Predicting the Expenditure of Anaerobic Work Capacity (AWCexp) based on Changes to the Torque-Velocity Curve

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Background

- Some **cancer risks** can be reduced by physical activity, but assessment is often self-reported and imprecise.
- Must establish **individuals' objective, quantitative, and predictive measures** for non-invasive means of activity levels.

Proposed Model
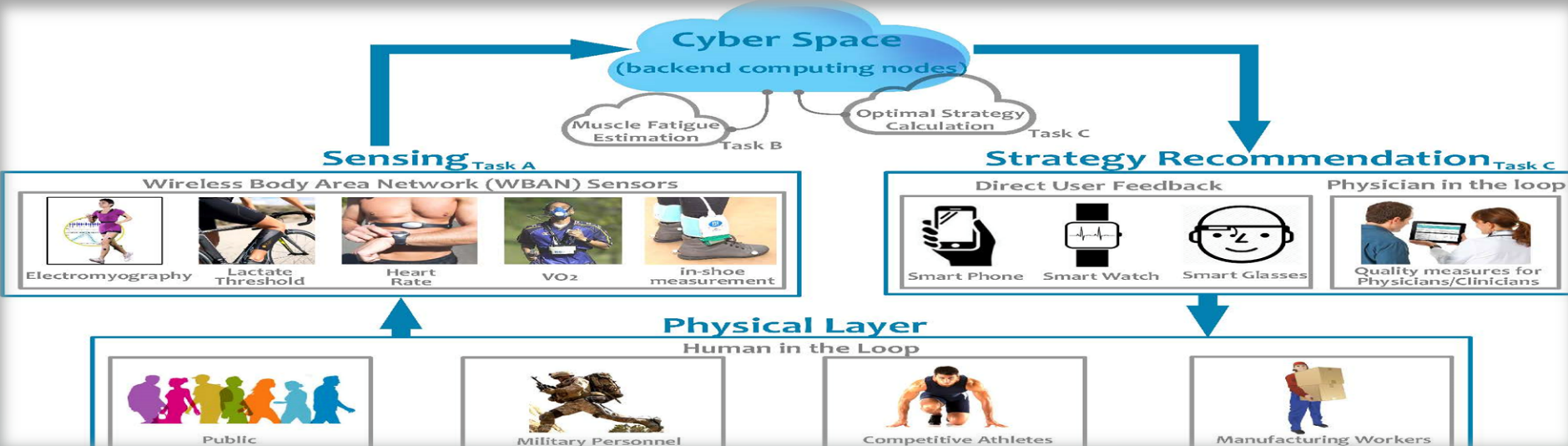
Cycling is an effective model for activity assessment and this study is to demonstrates how 3 tests can determine an individual's Anaerobic Work Capacity (AWC), the threshold between heavy and severe exercise known as Critical Power (CP), and the correlation between AWC expended (AWCexp) and changes to the torque-velocity curve (T-v).

Methods

Subjects
- Male (n=10) and female (n=2) subjects, regularly trained cyclists or triathletes. Age (37.8 ± 11.6). Weight (72.7±16.2)

V02 Ramp
- Exercise at increasing powers until exhaustion.

3 Min All-out
- Exercise for a set time at "all-out" power.
- CP=last 30 second average, AWC="area under the curve"

Sprints
- 3 Separate T-v sprints, each at a different AWCexp fatigue levels based on predicted 6-min exhaustive power (CP6).

Methods

Figure 1. 3 Min-All-Out Protocol

P
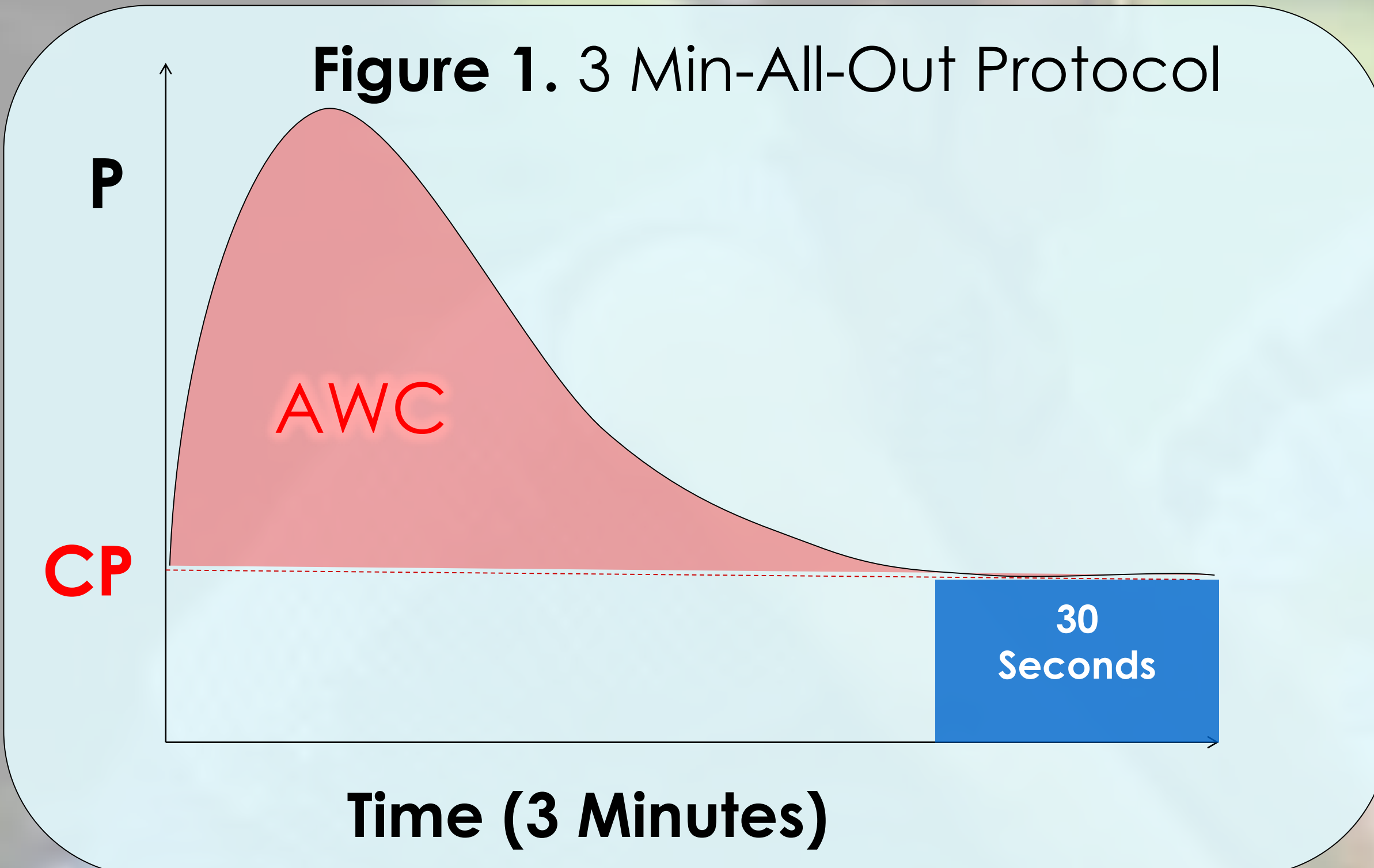
AWC

CP

30 Seconds

Time (3 Minutes)

Figure 1 represents the protocol used for the second day of testing. Literature has shown that an individual's CP can be determined by a 3 min all-out sprint.

Figure 2. Sprint Protocol (After Initial Fresh Sprint Established)

P

1   2

CP6

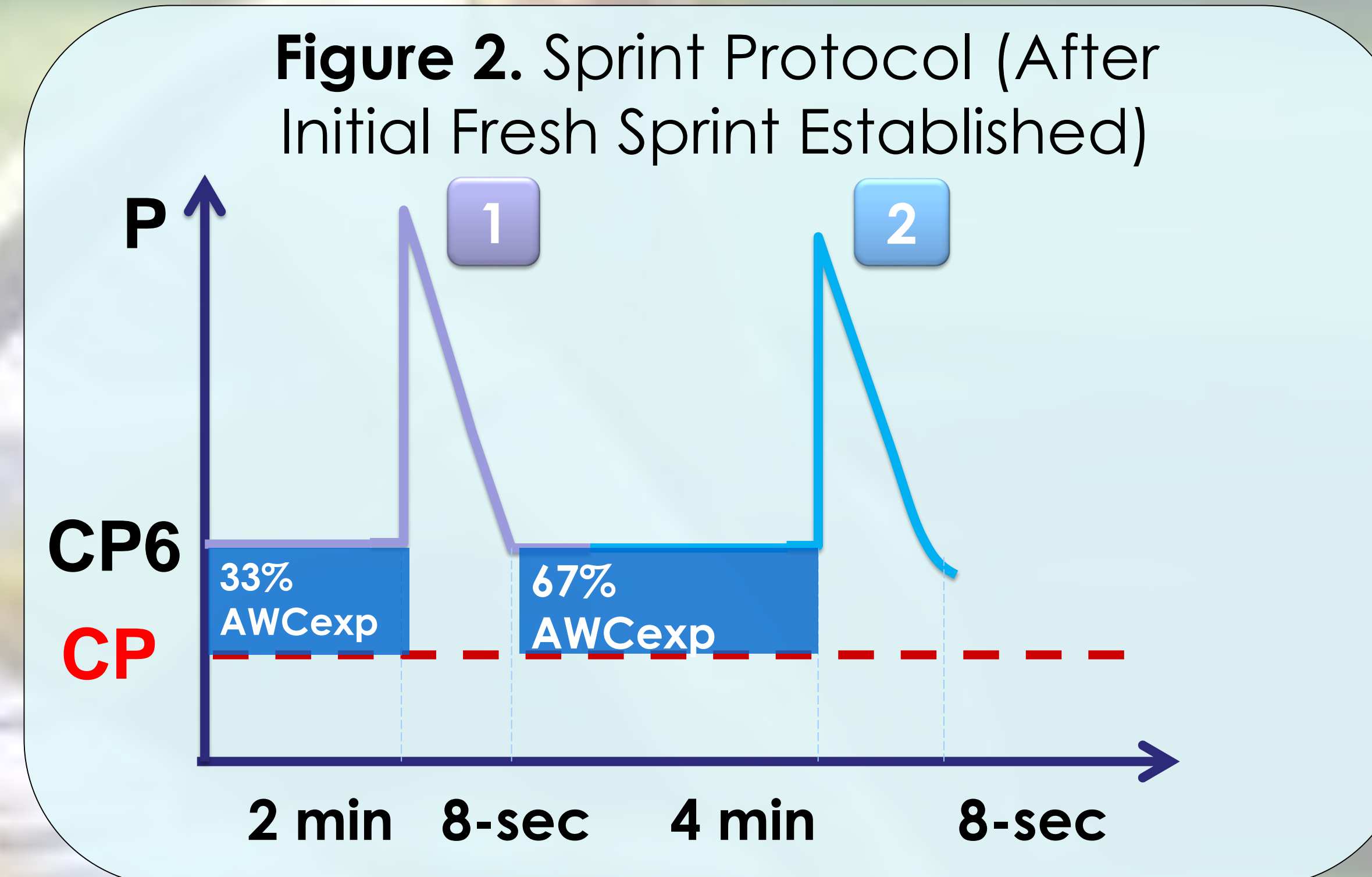33% AWCexp   67% AWCexp

CP

2 min   8-sec   4 min   8-sec

Figure 2 represents the novel protocol used for the third day of testing. We predicted that using an individual's CP6 for a fatigue interval power, 100% AWC would be expended.

Results

Figure 3. Effects of AWCexp on T-v Curve

— Fresh Sprint
— Fatigue Sprint 1
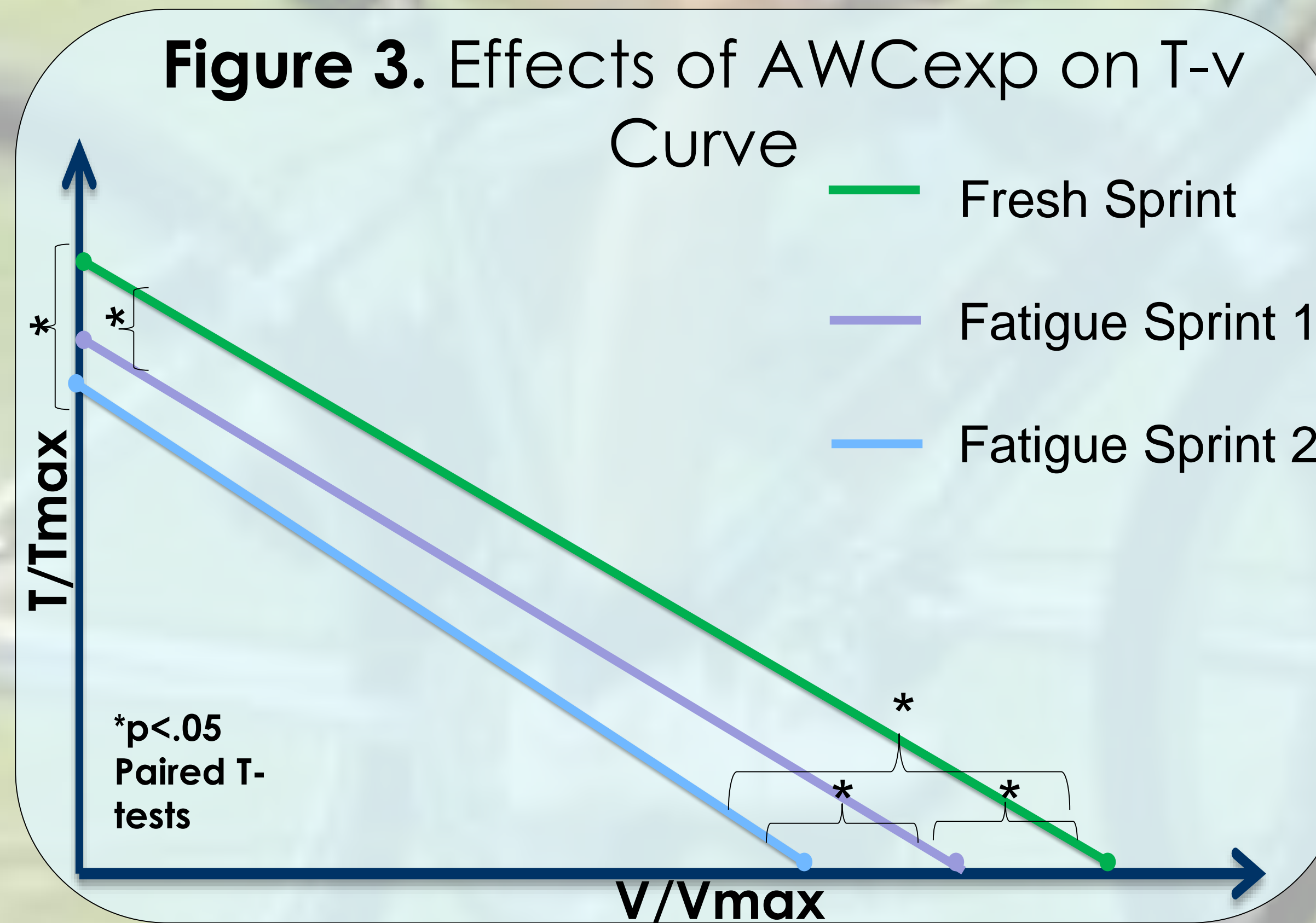— Fatigue Sprint 2

T/Tmax

*p<.05 Paired T-tests

V/Vmax

Figure 3 represents the actual T-v curve. Each line is representative of the torque and velocity data for the corresponding sprint throughout the protocol.
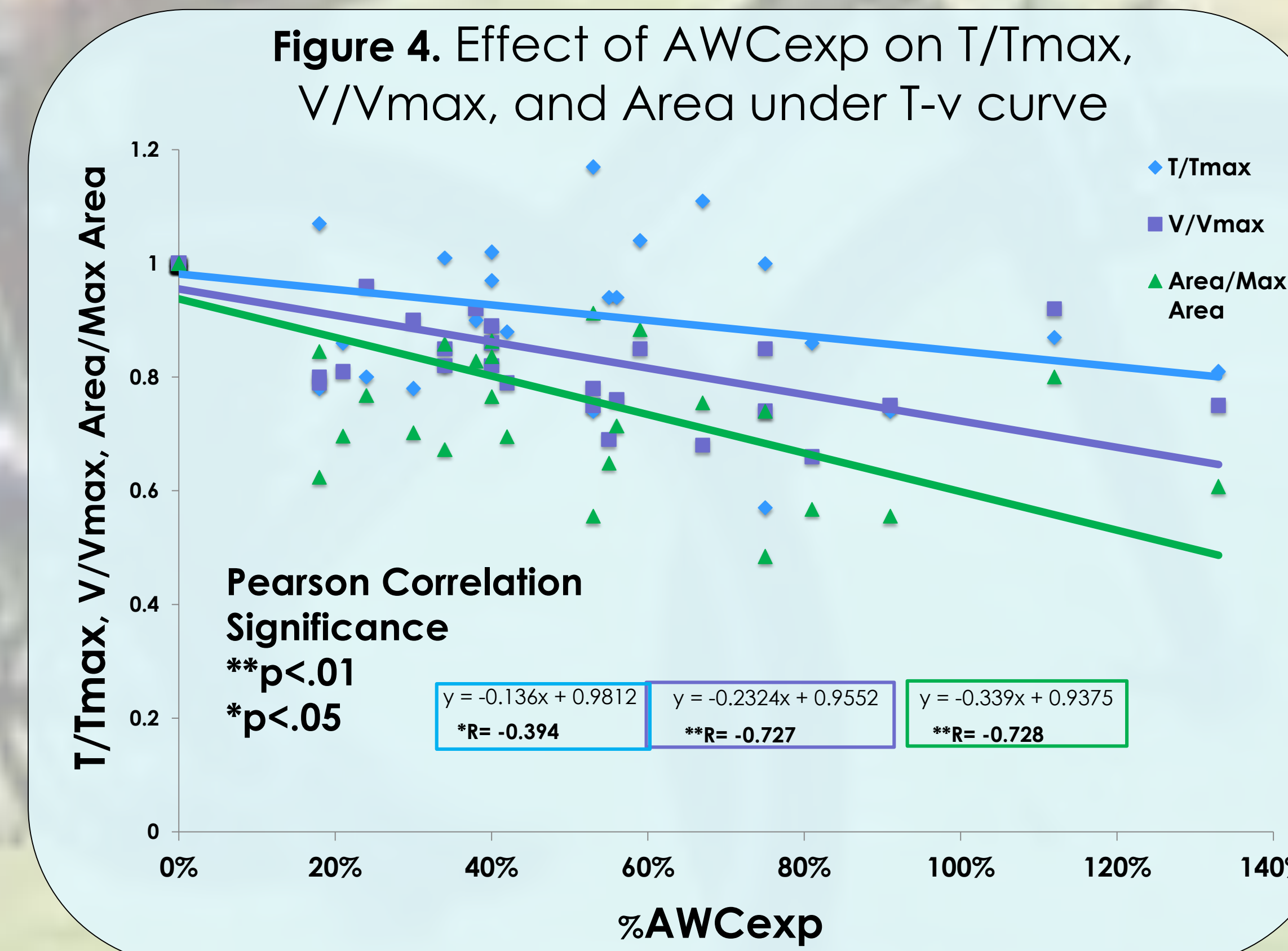
Figure 4. Effect of AWCexp on T/Tmax, V/Vmax, and Area under T-v curve

T/Tmax, V/Vmax, Area/Max Area

■ T/Tmax
■ V/Vmax
▲ Area/Max Area

Pearson Correlation Significance
**p<.01
*p<.05

$y = -0.136x + 0.9812$ $y = -0.2324x + 0.9552$ $y = -0.339x + 0.9375$
*R= -0.394   **R= -0.727   **R= -0.728

%AWCexp

Figure 4 represents the correlation between AWCexp and T/Tmax, V/Vmax, and the area under the T-v curve.

Conclusion

Our protocols can **individualize exercise prescription** by determining the threshold between moderate and vigorous exercise.

Potentially, at any moment in time, changes to the T-v curve during a 6-second sprint could determine a subject's state of fatigue or remaining AWC.

Concurrent &Future Research

- Protocol to Determine Changes to the Torque Velocity Curve above Critical Power while Cycling *(Kelly Humes)*
- Comparison of Threshold Determination between Blood Lactate Samples and Near Infrared Spectroscopy (NIRS) *(Kristine Knowles)*
- Modeling of real-time power output based on wearable, non-invasive NIRS device *(Clemson Univ.)*

References

Buttelli, O., Vandewalle, H., Jouanin, J. C., Seck, D., & Monod, H. (1997). Effects of aerobic exercise on the torque-velocity relationship inOccupational Physiology, 75(6), 499-503. ; Buttelli, O., Vandewalle, H., & Peres, G. (1996). The relationship between maximal power and maximal torque-velocity using an electronic ergometer. *European Journal of Applied Physiology and Occupational Physiology*, 73(5), 479-483.; Jones, A. M., Vanhatalo, A., Burnley, M., Morton, R. H., & Poole, D. C. (2010). Critical power: Implications for determination of V O2max and exercise tolerance cycling. *European Journal of Applied Physiology and. Medicine and Science in Sports and Exercise*, 42(10), 1876-1890.2004.

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