

EXERCISE PHYSIOLOGY EXPERIMENTAL PORTFOLIO

1. INTRODUCTION

Physiological testing provides objective data to assess training efficacy and individual capability while also motivating athletes (Impellizzeri, Rampinini and Marcora, 2005; Söderström *et al.*, 2024). This portfolio evaluates the interplay of physiological factors across three experiments and interprets results within wider physiology literature. SPSS analysis is included in the appendices.

Investigations include:

1. **Fatigue & recovery:** investigates the relationship between Wingate test fatigue index subsequent peak power restoration
2. **Aerobic contribution:** Analyses whether VO₂ max more strongly associates with power recovery than with initial peak anaerobic power.
3. **Power & Functional performance:** Assessing absolute power (W) versus relative power (W/kg) as predictors of 10m sprint performance.

2. EXPERIMENT 1:

Does the magnitude of fatigue during a 30s Wingate test predict the recovery of peak power in subsequent wattbike sprint efforts?

2.1 Method

Participants: University students (N=16: 12M, 4F, body mass = 78.22 ± 11.96 kg). All provided informed consent, were healthy and familiar with high-intensity exercise protocols.

Procedures: Participants followed a standardised 5-minute warm-up (4-minute wattbike cycling with sprint bursts, followed by 1-minute of mobility), followed by a 3-second wattbike peak power test. After 5-minutes of rest, a Keiser peak power leg press (10 repetitions) was completed. After a further 5-minute recovery, a 30-second max-effort Wingate test was performed. Recovery of peak power was assessed via 3-second wattbike sprints at 1, 4, 7 and 10-minutes post-Wingate. Equipment models include Wattbike Pro (Wattbike Ltd) and Keiser A300 leg press (Keiser Corporation, Fresno, CA, USA).

Measures: Peak Power Output (PPO), Fatigue Index (Power Drop %), Recovery Power (W).

Data Analysis: Pearsons correlation coefficient (r) was used to determine the relationship between Fatigue Index (%) and recovery percentage. Statistical p value was set at $p = 0.05$.

2.2 Personal Role

I monitored rest-intervals and recovery timeframes via stopwatch, ensuring precision. I calculated Wattbike resistance load based on the participant's body mass (Body Weight (kg) $\times 0.075$) and recorded the performance metrics into the group-data sheet (Saville, 2016).

2.3 Results

Measure	Baseline (W)	1-min post (W)	Fatigue Index (%)	Recovery (%)
Mean $\pm$ SD	1020.50 $\pm$ 223.89	782.50 $\pm$ 217.20	61.88 $\pm$ 5.50	95.83 $\pm$ 11.50

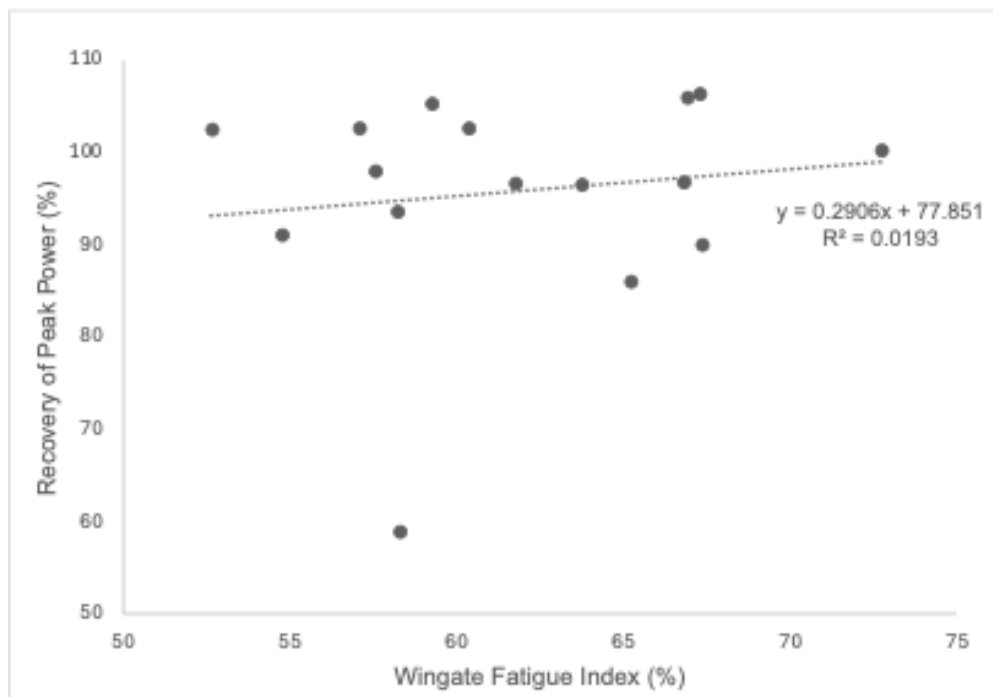


Figure 1: Relationship between Wingate Fatigue Index (%) and 10-minute Peak Power Recovery (%).

Pearson's correlation coefficient revealed a weak, non-significant positive relationship between fatigue magnitude and power restoration ($r = 0.140$, $p = 0.604$) (Schober, Boer and Schwarte, 2018). The coefficient of determination ($R^2 = 0.019$) indicates that fatigue index explained only 1.9% of the variance in recovery, suggesting the degree of power drop during the Wingate test did not significantly predict the extent of peak power restoration.

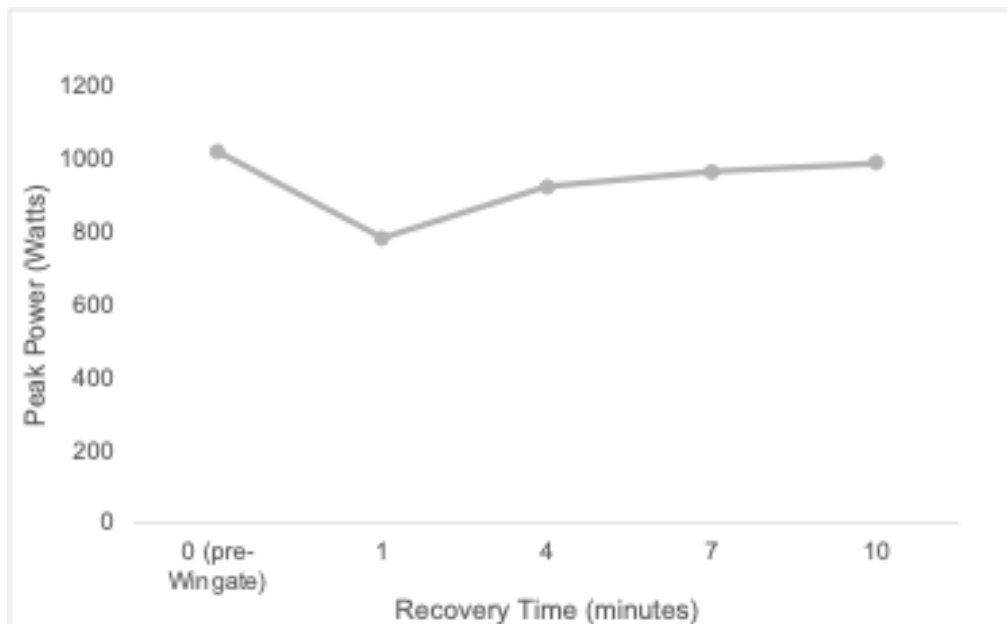


Figure 2: Mean peak power output (W) at baseline and across 10-minute recovery.

Figure 2 shows a steep decline from pre-Wingate (1020.50 ± 223.89) to the 1-minute recovery point (782.50 ± 217.20). Subsequent intervals at 4, 7 and 10 minutes illustrate a gradual restoration of power. Mean power remained below baseline measures at the 10-minute mark, indicating incomplete recovery.

2.4 Interpretation

This experiment examined whether the magnitude of fatigue during a 30-second Wingate test predicts peak power output (PPO) recovery. Correlation analysis demonstrated a weak, non-significant positive association between fatigue index and 10-minute PPO restoration ($r = 0.140$, $p = 0.604$), showing that participants with greater fatigue index did not necessarily recover more slowly. Suggesting that mechanisms responsible for fatigue during supramaximal exercise differ from those facilitating recovery.

Fatigue index during a Wingate test largely reflects rapid intramuscular phosphocreatine (PCr) depletion alongside accumulation of metabolic by-products (P_i and H^+), these lead to neuromuscular fatigue through inhibiting cross-bridge formation and impairing excitation-contraction coupling (Fitts, 2016; Pereira *et al.*, 2012; Sahlin, 2014; Keyser, 2010). Conversely, PPO recovery depends on PCr resynthesis, which is driven by mitochondrial oxidative capacity rather than the magnitude of initial depletion (McMahon and Jenkins, 2002; Zoladz *et al.*, 2010a). Research indicates ~80% of PCr is restored within ~4-minutes, with near-

complete resynthesis by ~6-10-minutes, supporting the progressive rise in PPO observed across intervals (Bogdanis *et al.*, 1996; Mendez-Villanueva *et al.*, 2012; Zoladz *et al.*, 2010b).

The lack of association could reflect individual physiological variability. Athletes with higher aerobic capacity and type I fibre recruitment resynthesise PCr more efficiently (Takahashi *et al.*, 1995; McMahon and Jenkins, 2002). Furthermore, neuromuscular factors like motor unit recruitment and central drive contribute to recovery variability (Aslam, Habyarimana and Bin, 2025). Glaister *et al.*, (2008) similarly reported weak relationships between initial fatigue and subsequent performance restoration, suggesting recovery cannot be predicted by one metric.

Limitations include a modest sample size (N=16) and gender imbalance, which may limit generalisability of findings (Cao, Chen and Katz, 2024). Additionally, fatigue index primarily represents peripheral fatigue and may not reflect central or neuromuscular influences on recovery (Beretta-Piccoli *et al.*, 2015).

Overall, the Wingate Fatigue index is not a reliable predictor of PPO recovery. Restoration may depend more on oxidative capacity, fibre-type distribution and neuromuscular efficiency (Bogdanis *et al.*, 1996). Future research should incorporate lactate and oxygen uptake measures to better identify recovery (Ražanskas *et al.*, 2015).

2.5 Reflection:

This experiment highlighted the importance of adhering to strict timings. Minor delays in starting the 1-minute post-Wingate sprint could lead to overestimated recovery values, reinforcing the need for precise time-keeping. I noted that participant unfamiliarity with 3-second wattbike sprints may have introduced 'learning effects' where technical inefficiency hides true physiological capacity (Hopkins, 2000). A familiarisation trial would have reduced this effect (Hibbert *et al.*, 2017). Conversely, some participants may have subconsciously paced the Wingate rather than producing a true maximal effort, lowering their fatigue index.

3. EXPERIMENT 2:

Is VO_2max more strongly associated with peak power recovery following supramaximal exercise than with initial peak anaerobic power?

3.1 Method

Participants: Male university students (N=6, body mass = 85.24 ± 10.56 kg; age = 23.71 ± 3.15 years; height = 178.21 ± 6.43 cm). Informed consent was obtained.

Procedures:

Aerobic: Participants performed a ramp test to exhaustion, starting at ~50W, +15W/min on a wattbike Pro (Wattbike Ltd, Nottingham UK). Upon exhaustion participants alerted the researcher, expired air was collected during the final minute via a 100L Douglas bag with 2100 series 3-way stopcock (Hans Rudolph Inc., Shawnee, KS, USA) and air was analysed using a servomex 5200 (Servomex Group Ltd, Crowborough, East Sussex, UK) and Harvard DGM1 meters (Harvard Apparatus, Holliston, MA, USA).

Anaerobic Testing & Recovery Scores: A 30-second Wingate test (7.5% BM resistance) provided peak anaerobic power. Recovery was assessed via 3-second wattbike sprints at 1,4,7,10-minutes post-Wingate to calculate the percentage of power restored. Conducted using wattbike Pro (Wattbike Ltd, Nottingham UK).

Measures: VO_2max ($\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$), Wingate Peak Anaerobic Power (W), Recovery Power (%).

Data Analysis: Pearsons correlation coefficients (r) compared VO_2max with recovery capacity versus initial peak power. Statistical p value was set at $p = 0.05$

3.2 Personal Role:

I calculated the Wingate resistance load (Body Weight (kg) $\times$ 0.075) and ensured subsequent sprints were performed on the exact 1-, 4-, 7-and 10-minute intervals.

3.3 Results

Measure	VO_2max ($\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$)	Wingate Peak Anaerobic Power (W)	Recovery (%)
Mean $\pm$ SD	42.28 ± 7.84	1247.33 ± 192.34	100.62 ± 4.51

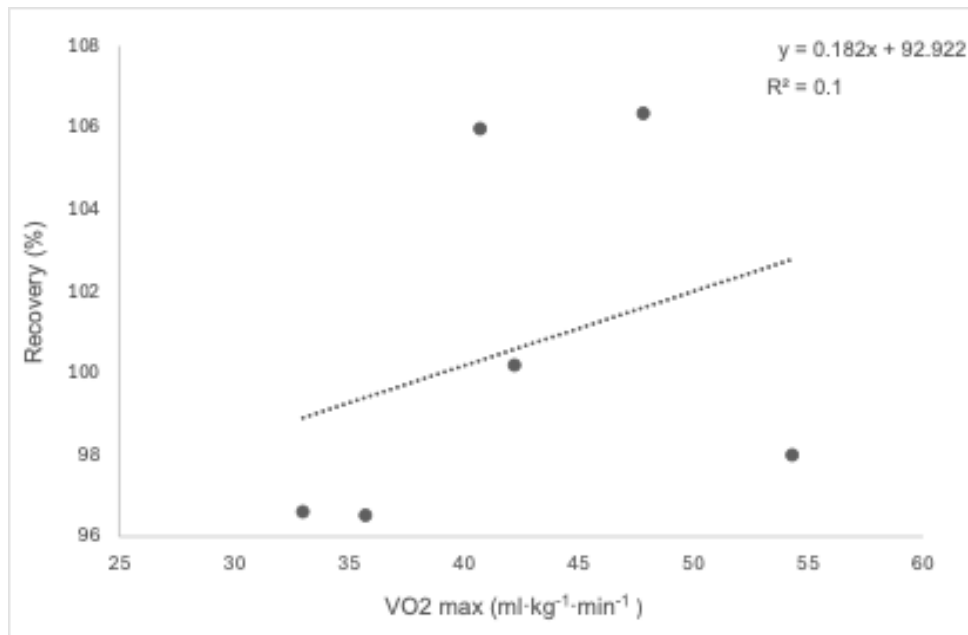


Figure 3: Relationship between VO₂max and 10-minute peak power recovery

Pearson's correlation coefficient indicated a weak, non-significant positive relationship between VO₂max and power restoration ($r = 0.316$, $p = 0.542$) (Schober, Boer and Schwarte, 2018). The coefficient of determination ($R^2 = 0.1$) indicates that VO₂max explained only 10% of the variance in recovery, indicating that higher aerobic fitness was not a strong predictor of peak power following supramaximal exercise.

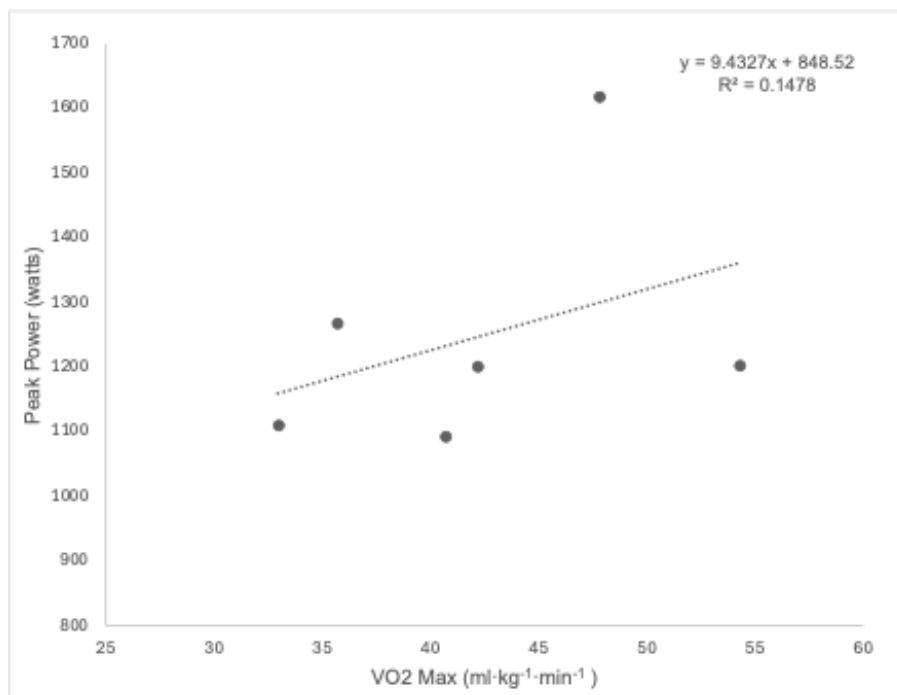


Figure 4: Relationship between VO₂max and absolute peak power (W)

Pearson's correlation coefficient indicated a weak, non-significant positive relationship ($r = 0.384$, $p = 0.452$) (Schober, Boer and Schwarte, 2018). The coefficient of determination ($R^2 = 0.147$) revealed that VO₂max explained only ~15% of the variance in peak power. Suggesting an individual's aerobic capacity is not a significant predictor of their ability to generate anaerobic peak power.

3.4 Interpretation:

This study examined whether aerobic capacity (VO₂max) was more strongly associated with peak power restoration rather than with initial anaerobic peak power. Correlations showed weak, non-significant positive relationships for both recovery ($r = 0.316$, $p = 0.542$) and peak power ($r = 0.384$, $p = 0.452$), indicating VO₂max was not a strong predictor of either variable.

The weak association between VO₂max and peak anaerobic power aligns with the specific physiological determinants of both variables. Peak Wingate Power is driven by phosphocreatine (PCr) availability, glycolytic enzyme activity, and type II fibre recruitment, rather than oxidative capacity (Yilmaz *et al.*, 2025; Hu *et al.*, 2025; Dann, 2019). As the Wingate test relies on intramuscular energy stores rather than oxygen delivery, individuals with high VO₂max do not necessarily produce superior peak power outputs (Bellar *et al.*, 2015).

Conversely, the slightly stronger, though still weak, relationship between VO₂max and recovery aligns with the role of aerobic metabolism in PCr resynthesis. Power restoration is primarily determined by mitochondrial oxidative phosphorylation (McMahon and Jenkins, 2002; Sahlin, Harris and Hultman, 1979). Consequently, higher aerobic capacity typically facilitates faster PCr restoration and more efficient removal of metabolic by-products (Pi, H⁺ ions, lactic acid) (Baker, McCormick and Robergs, 2010; Hargreaves and Spriet, 2018). Yoshida (2002) confirmed this, finding endurance-trained individuals had significantly faster PCr recovery than sedentary individuals.

Several factors may explain weak correlations observed. Recovery is influenced by multiple variables beyond VO₂max, such as fibre-type distribution and pacing strategies during the Wingate (Meyler, Bottoms and Muniz-Pumares, 2021). The small, homogenous sample ($n=6$) limits VO₂max variability, reducing the likelihood of detecting strong statistical associations (Patel, Doku and Tennakoon, 2003)

Overall, VO_2max is not a major determinant of peak anaerobic power, though it may play a supporting role within recovery. These findings reinforce that anaerobic performance and restoration are influenced by multiple factors and unable to be predicted by VO_2max alone.

3.5 Reflection:

This experiment highlighted the practical challenges of using Douglas bags for VO_2max assessment. Coordinating the final minute of expired air collection highlighted how easily small timing errors can affect aerobic capacity calculations. Using a small, similar group of participants increased awareness of how limited variability can restrict insights gained from the research.

4. EXPERIMENT 3:

Does power relative to body mass (W/kg) predict 10m sprint performance more strongly than absolute power (W)?

4.1 Method

Participants: University students (N = 9: 7M, 2F, body mass = $77.34 \pm 11.80\text{kg}$; height = $175 \pm 7.44\text{cm}$; age = 21.44 ± 1.67 years).

Procedures:

10-meter sprints: Maximal 10m sprint from a standing start, recorded using Brower Timing Systems Gates (Brower Timing Systems, Draper, UT, USA).

Keiser Leg Press: 10 repetitions on a Keiser A300 leg press (Keiser Corporation, Fresno, CA, USA) to determine absolute peak power (W).

Wingate Test: 30-second maximal cycle (7.5%BM resistance) to determine Wingate peak power, allowing calculation of relative power (W/kg).

Measures: 10m sprint time (s), Keiser Peak power (W), Relative Wingate Power (W/kg).

Data Analysis: Pearsons correlation coefficients were used to evaluate the relationship between both power metrics and sprint times. Statistical p value was set at $p = 0.05$.

4.2 Personal Role

I assisted in the alignment and testing of the timing gates prior to the trial. I collected and recorded the data for the Keiser leg press and Wingate tests.

4.3 Results

Measure	10m sprint time (s)	Relative Wingate Peak Power (W/kg)	Keiser Peak Power (W)
Mean $\pm$ SD	1.90 $\pm$ 0.21	12.31 $\pm$ 3.12	931.22 $\pm$ 433.24

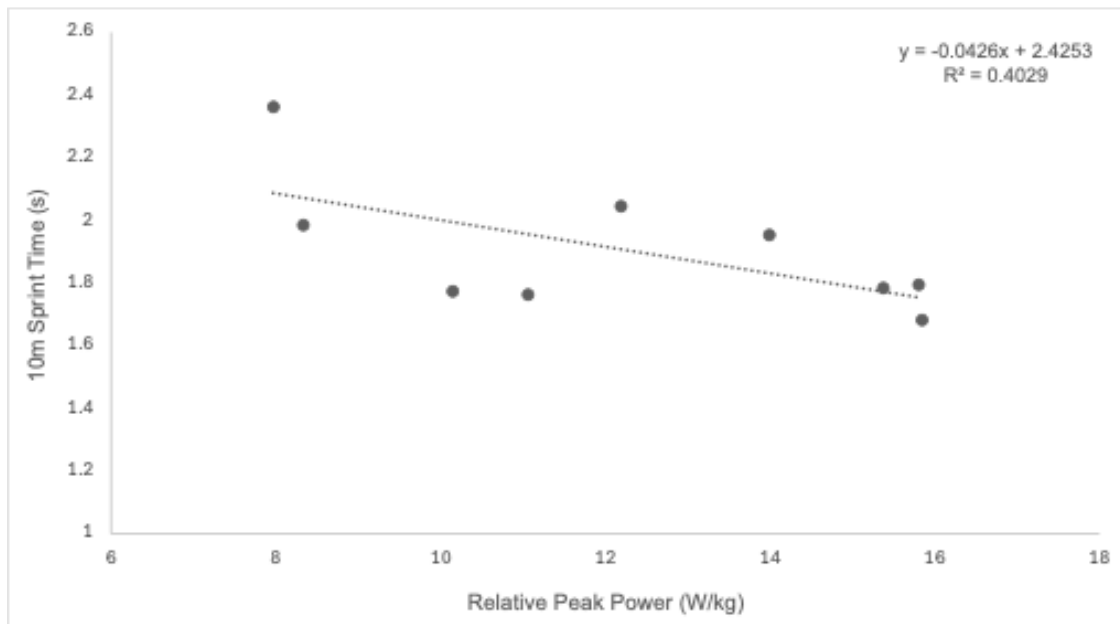


Figure 5: Relationship between relative anaerobic power (w/kg) and 10m sprint time.

Pearson's correlation coefficient indicated a strong negative relationship ($r = -0.635$, $p = 0.094$), indicating participants with higher power-to-weight ratios tended to achieve faster sprint times (Schober, Boer and Schwarte, 2018). However, this relationship did not reach statistical significance ($p = < 0.05$), likely due to small sample size ($N=9$). The coefficient of determination ($R^2 = 0.40$) suggests relative power explained ~40% of the variance in sprint times.

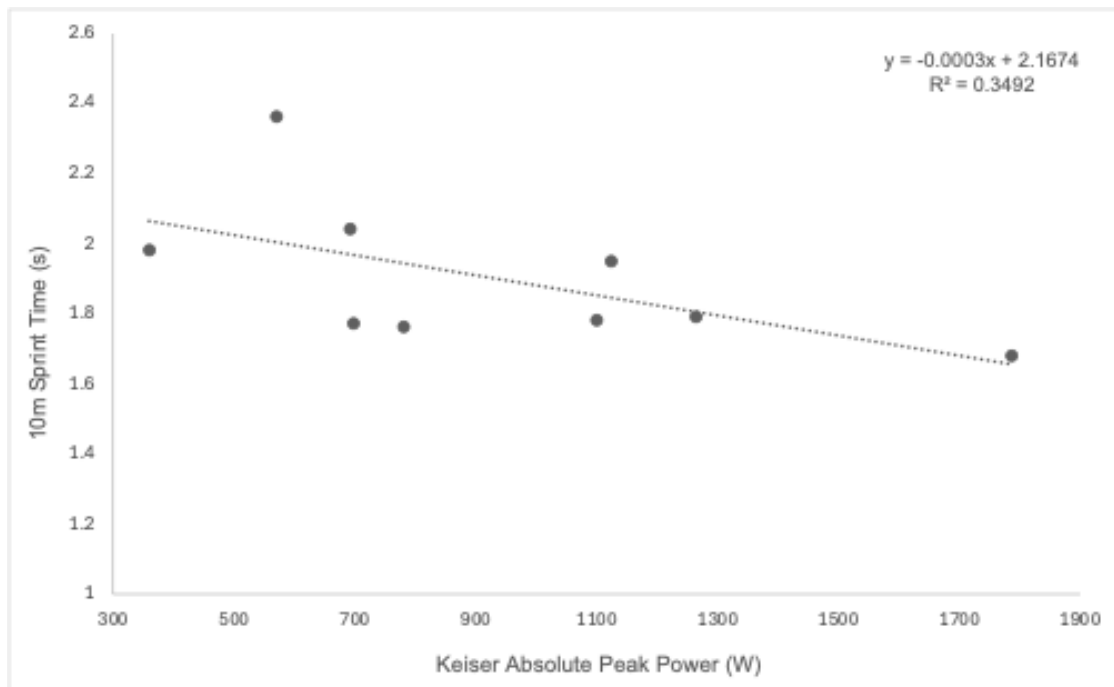


Figure 6: Relationship between absolute peak power (W) and sprint time.

Figure 6 represents an association between absolute power output and sprint times. A Pearson's correlation coefficient identified a moderate negative correlation ($r = -0.591$, $p = 0.094$), indicating that higher absolute power was associated with faster sprint times, though the relationship was not statistically significant (Schober, Boer and Schwarte, 2018). The coefficient of determination ($R^2 = 0.35$) shows that absolute power accounted for ~35% of the variance in sprint times.

4.4 Interpretation

This study examined whether relative power (W/kg) is a stronger predictor of 10m sprint time than absolute power (W). Correlations indicated a stronger association for relative power ($r = -0.635$) compared with absolute power ($r = -0.591$), although neither reached statistical significance due to the small sample size.

During a 10m sprint, an athlete must overcome inertia to accelerate body mass from a stationary position (Dawes and Lentz, 2012). Therefore, the ability to generate force relative to that mass is the primary determinant of acceleration (Hunter, Marshall and McNair, 2005). Athletes with superior power-to-weight ratios achieve greater velocity changes as a higher proportion of muscular work is dedicated to forward propulsion (Zabaloy *et al.*, 2020). Explaining why relative power (W/kg) showed a stronger association with sprint time.

Physiologically, the 10m sprint is a supramaximal effort dominated by the ATP-PCr energy system, requiring rapid breakdown of intramuscular PCr to fuel explosive contractions (Nimat, 2019). The ability to utilize this energy for explosive movement depends on the recruitment of Type IIx muscle fibres, which are characterised by high myosin ATPase activity and rapid rates of force development (Plotkin *et al.*, 2021; McCuller, Jessu and Callahan, 2025; Methenitis *et al.*, 2019). While absolute power reflects total force capacity, it fails to account for the inertial cost of moving heavier mass (Horvath and Andersson, 2025). Therefore, a lighter athlete with equivalent power would accelerate faster as each watt moves less mass (Van Hooren, Aagaard and Blazevich, 2024). This explains why absolute power is a weaker predictor of sprint performance.

Limitations include the use of the Keiser leg press as its seated, bilateral nature lacks the ecological validity of upright, unilateral sprinting (Larsen *et al.*, 2023). Furthermore, the warm-up lacked explosive actions necessary to induce post-activation potentiation (PAP) (Lorenz, 2011). Finally, while timing gates provided precision, slight variations in starting posture may have introduced measurement error (Haugen, Tønnessen and Seiler, 2015).

Overall, these findings indicate that relative peak power is a more meaningful predictor of 10m sprint performance than absolute power, highlighting the important role of ATP-PCr energy supply, Type II fibre recruitment and force production relative to body mass in acceleration.

4.5 Reflection

Supporting setup of timing gates and collecting sprint and power data allowed an understanding of how closely testing protocols need to align with the physiological measures being investigated. An appreciation for how small variations in testing conditions can alter results was gained.

5. CONCLUSION

This portfolio demonstrates how specific physiological mechanisms underpin high-intensity performance, recovery, and acceleration. Experiment 1 showed that the magnitude of fatigue during a Wingate test does not predict peak-power restoration, reinforcing that fatigue and recovery are governed by different processes. While fatigue reflects rapid PCr depletion and metabolite accumulation, recovery is driven by oxidative resynthesis of PCr, explaining the weak association observed (Keyser, 2010; McMahon and Jenkins, 2002). Experiment 2 supported this, showing VO_2max plays only a supporting, rather than dominating, role in peak power restoration (Sahlin, Harris and Hultman, 1979). Experiment 3 highlighted the functional

importance of power relative to body mass for acceleration. Collectively, these findings emphasise that anaerobic power, recovery and speed are affected by an interplay of multiple factors and cannot be accurately predicted by a single physiological variable.

References:

- Aslam, S., Habyarimana, J.D.D. and Bin, S.Y. (2025) 'Neuromuscular adaptations to resistance training in elite versus recreational athletes', *Frontiers in Physiology*, 16, pp. 1598149. Available at: <https://doi.org/10.3389/fphys.2025.1598149>.
- Baker, J.S., McCormick, M.C. and Robergs, R.A. (2010) 'Interaction among skeletal muscle metabolic energy systems during intense exercise', *Journal of Nutrition and Metabolism*, 2010, pp. 905612. Available at: <https://doi.org/10.1155/2010/905612>.
- Bellar, D., Hatchett, A., Judge, L., Breaux, M. and Marcus, L. (2015) 'The relationship of aerobic capacity, anaerobic peak power and experience to performance in HIT exercise', *Biology of Sport*, 32(4), pp. 315. Available at: <https://doi.org/10.5604/20831862.1174771>.
- Beretta-Piccoli, M., D'Antona, G., Barbero, M., Fisher, B., Dieli-Conwright, C.M., Clijsen, R. and Cescon, C. (2015) 'Evaluation of central and peripheral fatigue in the quadriceps using fractal dimension and conduction velocity in young females', *PLoS ONE*, 10(4), pp. e0123921. Available at: <https://doi.org/10.1371/journal.pone.0123921>.
- Bogdanis, G.C., Nevill, M.E., Boobis, L.H. and Lakomy, H.K. (1996) 'Contribution of phosphocreatine and aerobic metabolism to energy supply during repeated sprint exercise', *Journal of Applied Physiology*, 80(3), pp. 876–884. Available at: <https://doi.org/10.1152/jappl.1996.80.3.876>.
- Brower Timing Systems, Draper, UT, USA *Brower Timing Systems*. Available at: <https://www.browertiming.com/sprint-timing-gates> (Accessed: Mar 6, 2026).
- Cao, Y., Chen, R.C. and Katz, A.J. (2024) 'Why is a small sample size not enough?', *The Oncologist*, 29(9), pp. 761–763. Available at: <https://doi.org/10.1093/oncolo/oyae162>.
- Dann, R.A. (2019) 'The relationships between muscle fibre composition, muscle carnosine and multiple sprint (wingate) performance', *University of Queensland*, Available at: https://espace.library.uq.edu.au/data/UQ_3fff558/s4317321_final_thesis.pdf?Expires=1772835517&Key-Pair-Id=APKAJKNB4MJBNC6NLQ&Signature=Q8Z-v0Za-IMbD~e9ljB-4MfblprDrdb1XNZEb8iUSO69iRX6e6lgMUhJRvKYEWEEdYur-ItQNPfH0NpxQu9aiuiOHbbDaNUxedHsq05NgsOedrXfou3PGcKhReM4LNUW8zcl9kCvpEO RyvxWIGKca3wqxJ2iUjyTfDF5jyc2lajNvGCnCRwJNgDVUxVB~ZZSnPCG44uKvVS1ZjMcW sH6Uz~~2u2rX36wDIBXf0VyZg7bM~mLr3Pgdw9TP6AUqNWh804AqG8O62m42eYt1qUlq0 TMUWL-wxDpkW2o940JjV5eboPqZzC3SEoKU1M6f2Q7h-0V1YoaUt9iSGAUsvFvSQuBA.

Dawes, J. and Lentz, D. (2012) 'Methods of developing power to improve acceleration for the non-track athlete', *Strength & Conditioning Journal*, 34(6), pp. 44. Available at: <https://doi.org/10.1519/SSC.0b013e31827529e6>.

Fitts, R.H. (2016) 'The role of acidosis in fatigue: Pro perspective', *Medicine & Science in Sports & Exercise*, 48(11), pp. 2335. Available at: <https://doi.org/10.1249/MSS.0000000000001043>.

Glaister, M., Howatson, G., Pattison, J.R. and McInnes, G. (2008) 'The reliability and validity of fatigue measures during multiple-sprint work: An issue revisited', *The Journal of Strength & Conditioning Research*, 22(5), pp. 1597. Available at: <https://doi.org/10.1519/JSC.0b013e318181ab80>.

Hans Rudolph Inc., Shawnee, KS, USA '100L douglas bag with 2100 series 3-way stopcock', Available at: <https://doi.org/https://www.rudolphkc.com>.

Hargreaves, M. and Spriet, L.L. (2018) 'Exercise metabolism: Fuels for the fire', *Cold Spring Harbor Perspectives in Medicine*, 8(8), pp. a029744. Available at: <https://doi.org/10.1101/cshperspect.a029744>.

Harvard Apparatus, Holliston, MA, USA 'Harvard DGM1 dry gas meter', Available at: <https://doi.org/https://www.harvardapparatus.com>.

Haugen, T., Tønnessen, E. and Seiler, S. (2015) 'Correction factors for photocell sprint timing with flying start', *International Journal of Sports Physiology and Performance*, 10(8), pp. 1055–1057. Available at: <https://doi.org/10.1123/ijspp.2014-0415>.

Hibbert, A.W., Billaut, F., Varley, M.C. and Polman, R.C.J. (2017) 'Familiarization protocol influences reproducibility of 20-km cycling time-trial performance in novice participants', *Frontiers in Physiology*, 8, pp. 488. Available at: <https://doi.org/10.3389/fphys.2017.00488>.

Hopkins, W.G. (2000) 'Measures of reliability in sports medicine and science', *Sports Medicine*, 30(1), pp. 1–15. Available at: <https://doi.org/10.2165/00007256-200030010-00001>.

Horvath, M. and Andersson, E.P. (2025) 'Optimal body mass normalization of power output for accurate prediction of estimated cycling performance over complex time-trial courses', *Frontiers in Sports and Active Living*, 7 Available at: <https://doi.org/10.3389/fspor.2025.1599319>.

Hu, Y., Liu, W., Duan, Q. and Gong, Z. (2025) 'Muscle activity and power output recovery: The roles of rest duration and underlying endurance capacity in the wingate test', *Frontiers in Physiology*, 16, pp. 1674597. Available at: <https://doi.org/10.3389/fphys.2025.1674597>.

Hunter, J.P., Marshall, R.N. and McNair, P.J. (2005) 'Relationships between ground reaction force impulse and kinematics of sprint-running acceleration', *Journal of Applied Biomechanics*, 21(1), pp. 31–43. Available at: <https://doi.org/10.1123/jab.21.1.31>.

Impellizzeri, F.M., Rampinini, E. and Marcora, S.M. (2005) 'Physiological assessment of aerobic training in soccer', *Journal of Sports Sciences*, 23(6), pp. 583–592. Available at: <https://doi.org/10.1080/02640410400021278>.

Keiser Corporation, Fresno, CA, USA 'Keiser A300 leg press', Available at: <https://www.keiser.com>.

Keyser, R.E. (2010) 'Peripheral fatigue: High-energy phosphates and hydrogen ions', *PM&R*, 2(5), pp. 347–358. Available at: <https://doi.org/10.1016/j.pmri.2010.04.009>.

Larsen, F., Loturco, I., Sigvaldsen, E., Strand, M.F., Kallhovde, J.M. and Haugen, T. (2023) 'Reliability and validity of different lower-limb strength tests to determine 1RM in the keiser A300 leg press', *The Journal of Strength & Conditioning Research*, 37(10), pp. 1963. Available at: <https://doi.org/10.1519/JSC.0000000000004516>.

Lorenz, D. (2011) 'Postactivation potentiation: An introduction', *International Journal of Sports Physical Therapy*, 6(3), pp. 234–240. Available at: <https://pmc.ncbi.nlm.nih.gov/articles/PMC3164001/>.

McCuller, C., Jessu, R. and Callahan, A.L. 'Physiology, skeletal muscle' *StatPearls*. StatPearls Publishing, .

McMahon, S. and Jenkins, D. (2002) 'Factors affecting the rate of phosphocreatine resynthesis following intense exercise', *Sports Medicine*, 32(12), pp. 761–784. Available at: <https://doi.org/10.2165/00007256-200232120-00002>.

Mendez-Villanueva, A., Edge, J., Suriano, R., Hamer, P. and Bishop, D. (2012) 'The recovery of repeated-sprint exercise is associated with PCr resynthesis, while muscle pH and EMG amplitude remain depressed', *PLoS ONE*, 7(12), pp. e51977. Available at: <https://doi.org/10.1371/journal.pone.0051977>.

Methenitis, S., Spengos, K., Zaras, N., Stasinaki, A., Papadimas, G., Karampatsos, G., Arnaoutis, G. and Terzis, G. (2019) 'Fiber type composition and rate of force development in endurance- and resistance-trained individuals', *Journal of Strength and Conditioning Research*, 33(9), pp. 2388–2397. Available at: <https://doi.org/10.1519/JSC.0000000000002150>.

Meyler, S., Bottoms, L. and Muniz-Pumares, D. (2021) 'Biological and methodological factors affecting response variability to endurance training and the influence of exercise intensity prescription', *Experimental Physiology*, 106(7), pp. 1410–1424. Available at: <https://doi.org/10.1113/EP089565>.

Nimat (2019) *Energy Supply for Muscle*. Available at: <https://nismat.org/patient-care/patient-education/fitness/exercise-physiology-primer/energy-supply-for-muscle/> (Accessed: Mar 6, 2026).

Patel, M.X., Doku, V. and Tennakoon, L. (2003) 'Challenges in recruitment of research participants', *Advances in Psychiatric Treatment*, 9(3), pp. 229–238. Available at: <https://doi.org/10.1192/apt.9.3.229>.

Pereira, E.R., Nogueira, G.M.O., Coelho, D.B., Damasceno, W.C., Lima, A.M., Silami-Garcia, E. and Filho, A.G. (2012) 'Creatine supplementation alters power in the wingate test but increases creatinine concentration', *Exercise and Sports Medicine Clinic*, 18(5) Available at: <https://www.scielo.br/j/rbme/a/Mp9TYCxjLkStNHxVpq94dTq/?format=pdf&lang=en>.

Plotkin, D.L., Roberts, M.D., Haun, C.T. and Schoenfeld, B.J. (2021) 'Muscle fiber type transitions with exercise training: Shifting perspectives', *Sports*, 9(9), pp. 127. Available at: <https://doi.org/10.3390/sports9090127>.

Ražanskas, P., Verikas, A., Olsson, C. and Viberg, P. (2015) 'Predicting blood lactate concentration and oxygen uptake from sEMG data during fatiguing cycling exercise', *Sensors (Basel, Switzerland)*, 15(8), pp. 20480–20500. Available at: <https://doi.org/10.3390/s150820480>.

Sahlin, K. (2014) 'Muscle energetics during explosive activities and potential effects of nutrition and training', *Sports Medicine (Auckland, N.Z.)*, 44(Suppl 2), pp. 167–173. Available at: <https://doi.org/10.1007/s40279-014-0256-9>.

Sahlin, K., Harris, R.C. and Hultman, E. (1979) 'Resynthesis of creatine phosphate in human muscle after exercise in relation to intramuscular pH and availability of oxygen', *Scandinavian*

Journal of Clinical and Laboratory Investigation, 39(6), pp. 551–558. Available at: <https://doi.org/10.3109/00365517909108833>.

Saville, W. (2016) 'Wingate Anaerobic Test' *Science for Sport*, -01-26. Available at: <https://www.scienceforsport.com/wingate-anaerobic-test/> (Accessed: Mar 2, 2026).

Schober, P., Boer, C. and Schwarte, L.A. (2018) 'Correlation coefficients: Appropriate use and interpretation', *Anesthesia & Analgesia*, 126(5), pp. 1763. Available at: <https://doi.org/10.1213/ANE.0000000000002864>.

Servomex Group Ltd, Crowborough, East Sussex, UK 'Servomex gas analyser', Available at: <https://doi.org/https://www.servomex.com>.

Söderström, T., Sandlund, S., Westerlund, R. and Tervo, T. (2024) 'The role of physiological testing for athlete development in sport: The elite athlete perspective', *International Review for the Sociology of Sport*, 59(8), pp. 1244–1265. Available at: <https://doi.org/10.1177/10126902241258677>.

Takahashi, H., Inaki, M., Fujimoto, K., Katsuta, S., Anno, I., Niitsu, M. and Itai, Y. (1995) 'Control of the rate of phosphocreatine resynthesis after exercise in trained and untrained human quadriceps muscles', *European Journal of Applied Physiology and Occupational Physiology*, 71(5), pp. 396–404. Available at: <https://doi.org/10.1007/BF00635872>.

Van Hooren, B., Aagaard, P. and Blazevich, A.J. (2024) 'Optimizing resistance training for sprint and endurance athletes: Balancing positive and negative adaptations', *Sports Medicine (Auckland, N.Z.)*, 54(12), pp. 3019–3050. Available at: <https://doi.org/10.1007/s40279-024-02110-4>.

Wattbike Ltd, N.U. 'Wattbike pro', Available at: <https://doi.org/https://www.wattbike.com>.

Yılmaz, H.H., Ulupınar, S., Kırıyıcı, F., Kışalı, N.F., Gençoğlu, C., Özbay, S. and Çiydem, Ç (2025) 'Voluntary hyperventilation-induced hypocapnia enhances wingate test performance without altering energy system contributions', *BMC Sports Science, Medicine and Rehabilitation*, 17(1), pp. 167. Available at: <https://doi.org/10.1186/s13102-025-01217-z>.

Yoshida, T. (2002) 'The rate of phosphocreatine hydrolysis and resynthesis in exercising muscle in humans using ³¹P-MRS', *Journal of Physiological Anthropology and Applied Human Science*, 21(5), pp. 247–255. Available at: <https://doi.org/10.2114/jpa.21.247>.

Zabaloy, S., Carlos-Vivas, J., Freitas, T.T., Pareja-Blanco, F., Pereira, L., Loturco, I., Comyns, T., Gálvez-González, J. and Alcaraz, P.E. (2020) 'Relationships between resisted sprint performance and different strength and power measures in rugby players', *Sports*, 8(3), pp. 34. Available at: <https://doi.org/10.3390/sports8030034>.

Zoladz, J.A., Korzeniewski, B., Kulinowski, P., Zapart-Bukowska, J., Majerczak, J. and Jasiński, A. (2010a) 'Phosphocreatine recovery overshoot after high intensity exercise in human skeletal muscle is associated with extensive muscle acidification and a significant decrease in phosphorylation potential', *The Journal of Physiological Sciences : JPS*, 60(5), pp. 331–341. Available at: <https://doi.org/10.1007/s12576-010-0101-3>.

Zoladz, J.A., Korzeniewski, B., Kulinowski, P., Zapart-Bukowska, J., Majerczak, J. and Jasiński, A. (2010b) 'Phosphocreatine recovery overshoot after high intensity exercise in human skeletal muscle is associated with extensive muscle acidification and a significant decrease in phosphorylation potential', *The Journal of Physiological Sciences*, 60(5), pp. 331–341. Available at: <https://doi.org/10.1007/s12576-010-0101-3>.

Appendix:

Correlations

Correlations			
		wingate_wkg_r elative	sprint
wingate_wkg_relative	Pearson Correlation	1	-.635
	Sig. (2-tailed)		.066
	N	9	9
sprint	Pearson Correlation	-.635	1
	Sig. (2-tailed)	.066	
	N	9	9

Correlations

Correlations			
		keiser_absolut e	sprint
keiser_absolute	Pearson Correlation	1	-.591
	Sig. (2-tailed)		.094
	N	9	9
sprint	Pearson Correlation	-.591	1
	Sig. (2-tailed)	.094	
	N	9	9

Correlations

Correlations			
		wingate	recovery
wingate	Pearson Correlation	1	.140
	Sig. (2-tailed)		.604
	N	16	16
recovery	Pearson Correlation	.140	1
	Sig. (2-tailed)	.604	
	N	16	16

Correlations

Correlations			
		vo2max	recovery
vo2max	Pearson Correlation	1	.316
	Sig. (2-tailed)		.542
	N	6	6
recovery	Pearson Correlation	.316	1
	Sig. (2-tailed)	.542	
	N	6	6

Correlations

Correlations			
		vo2max	peak_wingate power
vo2max	Pearson Correlation	1	.384
	Sig. (2-tailed)		.452
	N	6	6
peak_wingatepower	Pearson Correlation	.384	1
	Sig. (2-tailed)	.452	
	N	6	6

Correlations

Correlations			
		wingate_fatigu e	recovery_pow er
wingate_fatigue	Pearson Correlation	1	.140
	Sig. (2-tailed)		.604
	N	16	16
recovery_power	Pearson Correlation	.140	1
	Sig. (2-tailed)	.604	
	N	16	16