



BRITISHROWING

Extreme Physiology

Methodology and science of training elite rowers

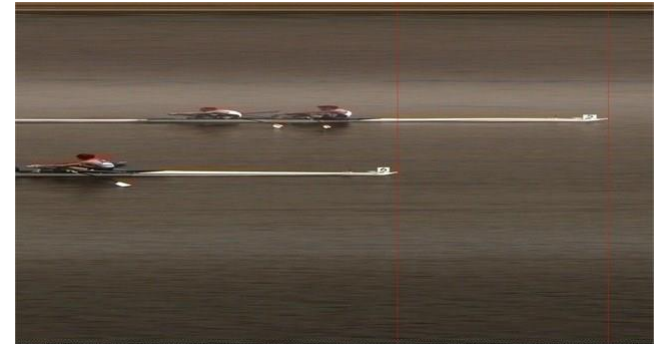


Paul Thompson MBE, Chief Coach, Women and Lightweights.

Great Britain Rowing Team

2012 Women and Lightweights Squad





9 6:28.8 6:29.7 6:29.4 6:28.5 6:28.4 6:28.3 6:28.2 6:28.1 6:28.8 6:27.9 6:27.8 6:27.7 6:27.6 6:27.5 6:27.4 6:27.3 6:27.2 6:27.1



Number of countries winning Olympic medals

Regatta	Gold	Silver	Bronze	Total
Montreal	5/14	7/14	7/14	11/42
Moscow	4/14	6/14	8/14	9/42
L.A.	8/14	8/14	9/14	15/42
Seoul	6/14	8/14	9/14	14/42
Barcelona	5/14	8/14	8/14	16/42
Atlanta	10/14	9/14	9/14	14/42
Sydney	9/14	9/14	9/14	18/42
Athens	11/14	12/14	9/14	23/42
Beijing	12/14	13/14	10/14	21/42
London	8/14	11/14	8/14	18/24



Estimated speed increase between
Olympiads

=.5 – 1%



Physiological Cost of 2000m Racing

- 20 - 30% Anaerobic
Start and finish of race
- 70 – 80% Aerobic
Body of race



Endurance



- Cardiac Output – Heart Rate x Stroke Volume
 - Resting Heart Rate decreases with training
 - Stroke volume increases
 - Limiting factor in trained individuals?

Endurance



- Vo₂ Max
- mL/kg/min
- Capillarisation

- Rowing Efficiency

Strength and Power



Average Ergometer Power – 2000m

Extreme Physiology

Lightweight Women	307 Watts	57.5Kg
Women	388 Watts	78.0kg
Lightweight Men	448 Watts	72.7kg
Men	566 Watts	101kg

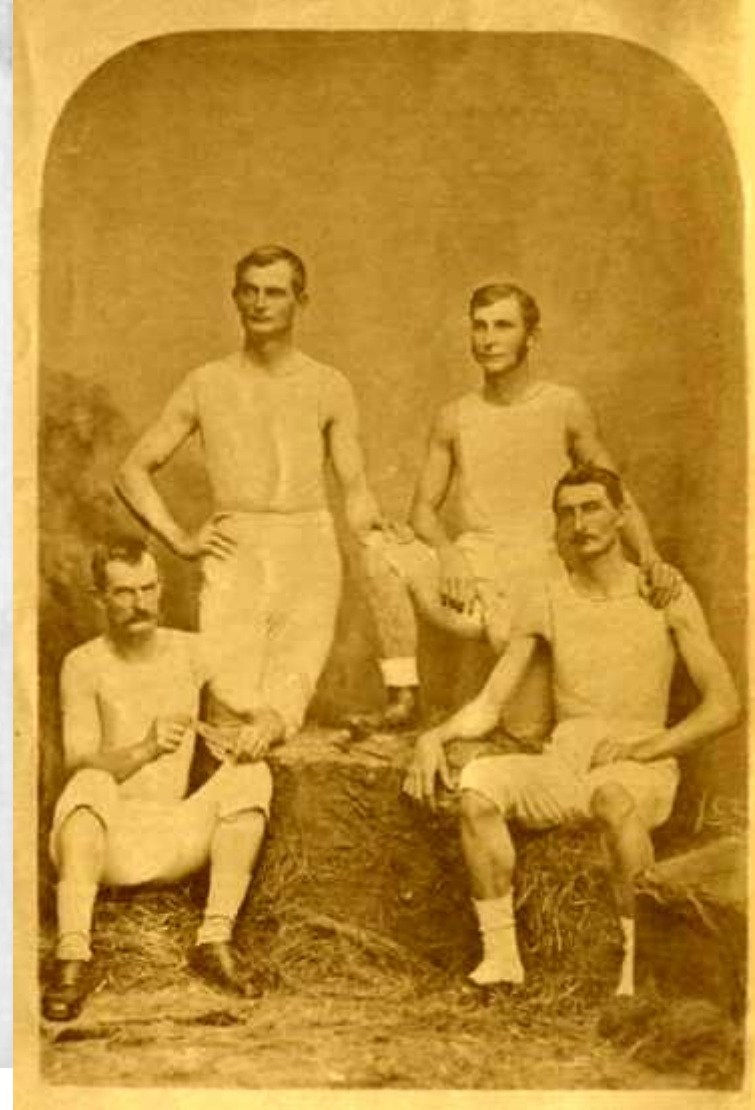
Anthropometrics	Men	Lwt Men*	Women	Lwt Women*
Height (m)	>1.93	>1.78	>1.81	>1.68
Weight (kg)	>88	68-72	>74	56-59
Arm Span (m)	>1.95	>1.80	>1.83	>1.68
Skinfolds (mm/4 sites)	30	23	38	28
• Physiology				
Vo2 Max (/litre)	>6.3	>5.5	>4.6	>3.96
Power Output 2mmol (Watts)	>340	>300	>220	>211
Power Output 4mmol (Watts)	>380	>350	>255	>265
Maximum Power (Watts)	>670	>507	>450	>356
Maximum Force (Newtons)	>790	>633	>576	>475
• Ergometer Scores				
2000m	<5:53min	<6:10min	<6:40min	<7:05min
30' Rate 20 (Split/500m)	<1:41.0	<1:43.5	<1:50	<1:55
• Muscle Strength				
Bench Pull (kg)	>110	>90	>60	>55
Bench Press (kg)	>110	>90	>60	>55
Squats (kg – 90 deg knee angle)	>120	>90	>90	>70
Power Clean (kg – technique!)	110	>90	Body weight	Body weight



Ned Hanlan ca 1880
173cm
71kg



Biglin Brothers ca 1865
180cm? 75-80kg?



Ward Brothers ca 1865
185cm?
80+kg?

Taller Population= Taller Elite Rowers



Oxford Crew-2005
Average Height: 197cm
Average bodyweight
98.3 kg



Training Definitions and Zones

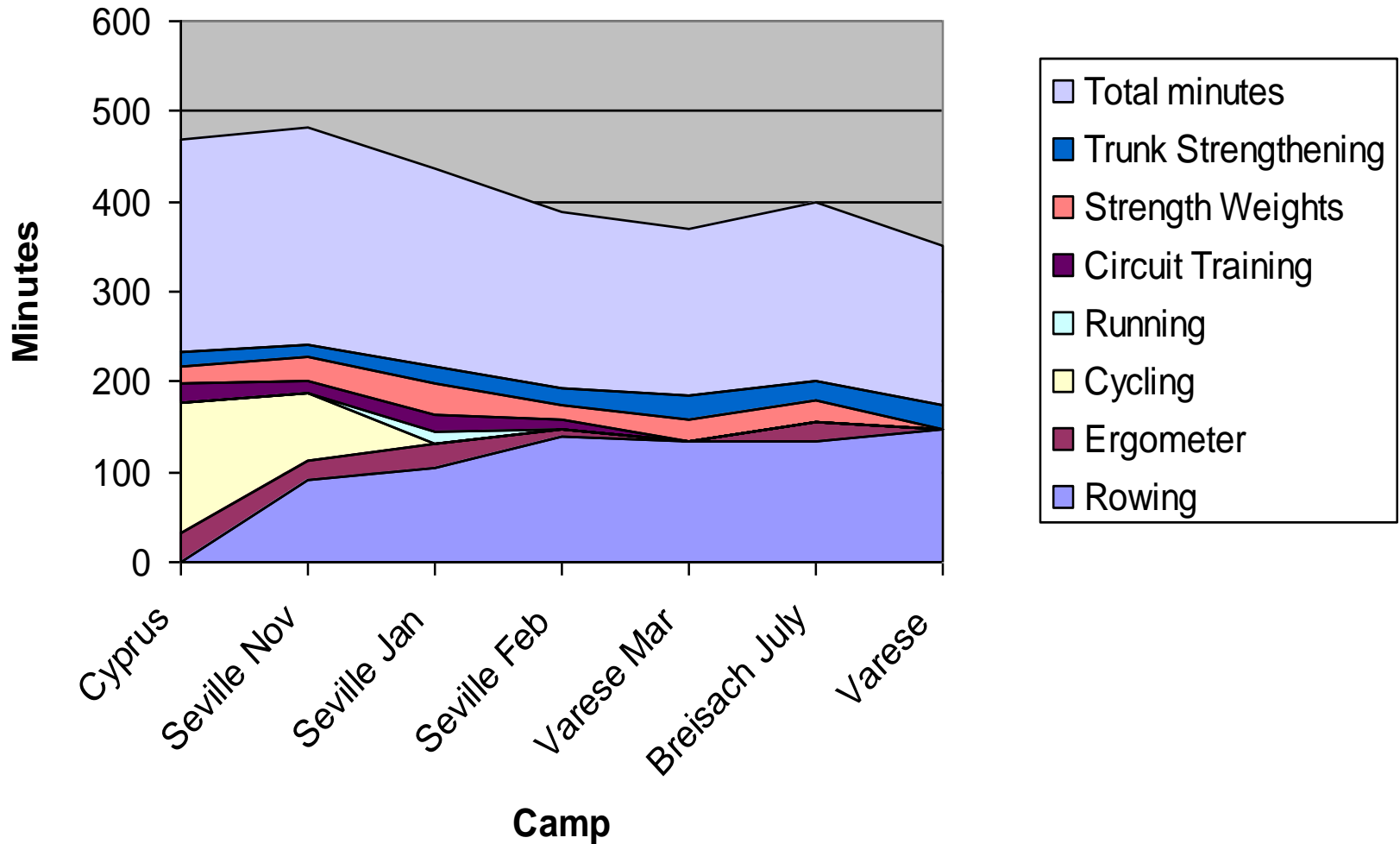
Zone	Stroke Rate Per Minute	% Of Gold Standard Time	% Of Maximum Heart Rate	Approx. Lactate (Mmol)	Physiological Zone Definition
Utilisation 3 (U3)	<18	< 70%	65-75%	>1	Below the onset of blood lactate accumulation
Utilisation 2 (U2)	17-18	70 - 76%	65-75%	>2	Below the onset of blood lactate accumulation
Utilisation 1 (U1)	19-23	77 - 82%	70-80%	2-4	Above the onset of blood lactate accumulation but below the onset of metabolic acidosis
Anaerobic Threshold (AT)	24-28	85-88%	82-86%	~ 4	Just below the onset of metabolic acidosis
Transport (TPT)	28-36	88-100%	87-95%	4-8	Above the onset of metabolic acidosis
Anaerobic (AN)	36+	100%+	Max		Maximum effort

Training Effects

Adapted from Dr Alan Hahn

<u>Effect</u>	<u>Classification of Training Zones</u>					
	U3	U2	U1	AT	TR	AN
Increased blood volume	****	****	***	**	*	
Increased activity of aerobic enzymes	****	****	****	***	**	*
Increased use of fatty acids as a fuel source	****	***	**	*		
Improved ability to use lactate as a fuel	**	**	***	****	****	**
Increased maximum rate of muscle glycogen use		*	**	***	****	****
Increased muscle capillarisation	****	****	***	***	***	**
Improved muscle and blood buffering capacity		*	**	***	****	****
Increased maximum cardiac output	**	**	***	***	****	***
Increased maximum ventilatory capacity	*	**	**	***	****	****
Development of race specific neuromuscular adaptations	*	*	**	**	***	****

Minutes of training at different camps



Testing and Monitoring Performance and Training

- Testing and monitoring must be:
 - Reliable
 - Specific
 - Repeatable
 - Accurate
 - Standardised
- On Water
- On Land



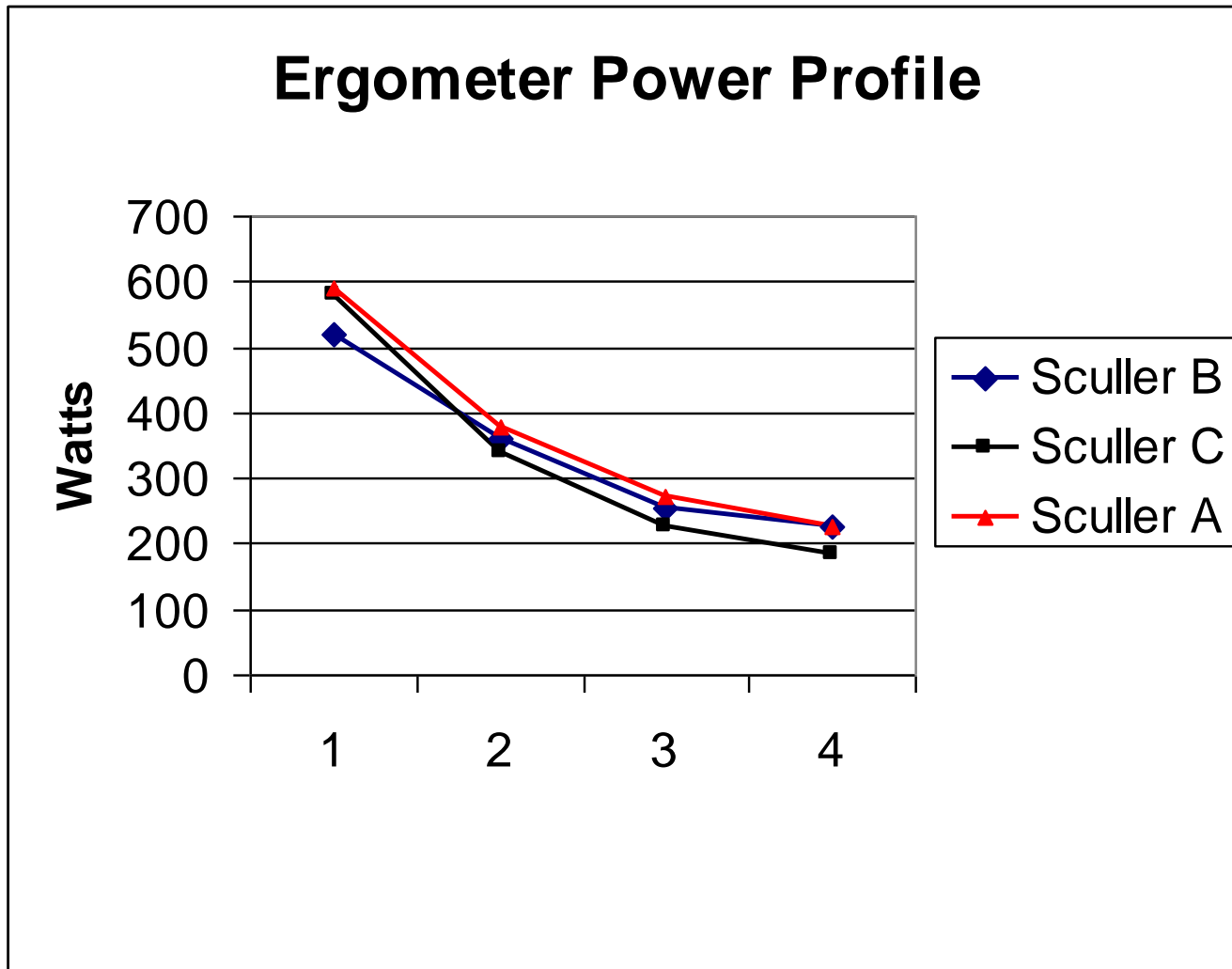
Athlete Monitoring v testing

- Physiological cost v load
- Ready to train?
- Psychological



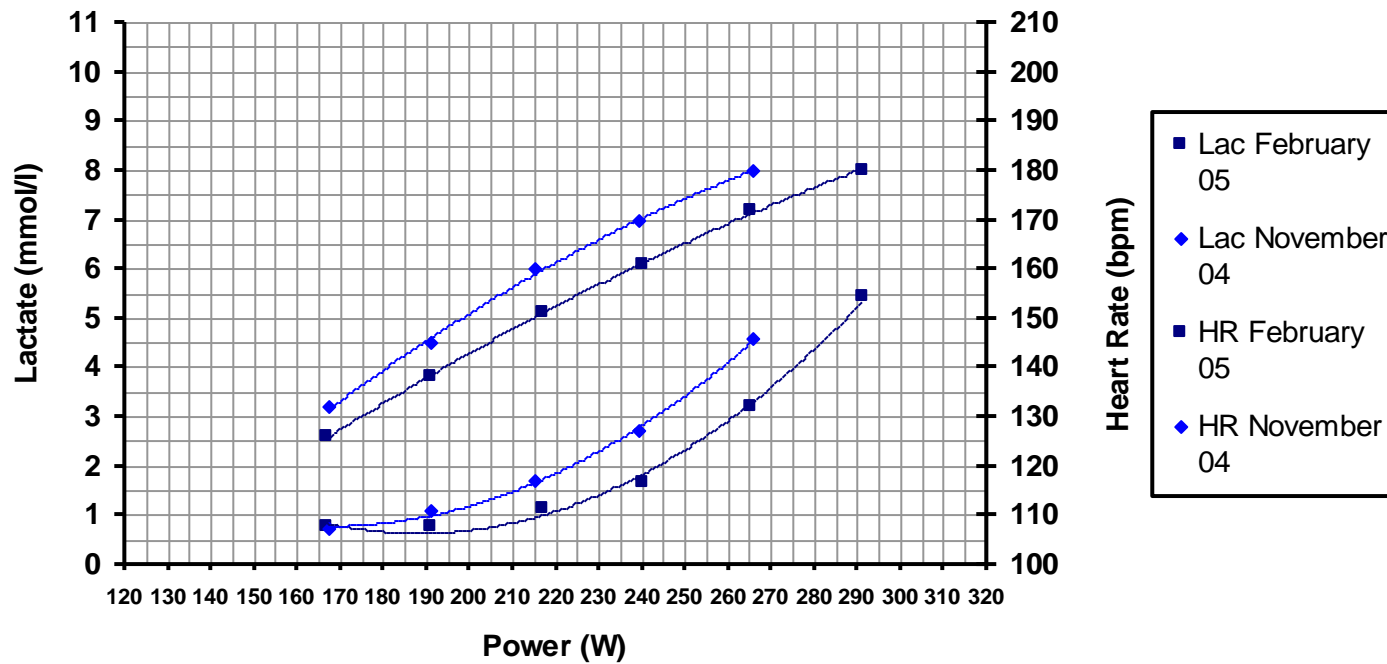


Monitoring Training

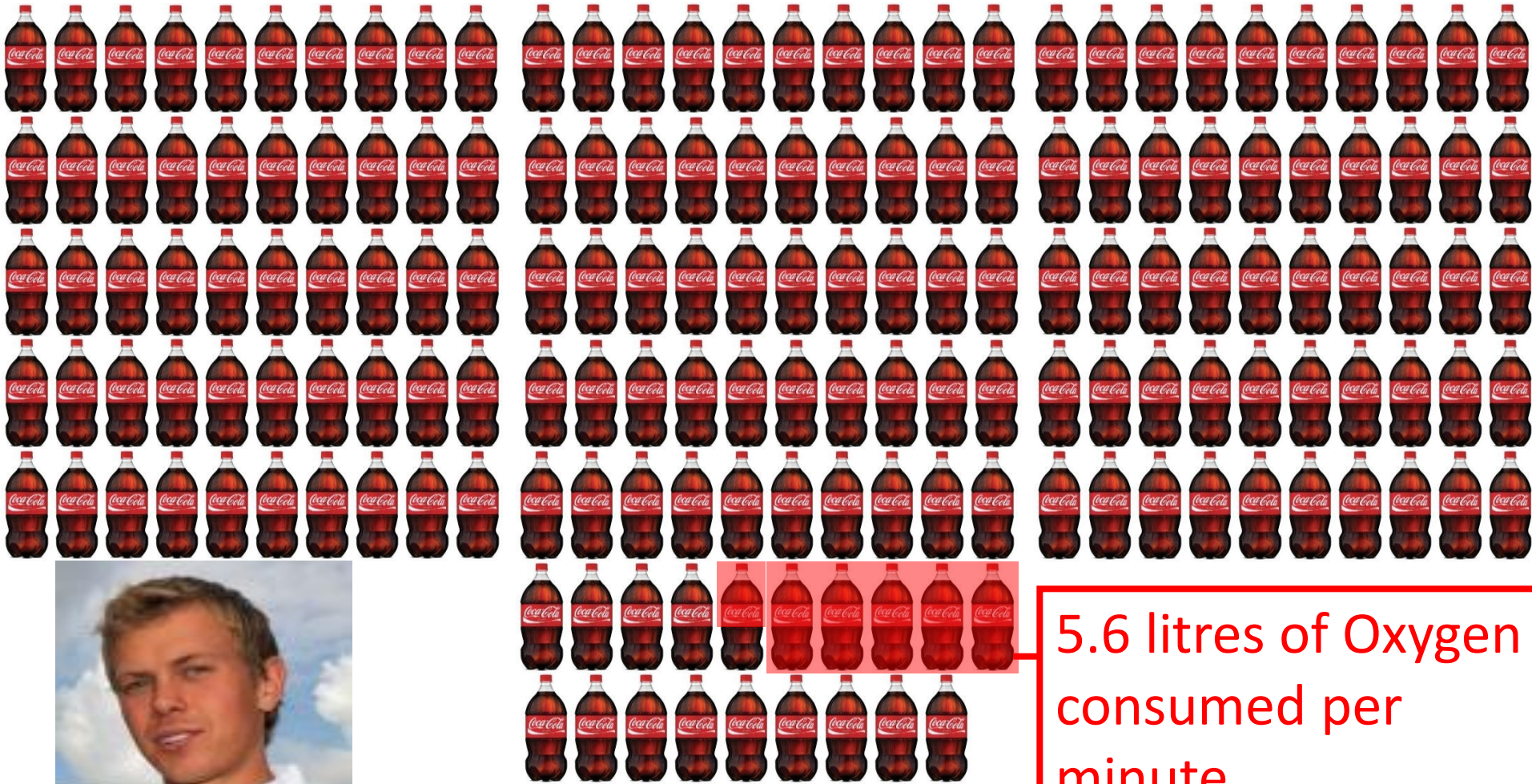


Monitoring Training

Incremental Step Test



Results: V_{O2}max



5.6 litres of Oxygen consumed per minute

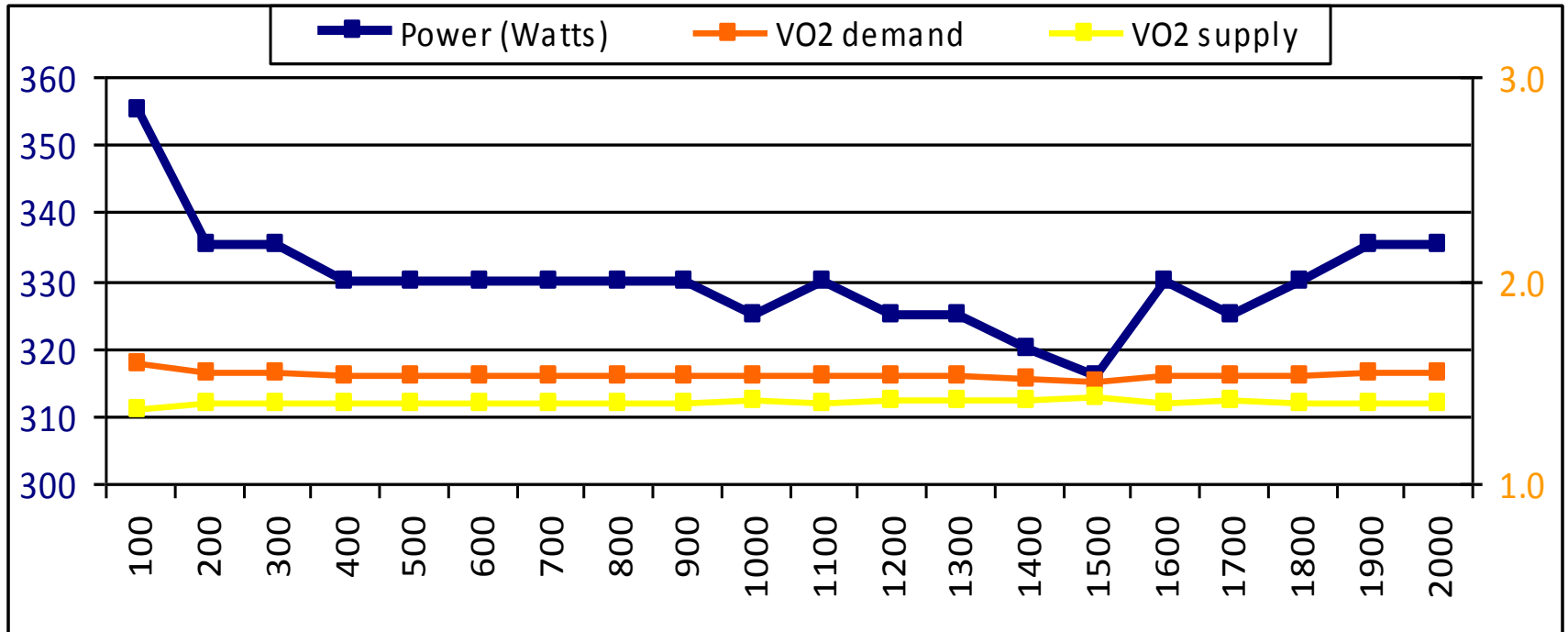
169 litres of air per minute



Ventilation v VO2 Max

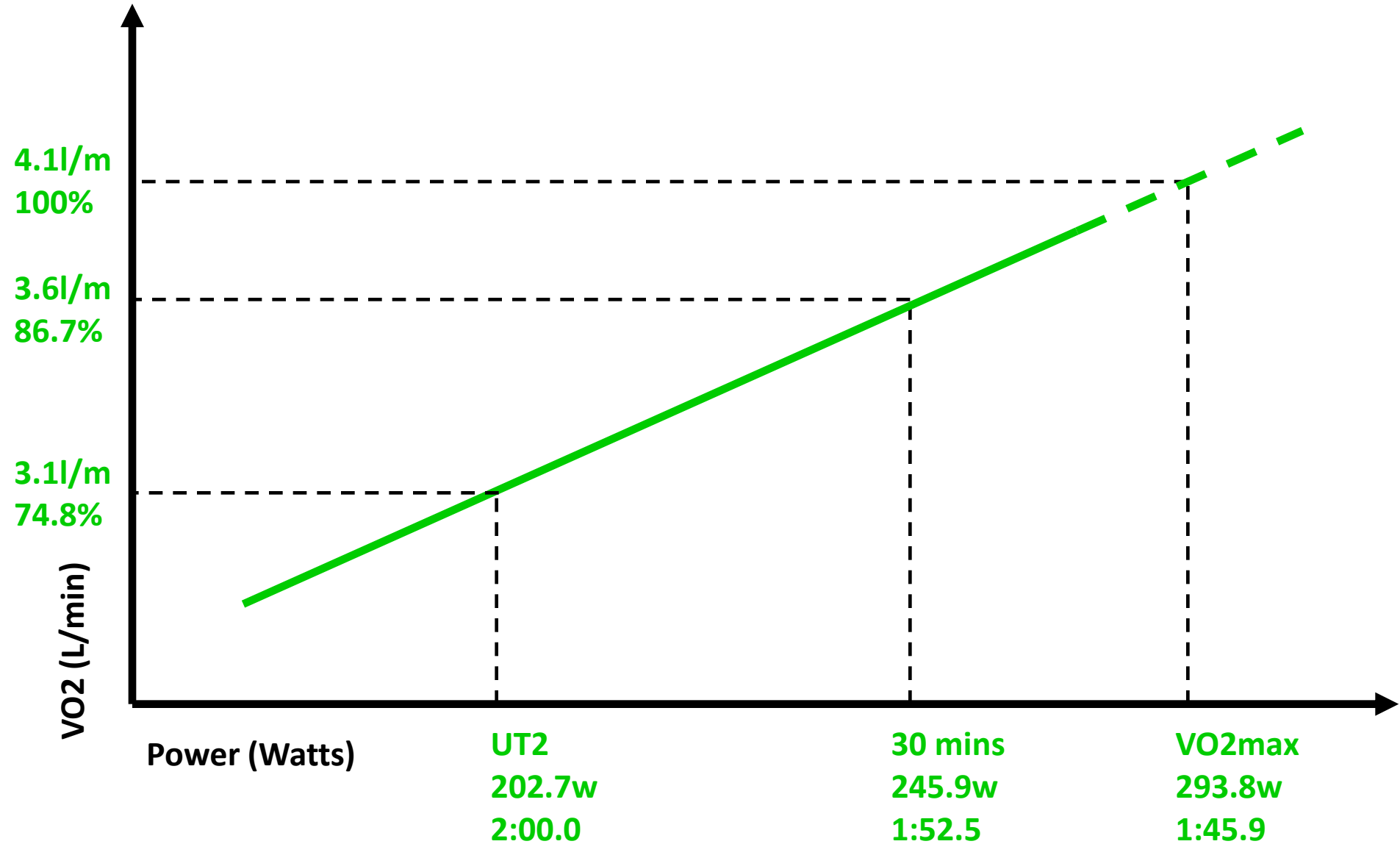
Lightweight Women	Women	Lightweight Men	Men
120 Litres/min	173 Litres/min	176 Litres/min	240 Litres/min
4.1 Litres	4.6 Litres	5.7 Litres	7 Litres

Relationship to Performance



- 100m splits
- 2km average = 330w
- 109.97% VO2max

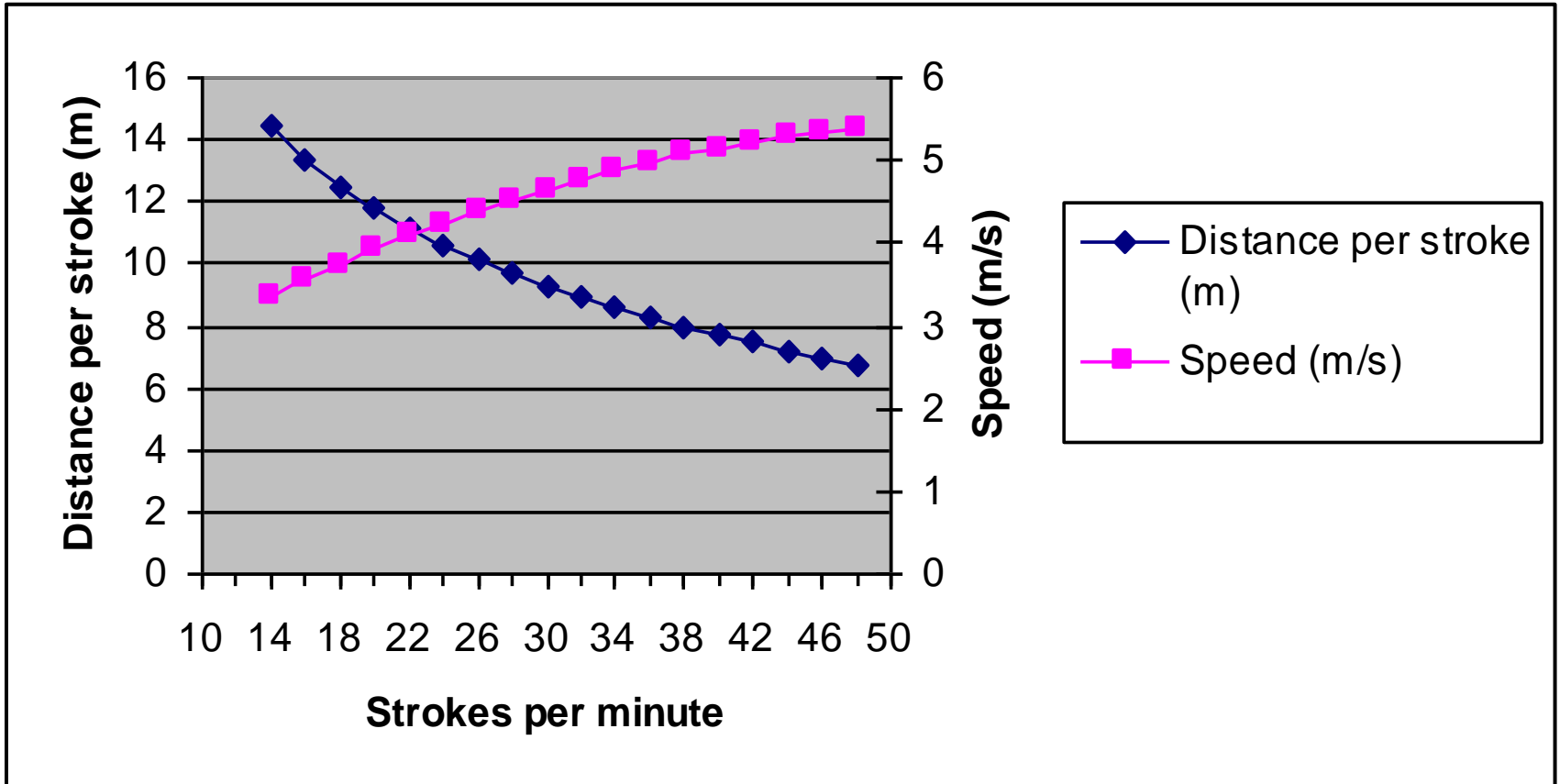
Relationship to Training



Individual Differences

	UT2	AT	2km
A	66%	76%	105%
B	76%	89%	112%
Average	71%	83%	110%

Distance per stroke



Training principles for physiological development

- Endurance foundation
- Race specific not race intense
- Resistance training for general and functional strength
- Optimise cross training
- Promote injury prevention

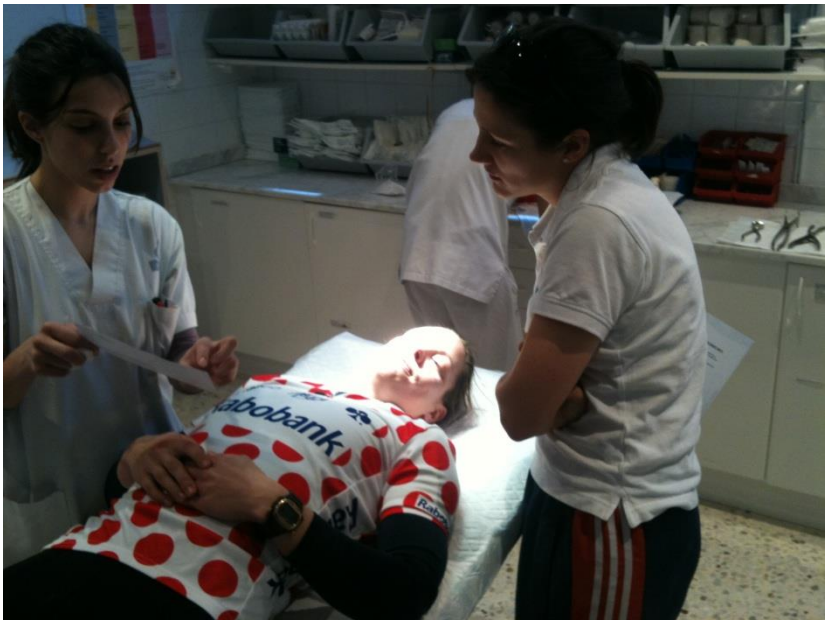
- On Water Training 175 – 200km/Week
- Strength Training(incl. Weights) 3 Sessions
- Ergometer Training – 2-3 Sessions
- Aerobic X-Training – Cycling/Running/X Country Skiing/Weights/Swimming



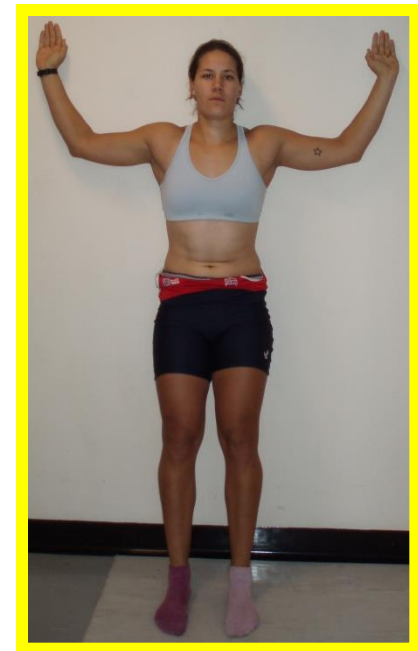


- 20 - 24 Hours per week training
- 1056 Hours training per year
- 4224 Hours per Olympiad
- 4-8 years until required level





Screening



Screening



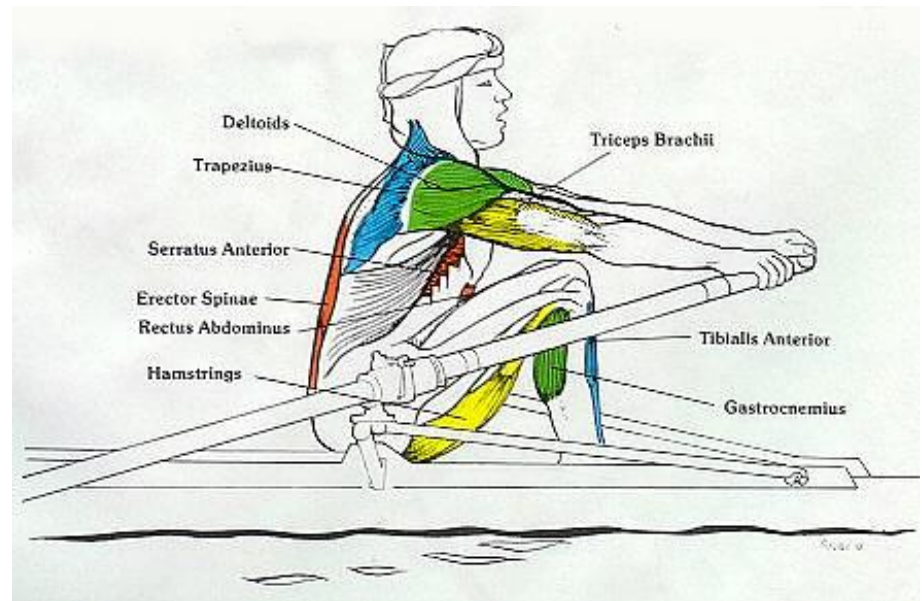
Cardiac Screening



- Cry
- Initial Screening
 - Cardiologist
 - History
 - Echocardiogram
 - ECG
- Annual follow up
 - History
 - ECG

Technical and Physical Development

- Flexibility – Hamstrings /Hip Flexors/Lats
- Glutes/Quads
- Lower Abs
- Trunk
- Shoulder complex



Functional Flexibility

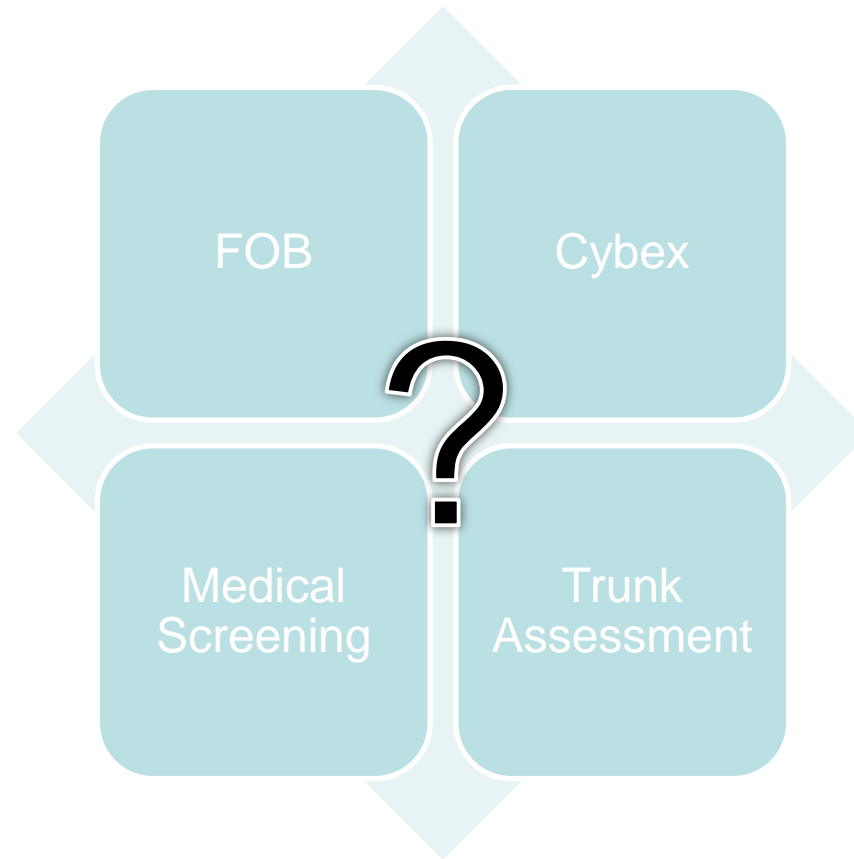


Lumbo Pelvic Position - Basic Posture



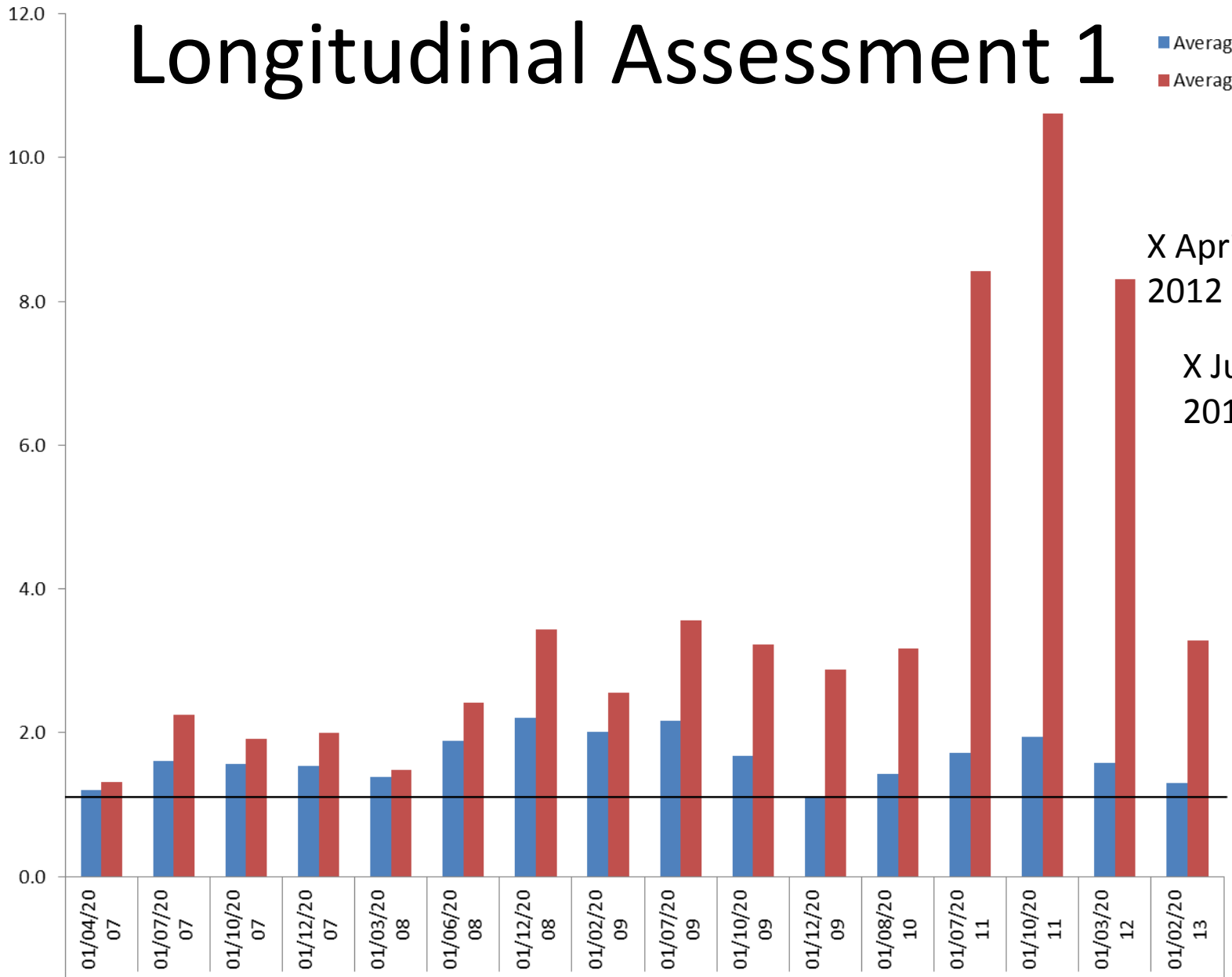
MRI Reproduced by Kind permission Dr Alison McGregor, Imperial College

Injury Predictors

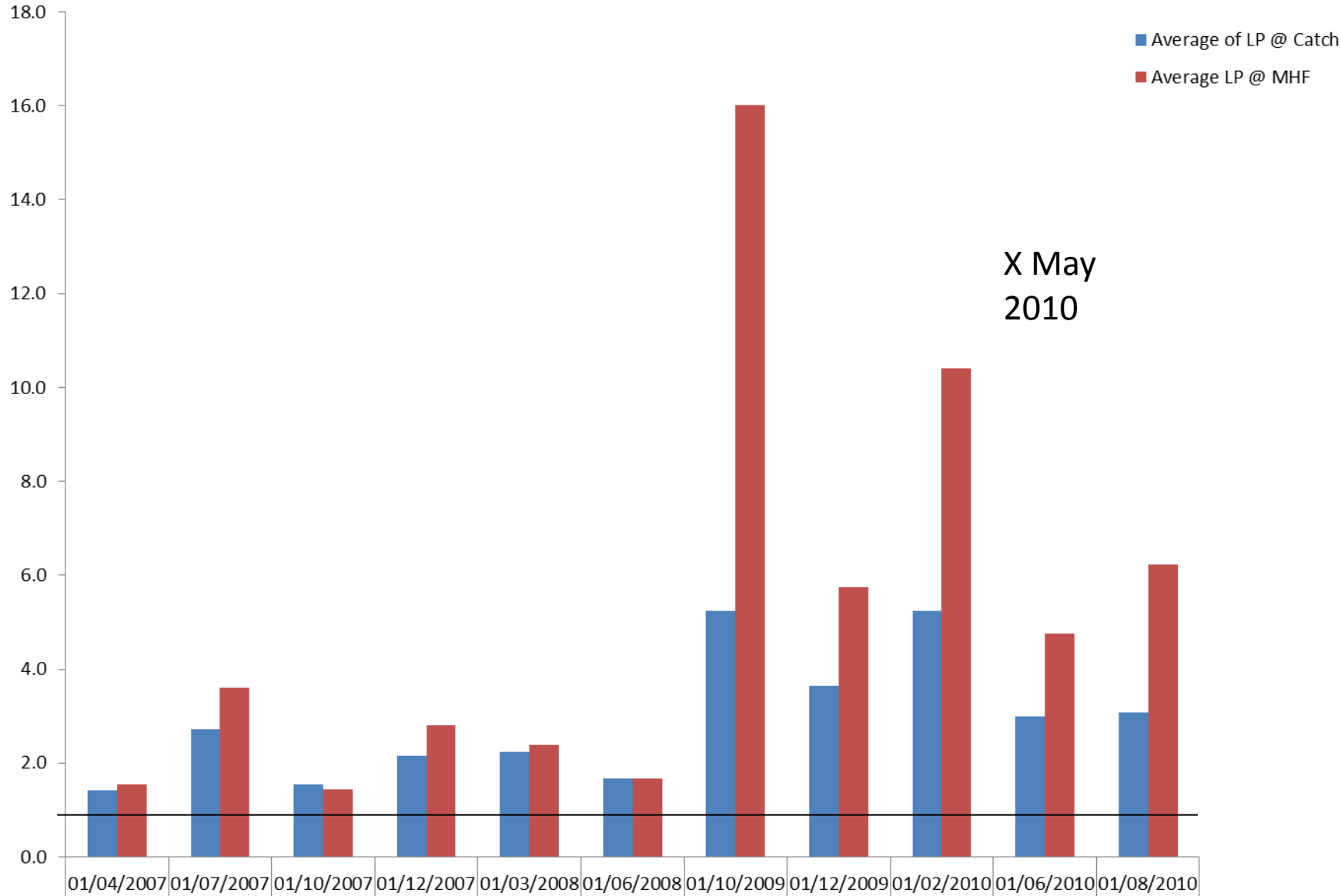


Longitudinal Assessment 1

Average of LP @ Catch
Average LP @ MHF

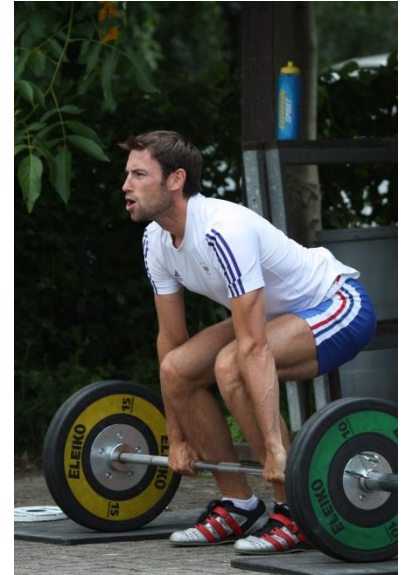


Longitudinal Assessment 2



Resistance Training

- Technique – supports rowing tech
 - Position
 - Acceleration
- General development - balance
- Strength/robustness to tolerate programme



Robust enough to do the programme



	% of Back Squat
Back Squat	100%
Power Clean	75-80%
Front Squat	85-90%
Deadlift	110-115%
RDL	100%
Good morning	65-70%
Step Up	70% +
Split Squat	80% +
Bench Pull	65-70%
Bench Press	65-70%
Seated Row	65-70%
Single Arm Row	25-30%
Bentover Row	50-55%
Dumbbell Bench Press	25-30%
Chin Ups (BW + load)	75-80%

Strength and weights testing

- Flexion/Extension
- Load
- Acceleration
- Screening



Health v Training 2006

2006

Breisach

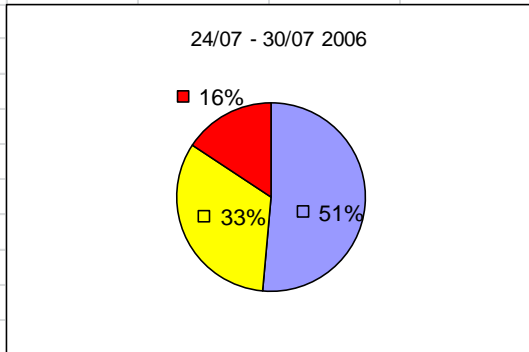


Figure 1. Training Adherence Week 1 2006

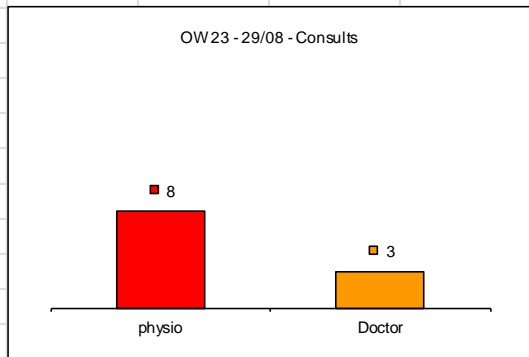


Figure 4. Consultations Week 1 2006

Breisach

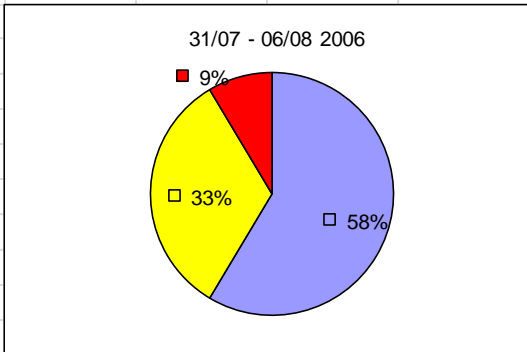


Figure 1. Training Adherence Week 2 2006

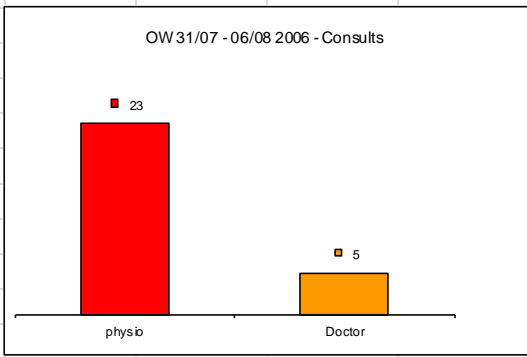


Figure 5. Consultations Week 2 2006

Varese

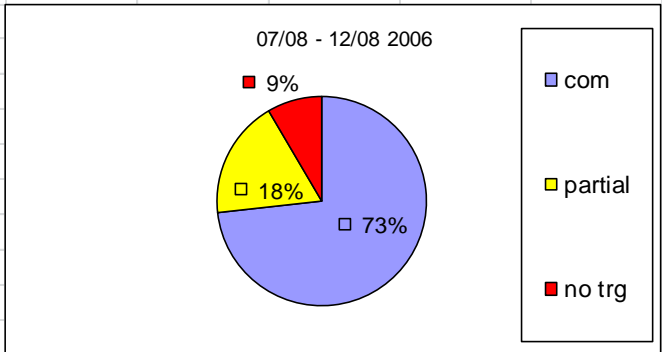


Figure 1. Training Adherence Week 3 2006

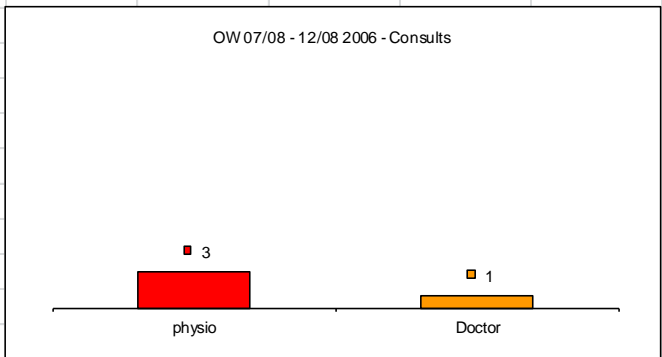


Figure 6. Consultations Week 3 2006

Health V Training 2007

2007

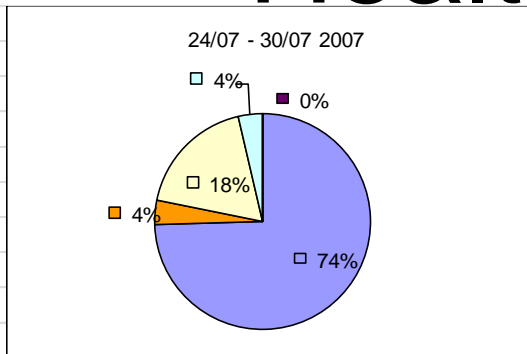


Figure 7. Training Adherence week 1 2007

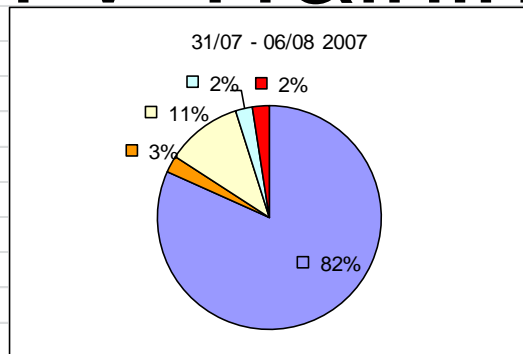


Figure 8. Training Adherence week 2 2007

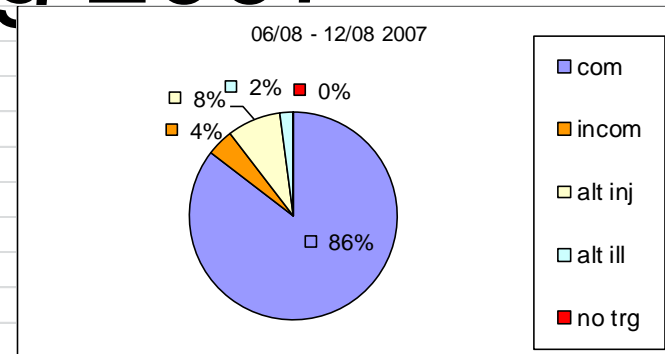


Figure 9. Training Adherence week 3 2007

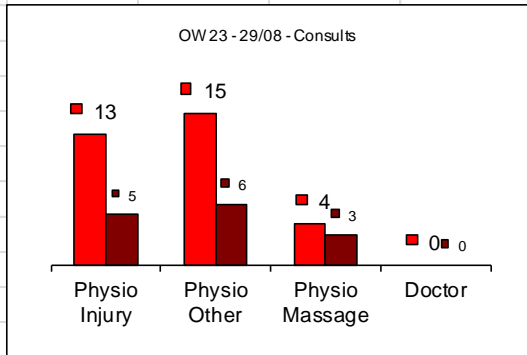


Figure 10. Consultations Week 1 2007

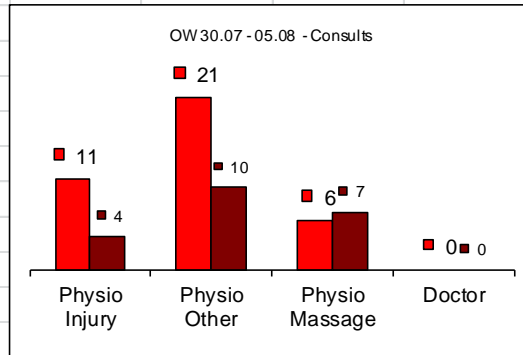


Figure 11. Consultations Week 2 2007

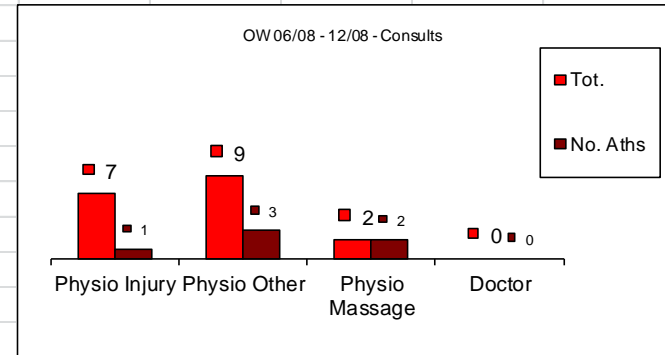


Figure 12. Consultations Week 3 2007

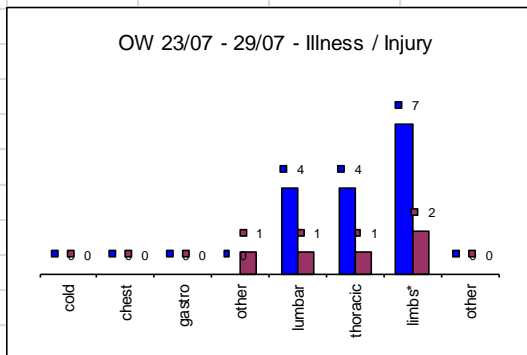


Figure 13. Type of injury / Illness Week 1 2007

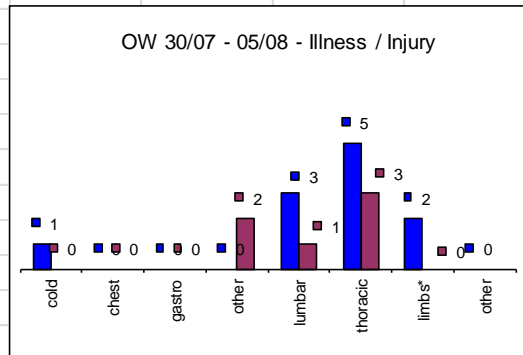


Figure 14. Type of injury / Illness Week 2 2007

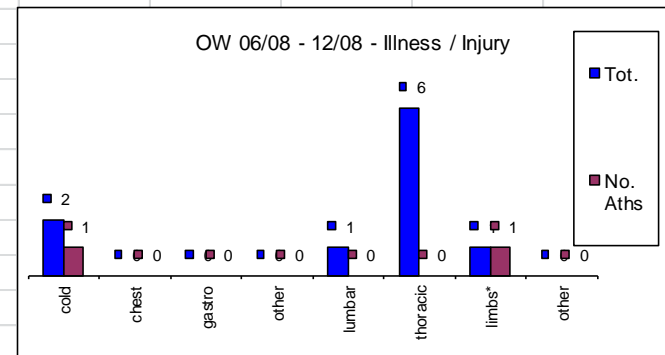
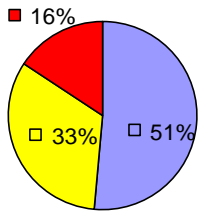


Figure 15. Type of injury / Illness Week 3 2007

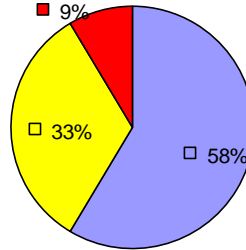
2006 v 2007

Breisach

24/07 - 30/07 2006

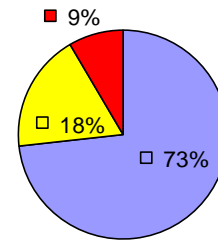


31/07 - 06/08 2006

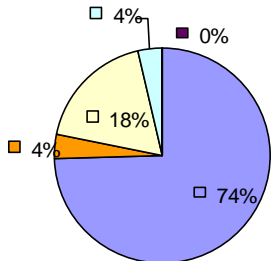


Varese

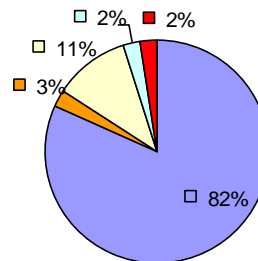
07/08 - 12/08 2006



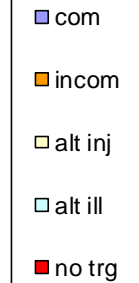
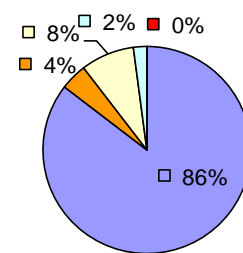
24/07 - 30/07 2007



31/07 - 06/08 2007



06/08 - 12/08 2007



Lightweights

- Lean muscle mass
- Homeostasis
- Hydration
- Carbohydrate
- Catabolic states and tapering



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