Subject name: **John Doe**

Test: **CPET**

Protocol: **50 30 3 Step**

Devices: Lode **Brachumeral/Corival/Excalibur/Cortex Metalyzer**

Name of the test facilitator: **Leutrim Mehmeti**

Fakultät für Sport- und Gesundheitswissenschaften

Technische Universität München

TUM Campus im Olympiapark

PZ Gebäude
Connollystraße 32
D-80809 München

Intro

Cardiopulmonary exercise testing (CPET) is a maximal exercise test with concomitant gas exchange analysis that provides an integrative and comprehensive assessment of physiologic responses to exercise and cardiorespiratory fitness. The direct noninavasive determination of minute ventilation, heart rate and expired gases analysis (oxygen uptake and carbon dioxide output) at rest and during exercise provides accurate and reproducible data on the interaction of ventilation, gas exchange, and cardiovascular and musculoskeletal function, and enables determination of deviations from normal.

CPET objective with the subject in question

1. Assessing exercise capacity and estimating prognosis in various disease states (including chronic heart failure);
2. Early detection and risk stratification of cardiovascular, pulmonary vascular and lung diseases, and musculoskeletal disorders;
3. Guiding and monitoring individual physical training in rehabilitation (e.g., cardiac, pulmonary), and in preventive and sports medicine;

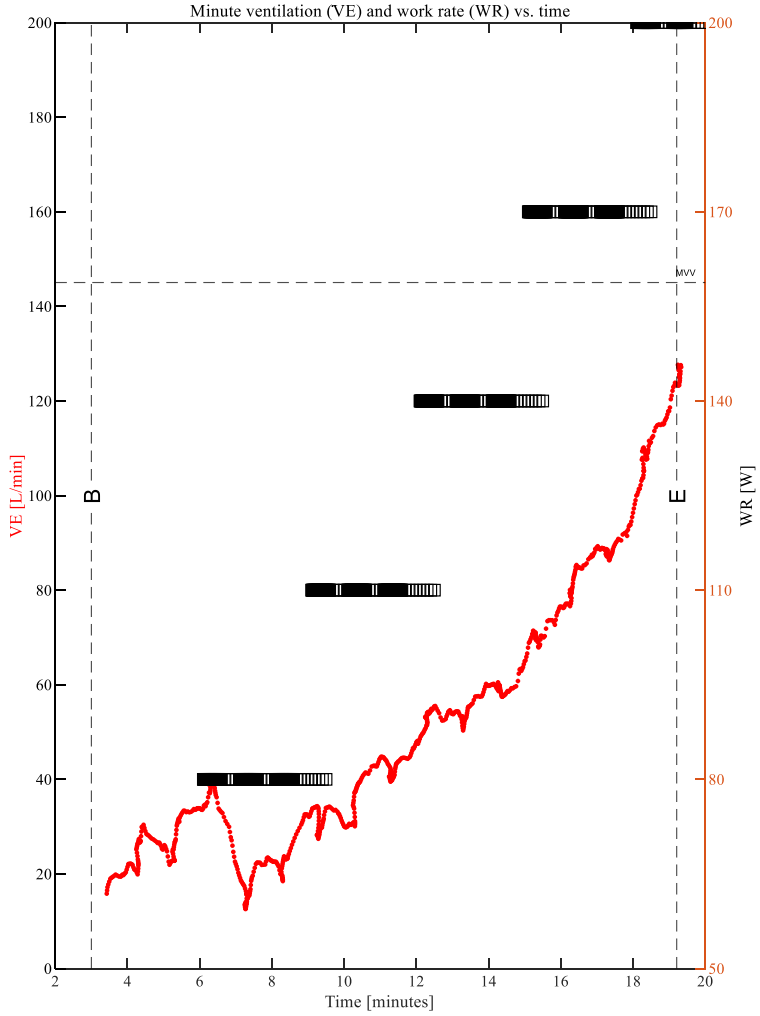
Plots

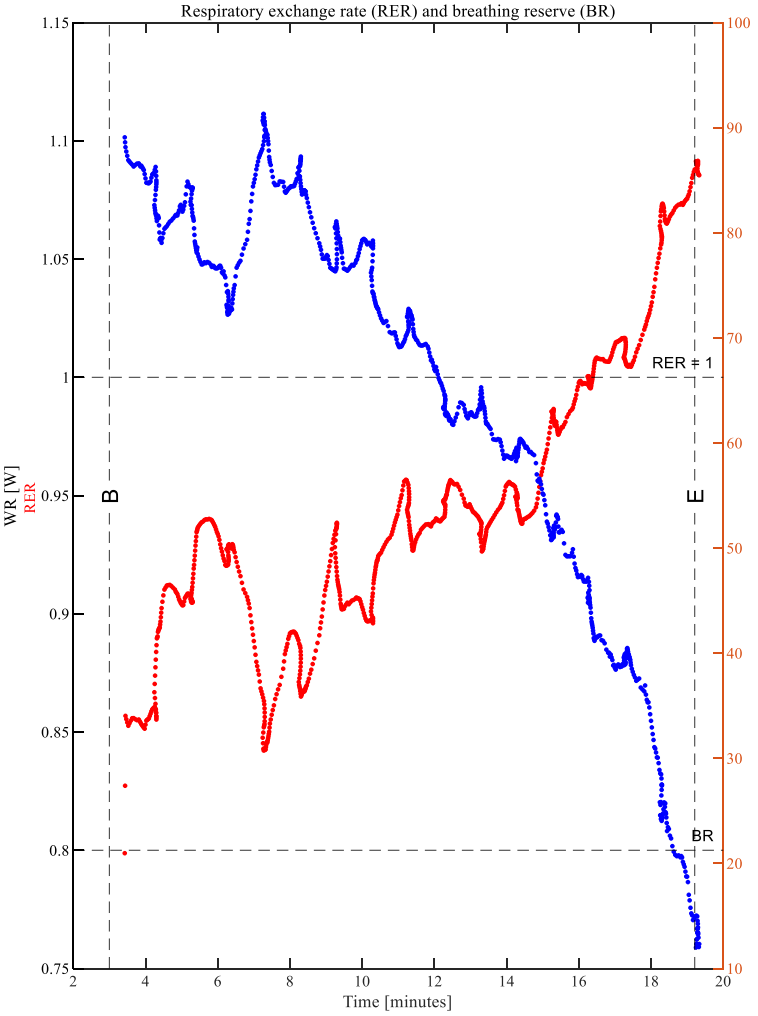
The analysis and interpretation of CPET results requires the basic knowledge of exercise physiology along with a structured approach. Regarding exercise capacity/performance, the maximum achieved exercise performance (VO_2 peak=highest oxygen uptake upon discontinuation of exercise) is more relevant than the maximum attainable exercise capacity (VO_2 max), which is the domain of sports medicine. Key variables and their interrelationships are systematically summarized in the 9-panel display also known as the Wasserman plots. The primary objective of the interpretation is to determine whether and to what extent there is impaired exercise capacity and what cause(s) of cardiovascular, pulmonary vascular or pulmonary origin may be primary.

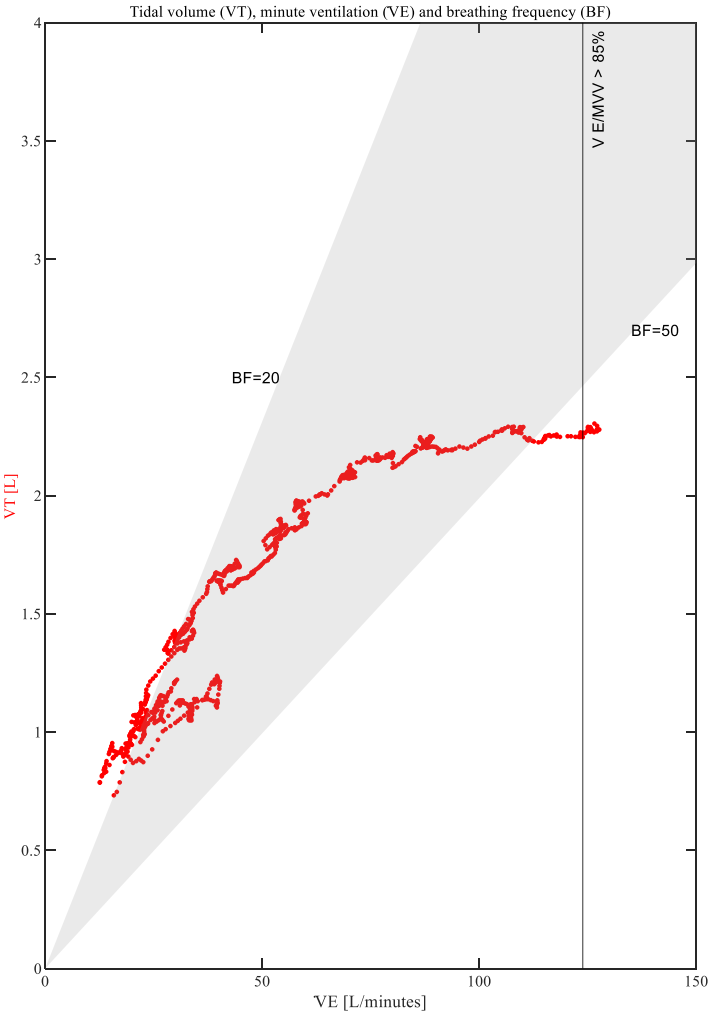
References:

[1] Glaab and Taube Respiratory Research (2022) 23:9 https://doi.org/10.1186/s12931-021-01895-6

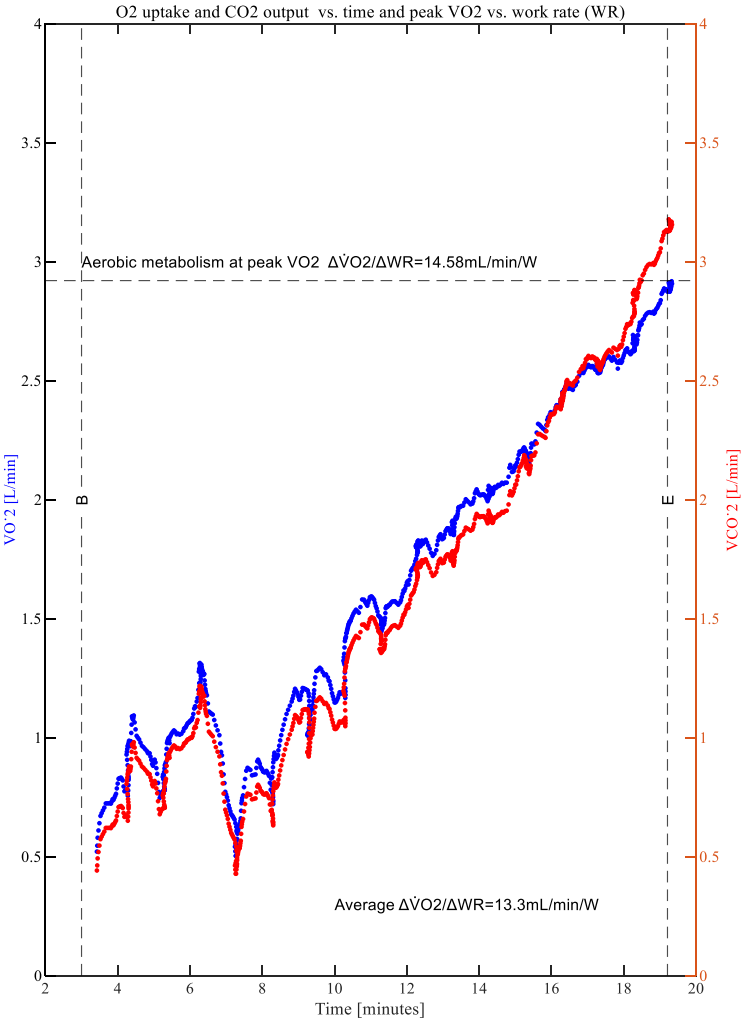
Ventilatory response panels

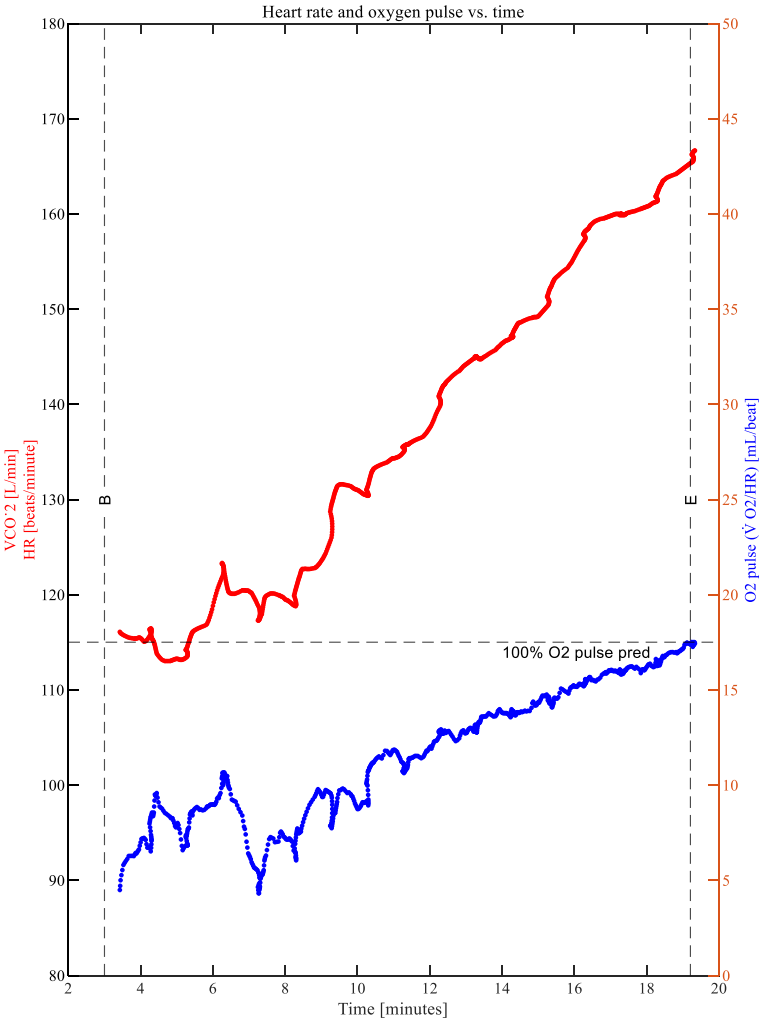


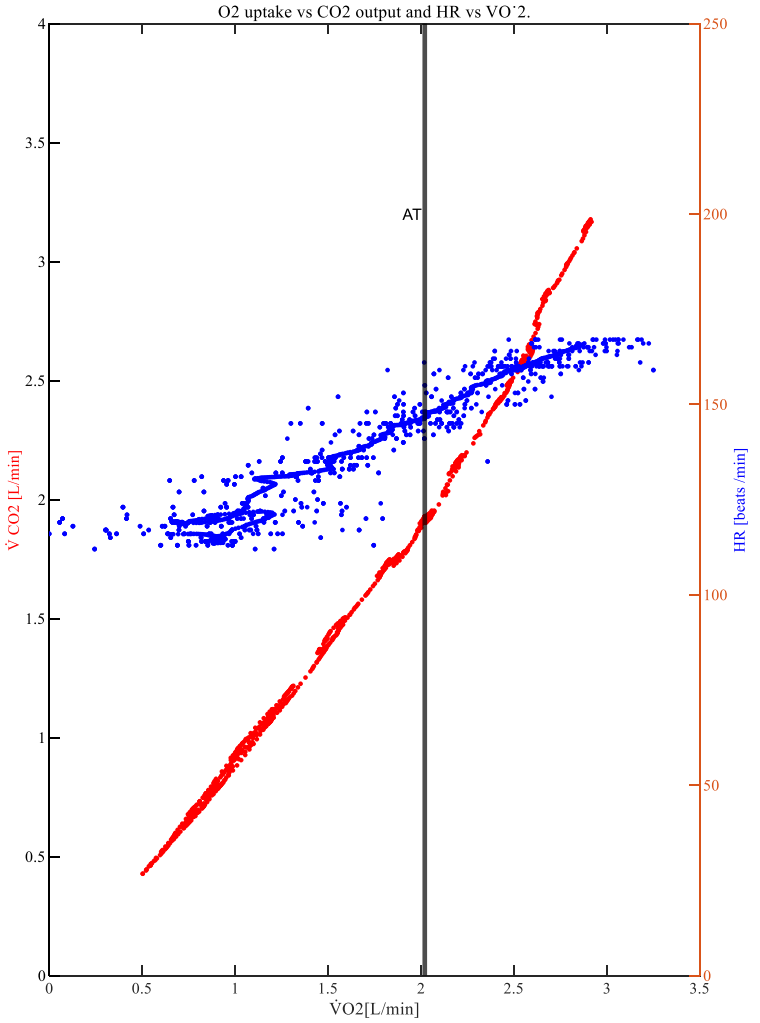




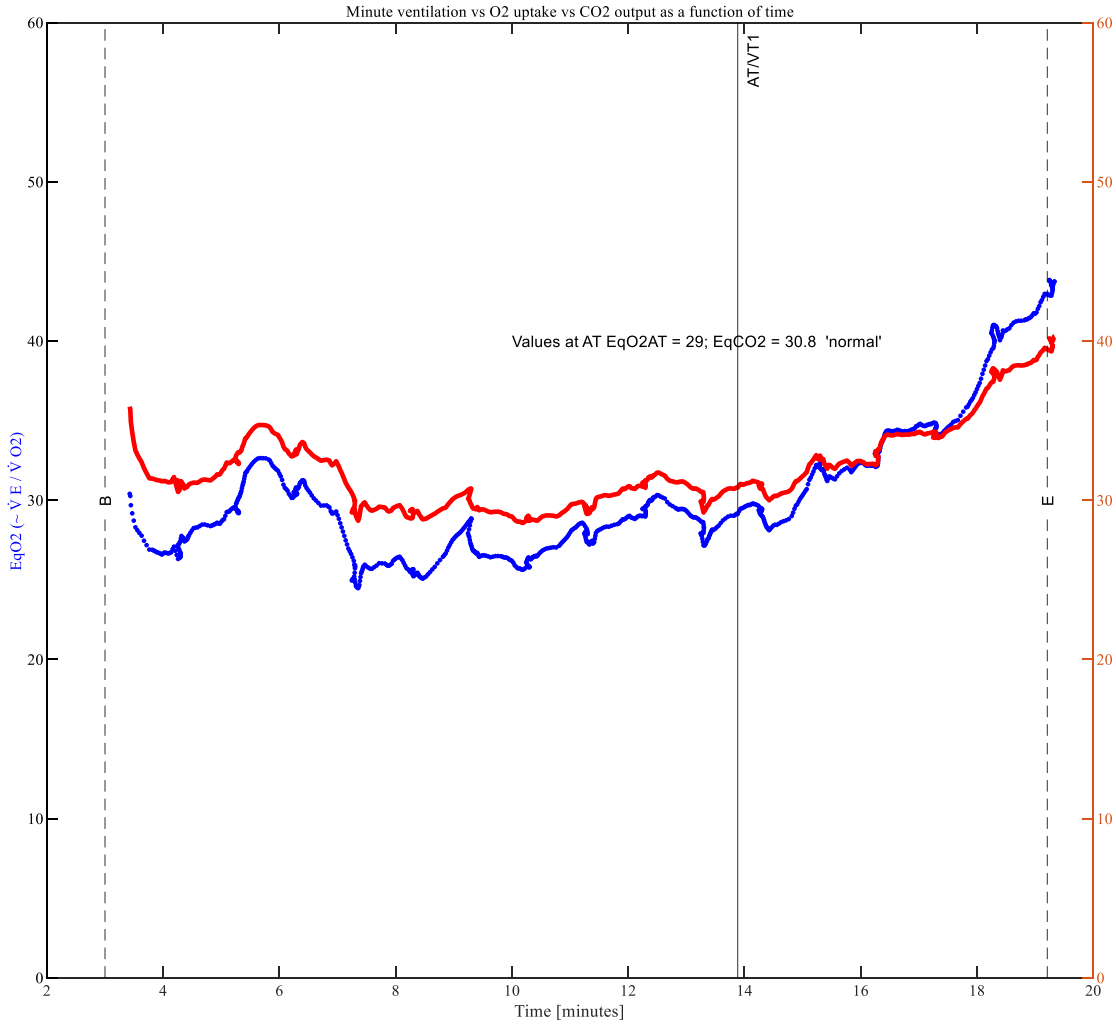
Cardiovascular panels

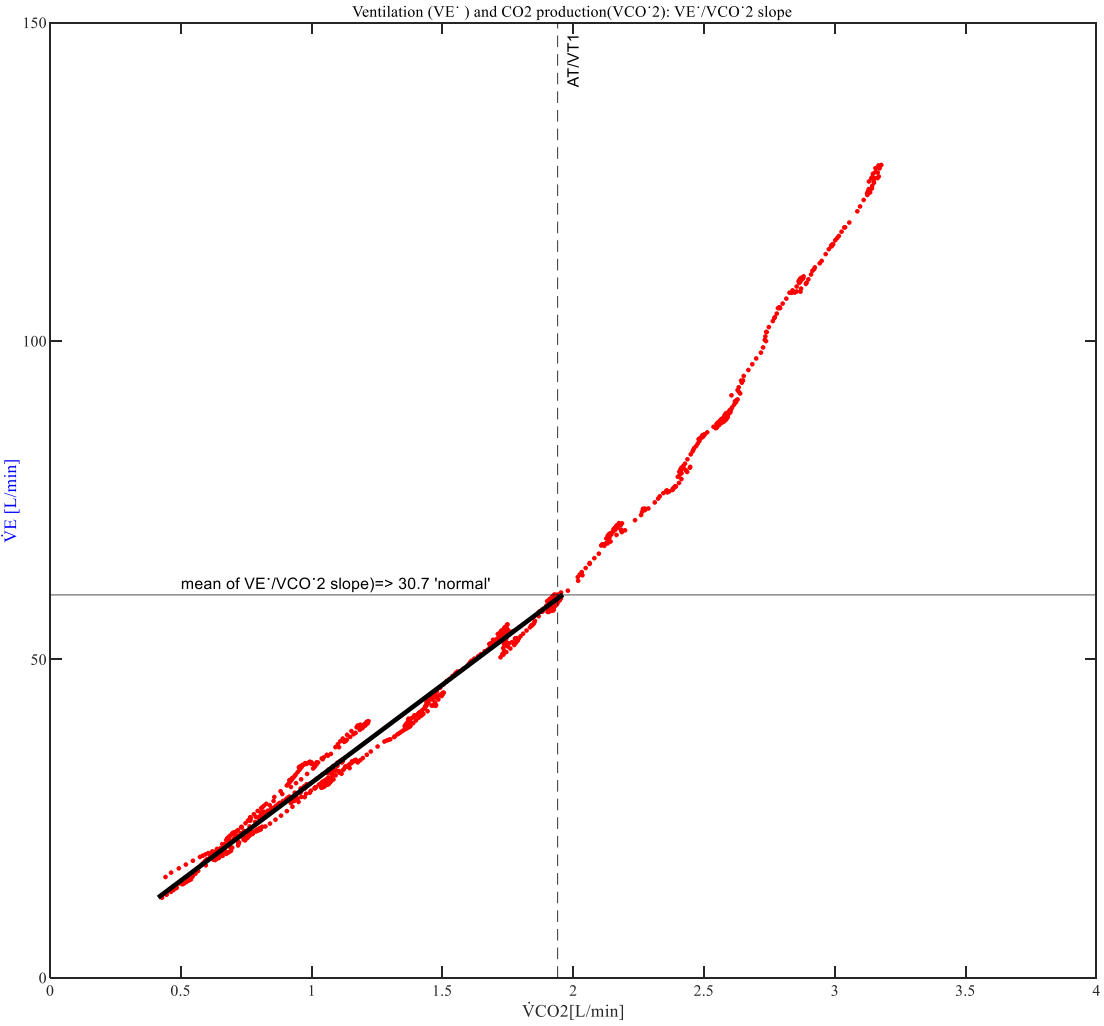


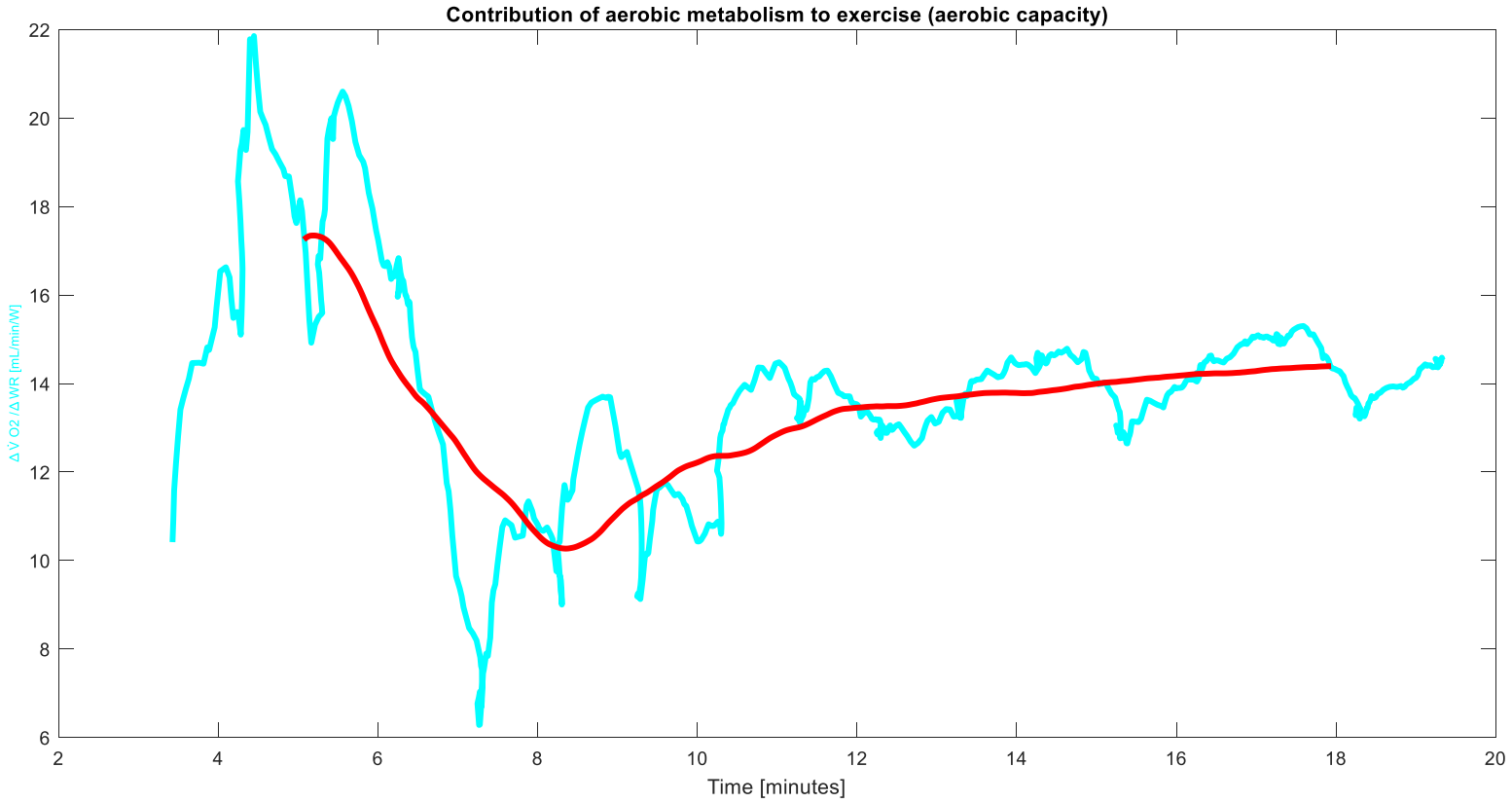




Pulmonary gas exchange panels







This is an extra plot created to show the contribution of aerobic metabolism to exercise. A low ratio indicates impaired O2 delivery and high anaerobic metabolism during exercise (e.g., peripheral artery, cardiovascular, pulmonary vascular and/or lung disease).

Target value: ≥9–10 mL/min/watt

Abnormal: ≤8 mL/min/watt

Actual: See graph above (cyan line – points averaged over 30 seconds; red line- points averaged over 90 seconds)

Variable	Unit	Rest	Unloaded Pedalling	Warm Up	VT1	VT1 % Norm	VT1 % Max	VT2	VT2 % Norm	VT2 % Max	V'O2peak	V'O2peak % Norm	Normal	Absolute Maximum Values
WR	**W**	-	-	50	131	88	66	156	104	78	200	133	150	200
V'O2	**L/min**	-	-	0.87	2.02	112	69	2.46	136	84	2.92	162	1.80	2.94
V'O2/kg	**ml/min/kg**	-	-	12	29	112	69	35	136	84	42	162	26	42
V'CO2	**L/min**	-	-	0.78	1.94	-	61	2.45	-	78	3.17	-	-	3.19
RER		-	-	0.90	0.95	-	88	1.00	-	92	1.08	-	-	1.09
Q'(est.V'O2max)	**L/min**	-	-	9.67	15.60	-	87	16.88	-	94	18.00	-	-	18.05
SV(est.V'O2max)	**ml**	-	-	84.0	106.3	-	98	106.6	-	99	108.0	-	-	108.8
HR	**/min**	-	-	115	147	81	88	158	87	95	167	92	181	167
V'O2/HR	**ml**	-	-	8	14	138	79	16	156	89	18	176	10	18
V'E/V'O2		-	-	26.0	27.6	-	67	31.5	-	76	41.2	-	-	41.5
V'E/V'CO2		-	-	29.0	29.0	-	76	31.5	-	83	37.9	-	-	38.1
V'E	**L/min**	-	-	25.4	59.9	68	47	81.9	93	65	126.8	144	88.0	128.5
VT	**L**	-	-	1.04	1.89	-	83	2.17	-	96	2.26	-	-	2.29
BF	**/min**	-	-	24	32	97	57	38	116	68	56	171	33	57
WR	**W**	-	-	50	131	88	66	156	104	78	200	133	150	200
FAT	**g/h**	-	-	9	9	-	-	0	-	-	0	-	-	14
CHO	**g/h**	-	-	42	125	-	59	178	-	84	213	-	-	215

Table 1. The main variables of interest are shown in this table.

Variable	Target value	Actual	Remarks
Peak VO˙ 2 (exercise capacity)	≥85% based on VO˙ 2 pred. or>20 mL O2/min/kg	42	See table 2 and CV panels (3)
VO˙ 2/WR (aerobic capacity)	≥9–10 mL/min/watt1	14.58	See CV panels (1)
VO˙ 2 at AT	≥40–80% pred. VO˙ (usually 50–65% of peak VO˙ 2)	2.02 @VT1 = 2.92 * (50-65%)= 1.46 - 1.89 L/min	AT/VT1 pushed to the right
O2 pulse (VO˙ 2/HR)2	≥80%	Checked - see graph	See CV panels (2)
Heart rate reserve (HRR)	≥85% pred. (<15 bpm)		
Breathing reserve (BR)	≥15–20% (or≥11–15 L/min)		See VR panels (3)
Breathing frequency (BF)	≤50/min	Over 50 at the end	See VR panels (3)
EqCO2 at AT	25–30 at AT,≤40 after AT	30.8	Normal - See PGE panels (1)
EqO2 at AT	20–30 at AT,≤40 after AT	29	Normal - See PGE panels (1)
VE˙ /VCO ˙ 2 slope	25–30 (slightly lower than EqCO2 at AT)	30.7	Normal - See PGE panels (2)
RER	≥1.05 (ill) or≥1.1 (healthy);>1.1–1.5 in recovery phase; at rest:>0.7,<1.0	>1.05	See VR panels (2)

Table 2. Suggested target values for key cardiopulmonary exercise testing variables