Chris Froome
Body Composition & Aerobic Physiology Report

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Introduction & Glossary

GSK HUMAN PERFORMANCE LAB

On Monday 17th August, the GSK Human Performance Lab welcomed two-time Tour de France Champion, Chris Froome, for a series of physiological and body composition assessments.

These assessments provided rich data, which would aid and inform Chris's preparation for Rio 2016 by providing a baseline from which progression and improvement can be measured. It also serves to quantify the integral components of Chris's physiology that make him an exceptional endurance athlete.

As requested by Froome himself, we are now providing full visibility of the report our scientists delivered to him. The report can be seen below.

For reference and guidance when interpreting the report, please see key scientific definitions and descriptions below:

Submaximal and Maximal Aerobic Profile – When conducting an aerobic profile test, there are two aspects to investigate: firstly, submaximal performance, which assesses the physiological responses to cycling intensities that are below a cyclist's maximal capacity. Typically, this requires cyclists to cycle at a range of intensities that are below and above predicted lactate threshold intensity. Secondly, maximal aerobic profiling assesses the physiological responses at the highest possible intensity a cyclist can maintain.

Lactate Concentration – Lactate concentration is the amount of lactate measured in a blood sample per standard volume of blood.

Lactate & HR vs. Power Graph – The graph provided is used to visualise the relationship between increases in intensity (x-axis), blood lactate accumulation (left y-axis) and heart rate (right y-axis). Blood lactate is assessed via a capillary blood sample taken from the earlobe during the final 30 seconds of each 4 minute stage, whilst heart rate is collected throughout using wireless heart rate telemetry. The data that creates this graph is used to determine a number of lactate and heart rate landmarks.

Lactate & HR Landmarks – A number of landmarks are presented which are used to predict the power at lactate thresholds and associated heart rates. Briefly, lactate threshold is the intensity at which lactate production exceeds the rate of removal. Above this intensity, lactate begins to accumulate and is implicated in the onset of fatigue. Other landmarks reflect different lactate production and removal dynamics and are often used to determine physiological capacity and to track training-induced adaptations.

Peak Oxygen Consumption ($\dot{V}O_2$peak) – This measure indicates the peak amount of oxygen an individual can utilise during exercise. It is often used to indicate aerobic fitness level, however it should be noted that $\dot{V}O_2$peak alone is rarely sufficient to determine or predict performance.

Peak Power Output (PPO) – In respect of cycle testing, peak power output is the final maintained power (30 second average) that a cyclist produces in the final stages of a maximal ramp test. A ramp test requires cyclists to cycle continuously against an ever increasing resistance, the rate of which is determined prior to the test.

Relative Peak Power Output (Relative PPO) – Relative peak power is the Peak Power Output expressed in respect of a cyclist's body mass (i.e. two cyclists with the same PPO, but different body mass would have different Relative PPO's).

Descriptive Details

Participant:
- Height: 185.7 cm
- Mass: 70.8 kg (Submaximal test); 69.9 kg (Maximal test)

Aerobic Physiology Laboratory conditions:
- Temperature: 19.5°C
- Humidity: 49.3% relative humidity
- Atmospheric Pressure: 762.2 mmHg

Aerobic Physiology Test timing:
- 2 hours post-prandial

Test Equipment:
- Cycle Ergometer: CompuTrainer™ (RacerMate® Inc, Seattle, USA)
- Cycle Ergometer Software: RacerMate® One (RacerMate® Inc, Seattle, USA)
- Expired Gas Analyser: Metalyzer 3B (Cortex, Leipzig, Germany)
- Expired Gas Analysis Software: MetaSoft® Studio (Cortex, Leipzig, Germany)
- Blood Lactate Analyser: Biosen C-Line (EKF-diagnostics GmbH, Barleben, Germany)

Body Composition

- **Test conducted following overnight fast (> 8 hours).**

1. Body mass and height measurement
2. Dual X-ray absorptiometry scan performed (GE Lunar iDXA , Amersham, UK)

Results			
Total Body Fat (% of mass)	**Total Body Fat (kg)**	**Total Lean Mass (kg)**	**Bone Mineral Content (kg)**
9.8	6.7	61.5	2.8

Submaximal Aerobic Profile - Protocol

1. Body mass and height measurement
2. Resting capillary blood sample (baseline lactate)
3. 10 minute self selected cycling warm-up on CompuTrainer™
4. Calibration of CompuTrainer™
5. Completion of 8 x 4 minute stages on CompuTrainer™ (Power Schedule – See Table 1)
6. Lactate & RPE (Borg, 1970) collected in final 30 seconds of stage
7. Expired gas & HR collected throughout
8. Data averaged over 30 second intervals

Submaximal Aerobic Profile

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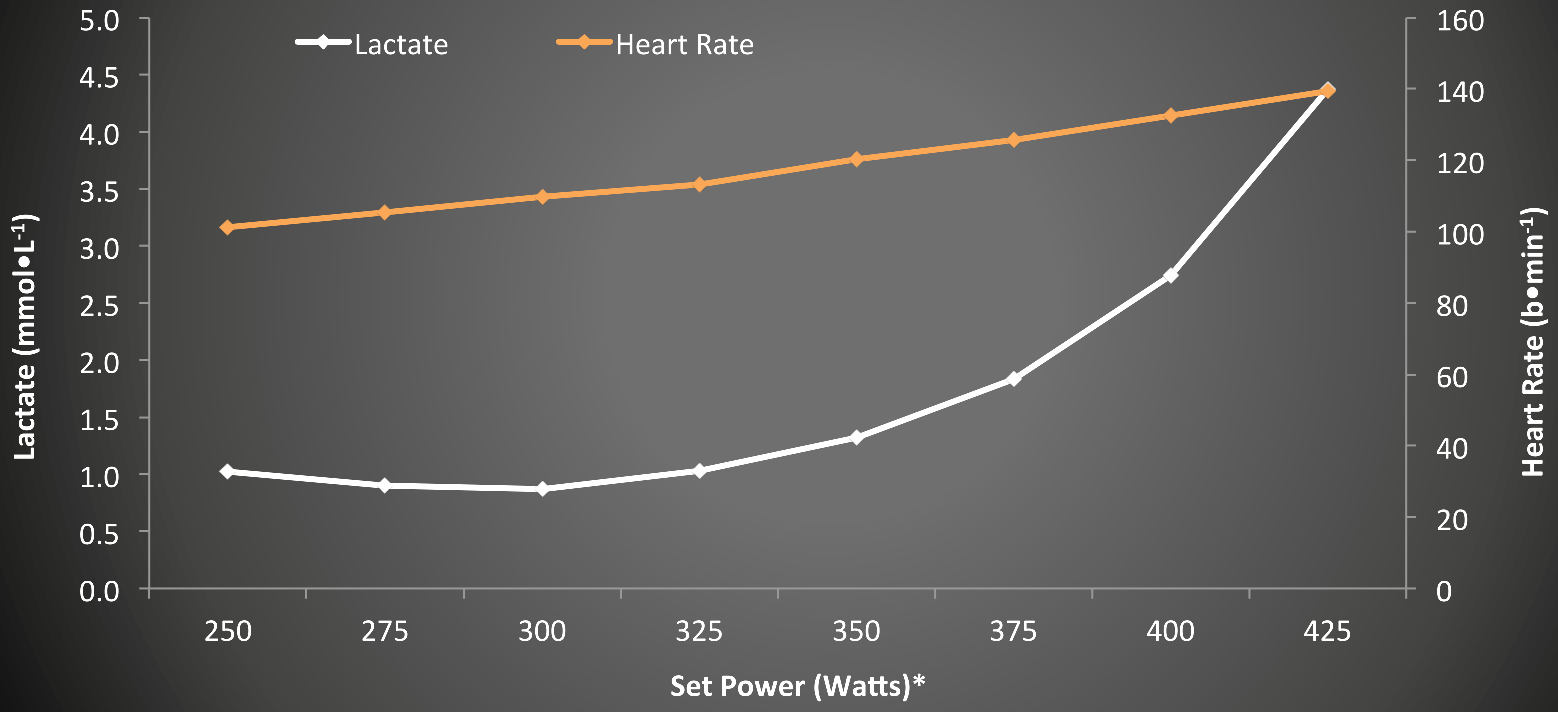
Table 1: Submaximal Aerobic Profile Schedule, Recorded Power, Lactate and RPE

Stage	Stage Time (Minutes)	Cumulative Time (Minutes)	CompuTrainer™ Set Power (Watts)	Recorded Stage Power (Watts)	Lactate ($mmol \bullet L^{-1}$)	Rating of Perceived Exertion (6-20 scale*)
1	0-4	4	250	250.6	1.02	8
2	4-8	8	275	272.7	0.90	10
3	8-12	12	300	299.0	0.87	11
4	12-16	16	325	323.8	1.03	13
5	16-20	20	350	348.1	1.32	14
6	20-24	24	375	374.9	1.83	15
7	24-28	28	400	399.3	2.74	16
8	28-32	32	425	423.6	4.37	17

*Borg, G. (1970) Perceived exertion as an indicator of somatic stress. *Scand J Rehabil Med, 2*(2), 92-98

Lactate & HR vs. Power



*Set power on CompuTrainer™. Actual collected power data 0.3 ± 0.3% (mean ± SD) error per stage (Table 1)

Lactate & HR Landmarks

Lactate Landmark	Power (Watts)	Watts•kg^{-1} @ 70.8	Watts•kg^{-1} @ 67 kg*	Heart Rate (b•min^{-1})	Lactate (mmol•L^{-1})
Baseline (Resting)	N/A	N/A	N/A	N/A	1.09
1 mmol•L^{-1} above baseline	381.8†	5.4	5.7	128	2.09
DMAX$ (Cheng et al, 1992)	355.7	5.0	5.3	121	1.36
Modified DMAX$ (Bishop et al, 1998)	385.2	5.4	5.8	129	2.22
Fixed Blood Lactate (2 mmol•L^{-1})	379.3†	5.4	5.7	127	2.00
Fixed Blood Lactate (4 mmol•L^{-1})	419.0†	5.9	6.3	138	4.00

*Predicted value - assumes maintenance of power performance at lower race body mass

†Derived using 3rd Order Polynomial (Lactate vs. Recorded Power)

$Calculated using Lactate-E software (Newell et al, 2007)

Maximal Aerobic Profile - Protocol

- **Test conducted 15 minutes following the submaximal test.**

1. Body mass measurement
2. 10 minute self selected cycling warm-up on CompuTrainer™
3. Calibration of CompuTrainer™
4. Completion of ramp test on CompuTrainer™ (30 W•min^{-1}) starting at 150W
5. Expired gas & HR collected throughout
6. Test terminated when cadence < 70 RPM
7. Data averaged over 30 second intervals

Maximal Aerobic Profile – $\dot{V}O_2$peak

$\dot{V}O_2$peak[$]			Peak Power Output*	
Test Body Mass (69.9 kg)		Predicted Race Body Mass (67.0 kg)	Absolute	Relative
Absolute ($L \bullet min^{-1}$)	Relative ($mL \bullet kg^{-1} \bullet min^{-1}$)	Relative ($mL \bullet kg^{-1} \bullet min^{-1}$)	Watts (W)	Watts ($W \bullet kg^{-1}$)
5.9	84.6	88.2†	525.3	7.5

[$] Highest 30 second average prior to test termination (Lamberts et al, 2012)

†Assumes maintenance of absolute $\dot{V}O_2$peak at lower weight

*Highest 30 second average prior to cadence < 70 RPM (Lamberts et al, 2012)

Comparison vs. 2007 Results*

Measure	GSK Human Performance Lab (17/08/15)	Swiss Olympic Medical Centre* (25/07/07)
Body Mass (kg)	70.8 (pre-submax), 69.9 (pre-max)	75.6
Total Body Fat (kg)	6.7	12.8
Total Body Fat (% of mass)	9.8	16.9
$\dot{V}O_2$peak ($L \bullet min^{-1}$)	5.91	6.07
$\dot{V}O_2$peak ($mL \bullet kg^{-1} \bullet min^{-1}$)	84.6	80.2
Peak Power Output (W)	525.3	540.0
Relative Peak Power Output ($W \bullet kg^{-1}$)	7.5	7.1

Comparison of data collected from the GSK Human Performance Lab (2015) vs. that from Swiss Olympic Medical Centre (2007) suggests a similar absolute aerobic capacity ($\dot{V}O_2$peak). The significant improvement in aerobic capacity relative to body mass, is therefore due to a reduction in body mass. Importantly, the change in body mass is attributed to a large loss in body fat (~6kg), with a similar lean body mass recorded.

*Results taken from original report from Swiss Olympic Medical Centre in July 2007. No protocol or test equipment information provided in report, therefore direct comparisons should be interpreted with a degree of caution.

Method References

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