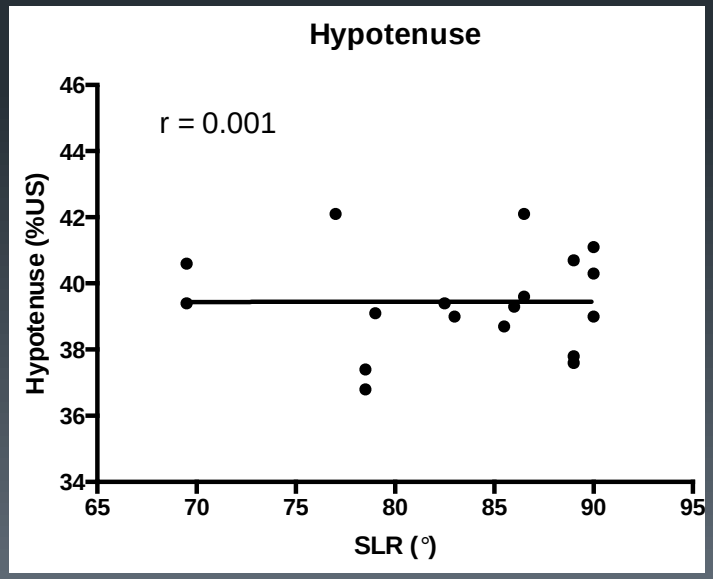




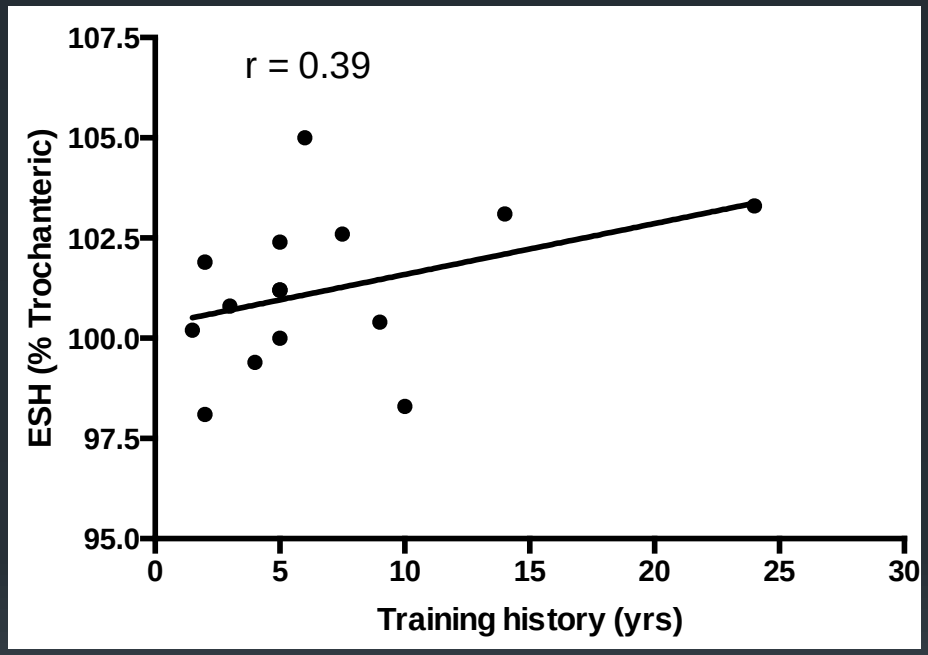
Results – Flexibility vs Handlebar

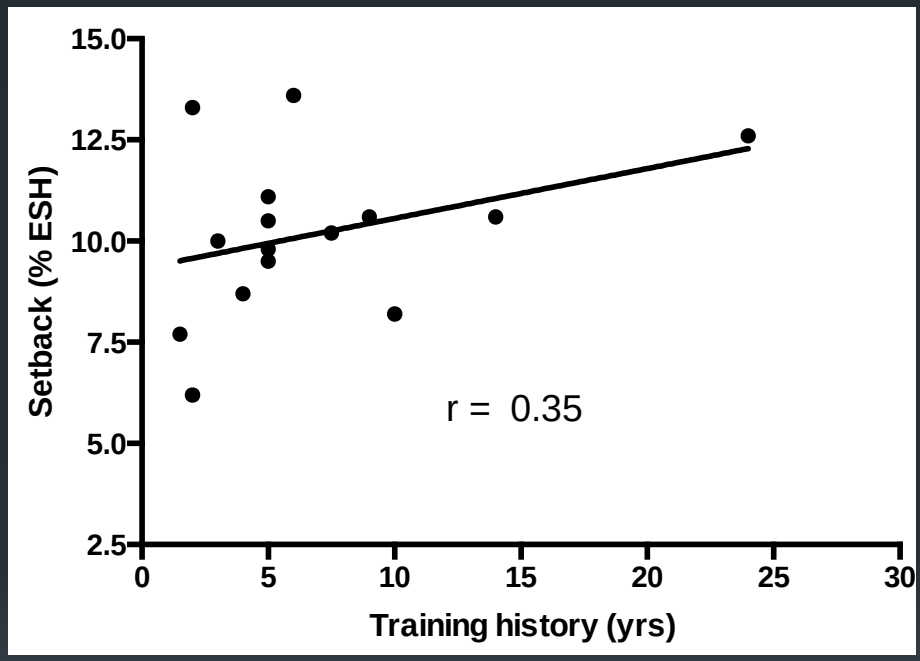






Results – Training hist. vs Seat position





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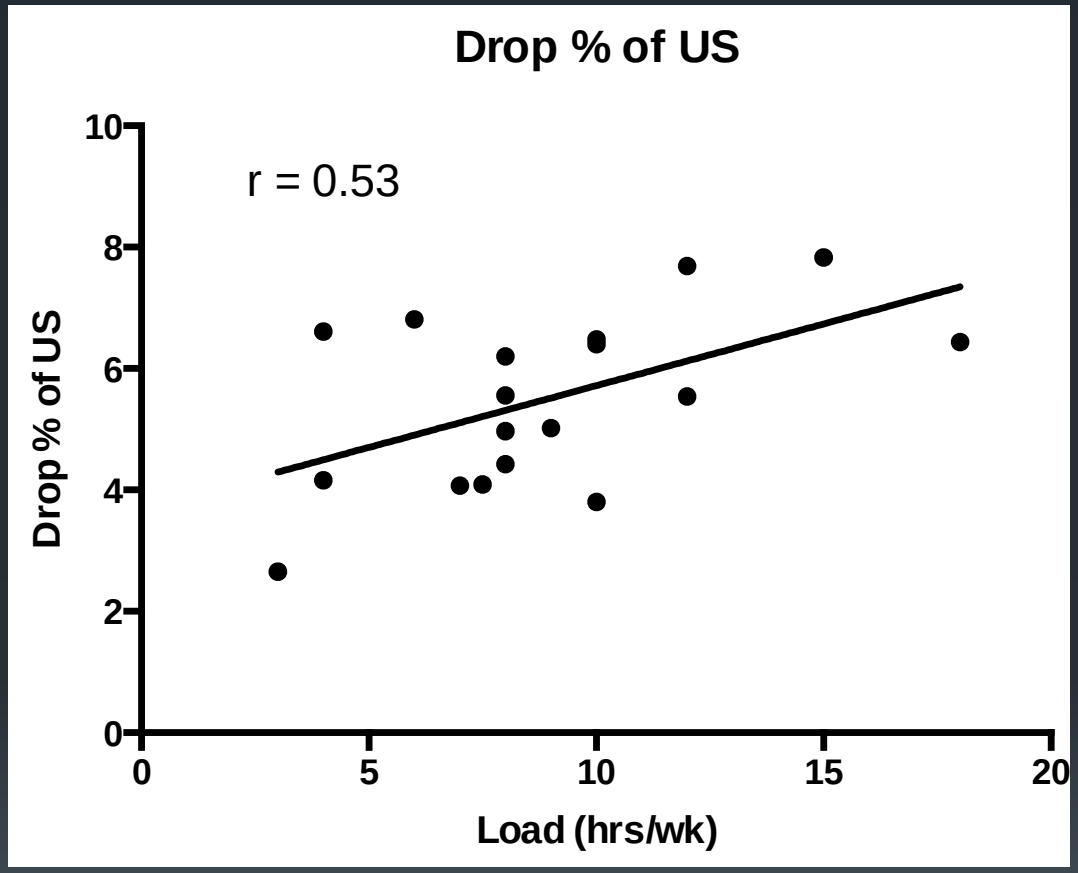

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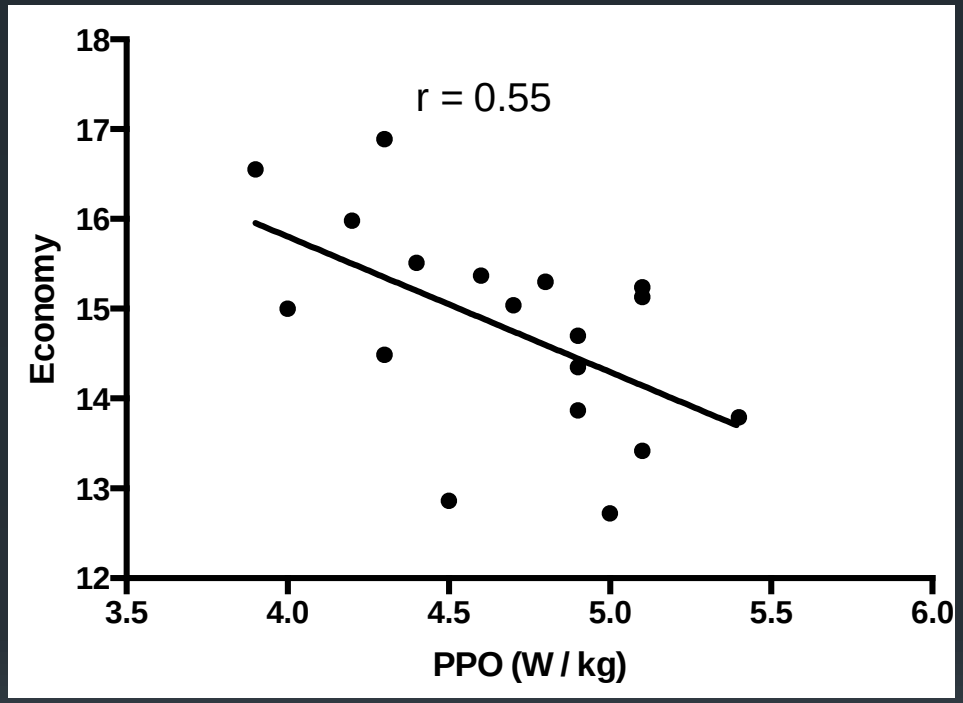

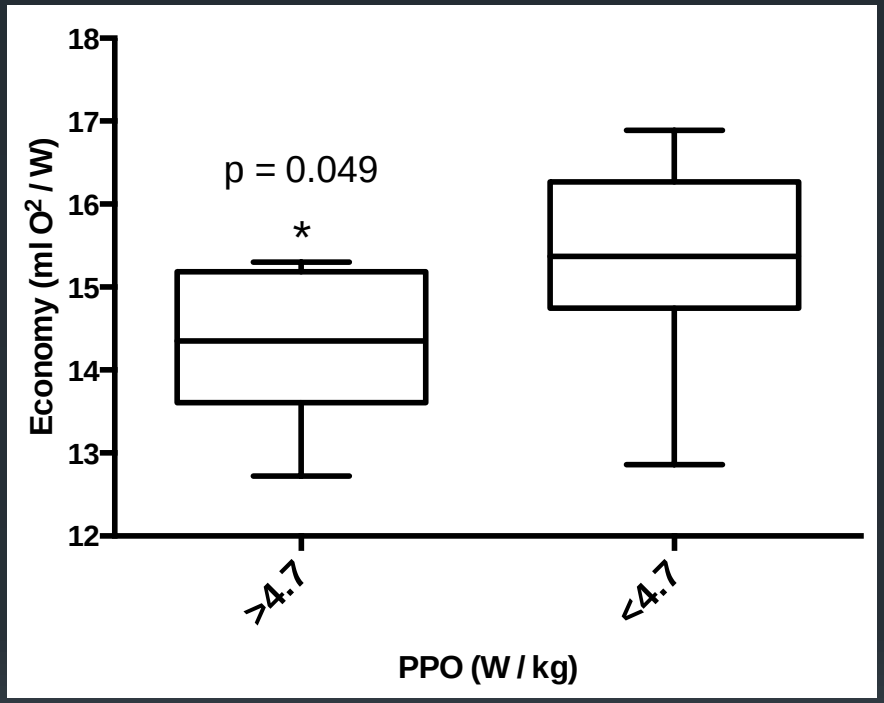

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Discussion

- First research study to report 3D kinematic KFA for freely chosen bike fit.
- First research study to report both static & dynamic hip, shoulder and elbow flexion data for freely chosen bike fit
- Changes for static➔ dynamic KFA values opposite to previous studies - mainly due to control of foot position at BDC.

Discussion

- VICON data not as reliable as expected. Influenced by repeatability of marker placement and marker movement during studies.
- Freely chosen bike configuration not dependent on flexibility
- Increased training history associated with increased saddle height and setback
- Increased drop with higher training loads
- Improved economy with improved training status

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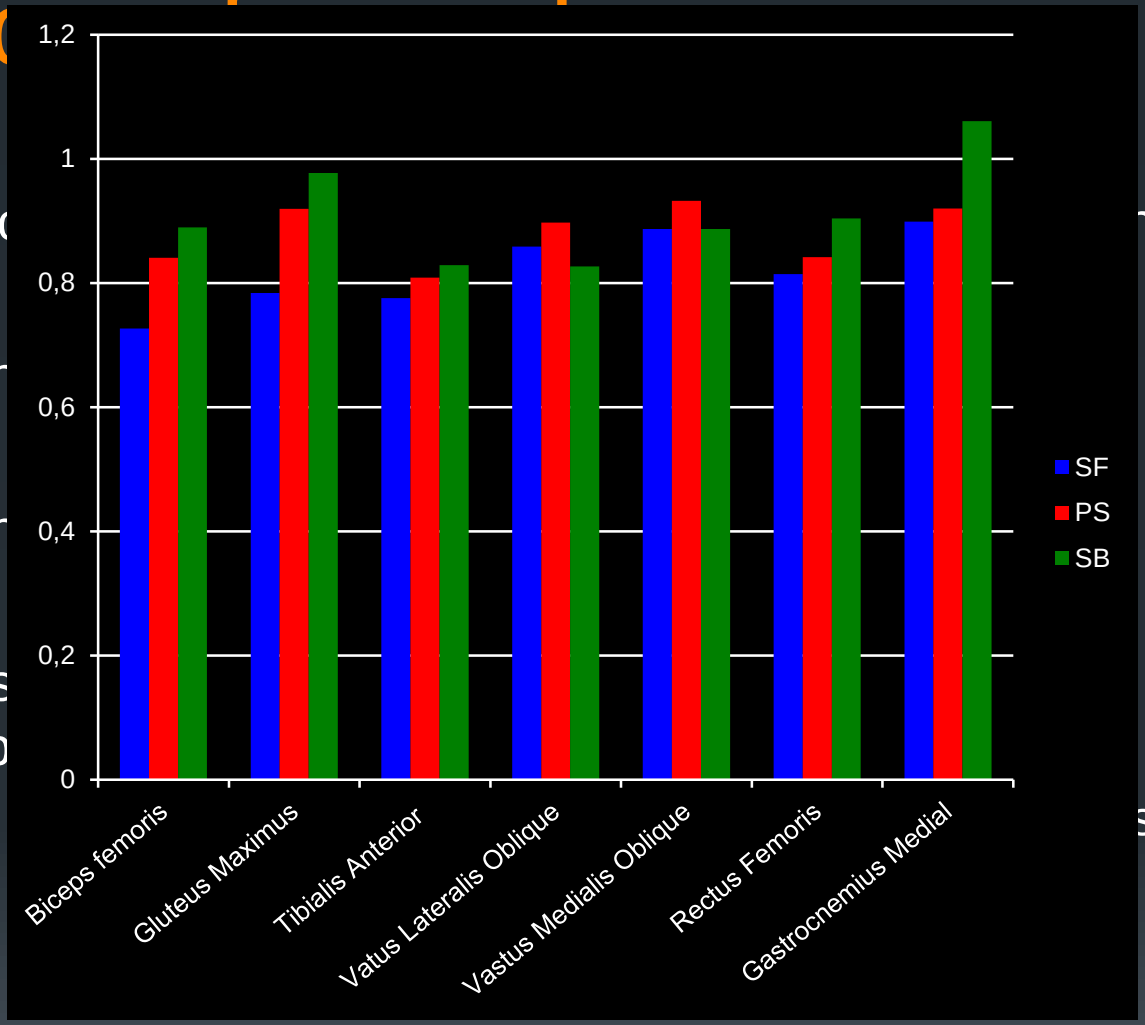

Thank You

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