ROWING MECHANICALLY-PHYSIOLOGICAL CONSISTENCY PROFILING

5+4x4 Incremental Test

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1. TEST PROTOCOL & METHODOLOGY

The Protocol: The measurement is performed on a rowing ergometer and consists of five incremental stages (1x5 minutes followed by 4x4 minutes), separated by 1-minute rest intervals. Intensity increases progressively with each stage (A0, A1, A2, AP - aerobic lactate threshold, and AN1).

Data Acquisition: Prior to the test, body mass, height, arm span, resting HR, and baseline lactate are measured. During each stage, we record peak HR during the load, minimum HR before the next stage, 500m split time, distance, average power, and blood lactate.

Note: *The predictive validity of the test relies heavily on correctly calibrating the initial stage speed and strictly reducing the average 500m time by exactly three seconds per stage.*

Real-time blood lactate sampling during the 1-minute inter-stage recovery periods.

Cohort undergoing synchronized incremental testing on Concept2 ergometers.

2. COHORT FINDINGS

- **Performance Disparity:** Total distances spanned from 5579 m to 6441 m, revealing a significant gap between developmental athletes and the elite tier.
- **Physiological Benchmarks:** Athletes maintaining sub-2.0 mMol/L lactate beyond 300W significantly outperformed peers in total accumulated distance.

3. SUBJECT 01: DERIVED METRICS

CALCULATED THRESHOLDS

Metric	Lactate	Power	HR
Aerobic (AP)	2.9 mM	382.8 W	187.5 bpm

CATEGORY ELITE

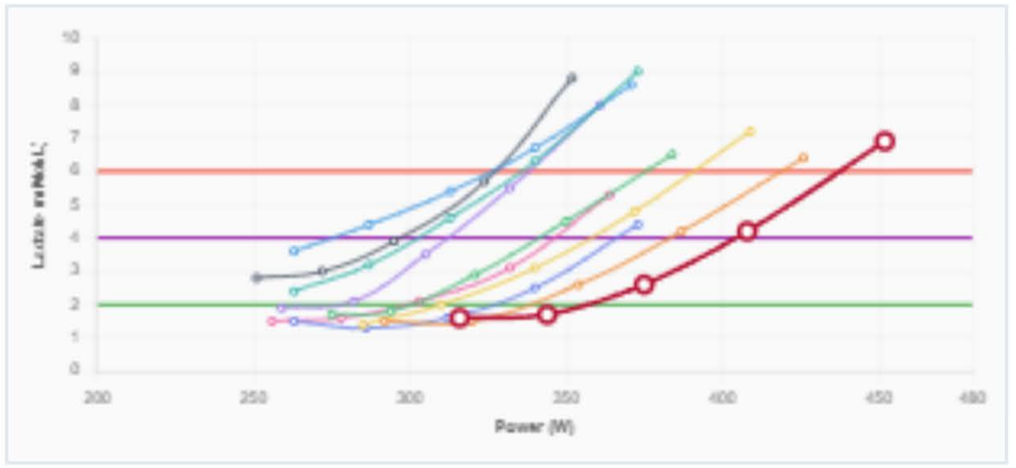
BMI NORM

4. SUBJECT 01: STAGE DATA

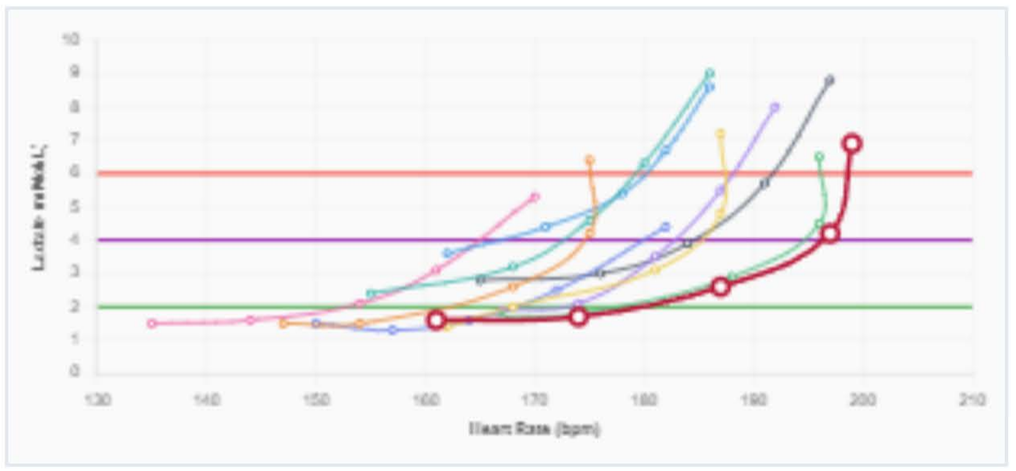
Subject 01 completed a total distance of **6441 meters** with an average power of **379 W** and an average 500m split of **1:37.6**, equating to a relative power of **3.93 W/kg** body weight.

Stage	Time *(min)*	HR Max *(bpm)*	Laktat *(mmol/l)*	Pace *(min:ss)*	Avg Pwr *(W)*	Dist *(m)*	Rel Pwr *(W/kg)*
1	5	161	1.6	1:43.4	316	1450.0	3.28
2	4	174	1.7	1:40.5	344	1193.0	3.57
3	4	187	2.6	1:37.7	375	1228.0	3.89
4	4	197	4.2	1:35.0	408	1263.0	4.23
5	4	199	6.9	1:31.8	452	1307.0	4.69

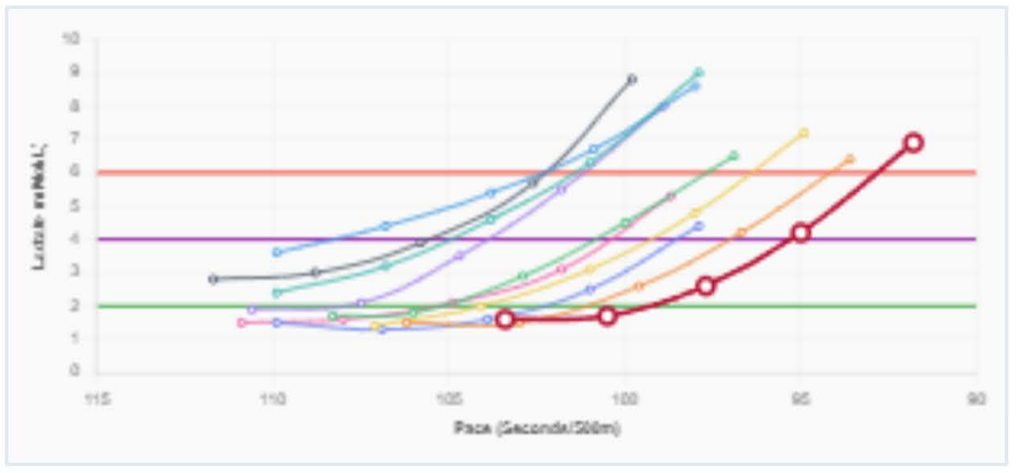
5. POWER (W) VS. LACTATE



6. HEART RATE (BPM) VS. LACTATE



7. PACE (SEC/500M) VS. LACTATE



Advanced 3D skeletal tracking for biomechanical efficiency analysis.

8. CONCLUSIONS

The **5+4x4** protocol proves to be a highly effective diagnostic tool for establishing physiological profiles in elite rowers.

By cross-referencing mechanical power output with physiological cost (blood lactate and cardiovascular response), we can accurately pinpoint the Aerobic Threshold (AP). Athletes like *Subject 01*, demonstrating massive power outputs (>380W) at sub-maximal lactate levels (<3.0 mMol/L), represent the elite standard for work capacity.

Furthermore, as illustrated by the 3D modeling, pairing these physiological metrics with **biomechanical tracking** provides a holistic view of the athlete. It enables coaches to identify whether an athlete's limitations are rooted in cardiovascular capacity or in the technical inefficiency of power application.

REFERENCES

1. Concept2 RowErg
2. EKF Diagnostics Biosen
3. Polar H10 Heart Rate Sensor
4. Concept2 Logbook

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