An Institute of

Effects of Blood Flow Restriction Training and HIIT on Aerobic and Anaerobic Capacities of Physically Active Individuals

Syntyche Yeo Syn Yu
Physical Education and Sports Science Academic Group
National Institute of Education, Nanyang Technological University, Singapore

ABSTRACT

Blood Flow Restriction Training (BFR) and High-Intensity Interval Training (HIIT) are two exercise modalities that show promise in improving physical fitness. This study aims to investigate the differences between BFR with HIIT and HIIT alone on aerobic and anaerobic capacity in physically active individuals through VO2max and Wingate tests, hypothesizing significant differences. In this randomized, counterbalanced study, 10 male participants completed 5 sessions: screening, familiarization, training (3 weeks), and pre-post testing. Participants were allocated to either the BFR + HIIT group or the HIIT Altitude group. Training involved a high-intensity short interval protocol. Group (1) wore pneumatic cuffs inflated to 80% of limb occlusion pressure for 2 minutes during rest breaks. Group (2) believed they were exercising in an altitude chamber but were in normal conditions. No significant differences between the groups were reported for absolute and relative VO2max (absolute p=0.181; relative p=0.081). However, significant between group differences in relative mean power output (MPO)(p=0.038) was observed. With further post hoc analyses revealed changes in the BFR group (pbonf=0.065). This suggests that BFR supplementation in HIIT does not significantly enhance aerobic capacity but does enhance anaerobic capacity. Future studies exploring BFR with HIIT should consider additional performance measures and HIIT protocols for more robust conclusions.

INTRODUCTION

Evidence has shown that BFR training can lead to various physiological adaptations, including increased strength, endurance, and muscle hypertrophy (Loenneke et al., 2011). However, most research has primarily paired BFR training with low-intensity aerobic exercises and evidence is then equivocal with regards to the effects of BFR training with high-intensity aerobic exercises.

Research Objectives

1. Investigate hypothesis that BFR and HIIT significantly improves aerobic and anaerobic capacities compared to just HIIT training
2. Produce findings that can help find strategies to optimise the adaptive responses to training, as well as ensure its safe and effective implementation in individuals.

METHODS

- Participants: 10 male physically active individuals
- Randomised, counterbalanced experimental design
- 5 weeks: 1 screening and familiarization, 9 training sessions, 1 pre-test and 1 post-test

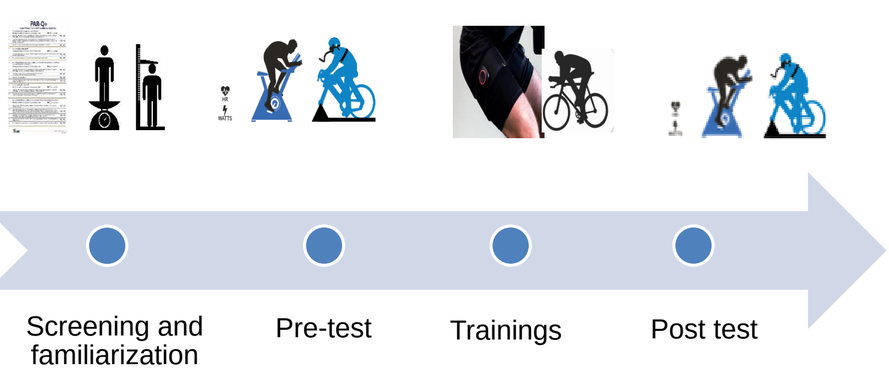

Figure 1. Schematic representation of procedures

HIIT Intervention: Total 9 sessions in 3 weeks of
3 sets x 8 repetitions of 30-s Work, 30-s Active Recovery with 4-min rest

Session 1 Session 2	*Ex. Intensity: 90% MAP, Active Recovery: 40% MAP*
Session 3 Session 4	*Ex. Intensity: 95% MAP, Active Recovery: 30% MAP*
Session 5 Session 6	*Ex. Intensity: 100% MAP, Active Recovery: 25% MAP*
Session 7 Session 8	*Ex. Intensity: 102.5% MAP, Active Recovery: 20% MAP*
Session 9	*Ex. Intensity: 105% MAP, Active Recovery: 20% MAP*

**MAP – Maximal Aerobic Power – derived as the highest 1-min power sustained in the $\dot{V}O_{2max}$ test*

Figure 2. HIIT training protocol

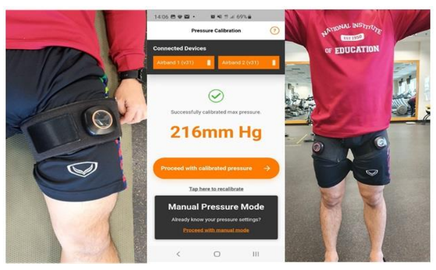

Figure 3. Calibration of Limb Occlusion Pressure (LOP) with Airbands

Using JASP statistics,

- Two-way repeated measures ANOVA used to determine significant differences ($p<0.05$) followed with Bonferroni adjustment
- Confidence intervals set at 95%, statistical significance set at $p<0.05$

RESULTS

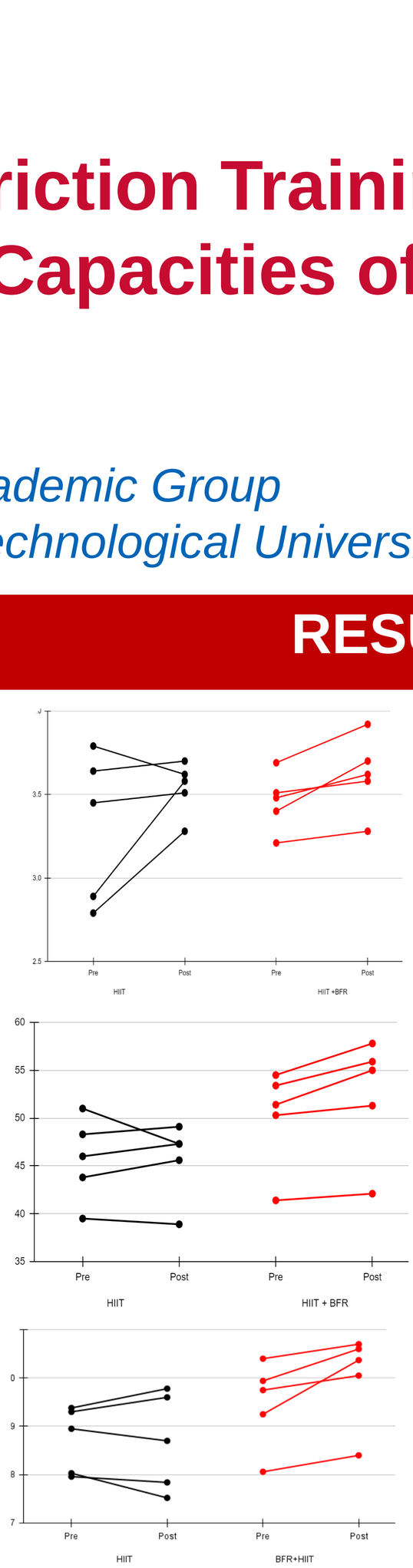

Figure 4. Line Graph of VO2max (l/min)

No significant (p=0.181) difference between VO2max(L/MIN) in BFR+HIIT (3.62±0.23) and HIIT (3.34±0.32).

Figure 5. Line Graph of VO2max (ml/kg/min)

No significant (p=0.081) difference between VO2max(ml/kg/min) in BFR+HIIT (45.6±3.97) and HIIT (52.4±6.23).

Figure 7. Line Graph of relative MPO (w/kg)

Significant (p=0.038) difference between MPO (W) in BFR+HIIT (10.0±0.94) and HIIT (8.69±1.01). Further post hoc analysis showed significant BFR group*time effect (pbonf = 0.065)

SUMMARY AND CONCLUSION

- BFR + HIIT was not observed to significantly increase relative and absolute VO2 max as compared to just HIIT alone, rejecting our first hypothesis.
- Significant difference in MPO, with further post hoc analyses revealing a significant group and time effect.

The findings of this study suggest that implementing BFR into HIIT training protocols adds no significant benefit to aerobic capacity but is beneficial for anaerobic capacity. Limitations include sample size, adaptive blunting and lack of gold standard measurement for occlusion pressure.
Considering the novelty of this research area, future studies should be conducted to form more conclusive evidence. Additionally, other exercise performance measures should be included to better understand the effects of BFR training.

ACKNOWLEDGEMENTS

I am grateful for Associate Professor Stephen Francis Burns, Dr Man Tong Chua and Dr Alexia Sim for their guidance and cooperation throughout this project, and all my participants for their time and effort.

REFERENCES

* Amani-Shalamzari S, Rajabi S, Rajabi H, Gahreman DE, Paton C, Bayati M, Rosemann T, Nikolaidis PT, Knechtle B. Effects of Blood Flow Restriction and Exercise Intensity on Aerobic, Anaerobic, and Muscle Strength Adaptations in Physically Active Collegiate Women. Front Physiol. 2019 Jun 26;10:810. doi: 10.3389/fphys.2019.00810. PMID: 31297065; PMCID: PMC6607282.
* Abe T, Fujita S, Nakajima T, Sakamaki M, Ozaki H, Ogasawara R, Sugaya M, Kudo M, Kurano M, Yasuda T, Sato Y, Ohshima H, Mukai C, Ishii N. Effects of Low-Intensity Cycle Training with Restricted Leg Blood Flow on Thigh Muscle Volume and VO2MAX in Young Men. J Sports Sci Med. 2010 Sep 1;9(3):452-8. PMID: 24149640; PMCID: PMC3761718.
* Baygutalp F, Buzdağlı Y, Ozan M, Koz M, Kılıç Baygutalp N, Atasever G. Impacts of different intensities of exercise on inflammation and hypoxia markers in low altitude. BMC Sports Sci Med Rehabil. 2021 Nov 22;13(1):145. doi: 10.1186/s13102-021-00375-0. PMID: 34809670; PMCID: PMC8609846.
* de Oliveira, M. F. M.; Caputo, F.; Corvino, R. B.; Denadai, B. S. (2015). *Short-term low-intensity blood flow restricted interval training improves both aerobic fitness and muscle strength. Scandinavian Journal of Medicine & Science in Sports, (), n/a–n/a.* doi:10.1111/sms.12540
* Chua, M. T., Sim, A., & Burns, S. F. (2022). Acute and Chronic Effects of blood Flow Restricted High-Intensity Interval Training: A Systematic review. *Sports Medicine - Open*, *8*(1). https://doi.org/10.1186/s40798-022-00506-y
* Formiga, M. F. (2020, April 1). *EFFECT OF AEROBIC EXERCISE TRAINING WITH AND WITHOUT BLOOD FLOW RESTRICTION ON AEROBIC CAPACITY IN HEALTHY YOUNG ADULTS: A SYSTEMATIC REVIEW WITH META-ANALYSIS*. PubMed Central (PMC). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7134358/
* Mitchell, E., Martin, N. R., Turner, M. C., Taylor, C. W., & Ferguson, R. A. (2019). The combined effect of sprint interval training and postexercise blood flow restriction on critical power, capillary growth, and mitochondrial proteins in trained cyclists. *Journal of Applied Physiology*, *126*(1), 51–59. https://doi.org/10.1152/japplphysiol.01082.2017
* Patterson, S. D., Hughes, L. J., Warmington, S. A., Burr, J. F., Scott, B. R., Owens, J. G., Abe, T., Nielsen, J. L., Libardi, C. A., Laurentino, G., Neto, G. R., Brandner, C. R., Martín-Hernández, J., & Loenneke, J. P. (2019). Blood flow Restriction Exercise: Considerations of methodology, application, and safety. *Frontiers in Physiology*, *10*. https://doi.org/10.3389/fphys.2019.00533
* Peterson, B. K. (2007). Vital signs. In *Elsevier eBooks* (pp. 598–624). https://doi.org/10.1016/b978-072160361-2.50025-9
* Scott, B. R., Loenneke, J. P., Slattery, K. M., & Dascombe, B. J. (2014). Exercise with Blood Flow Restriction: An Updated Evidence-Based Approach for Enhanced Muscular Development. *Sports Medicine*, *45*(3), 313–325. https://doi.org/10.1007/s40279-014-0288-1
* Vehrs, P. R., Richards, S., Blazzard, C., Hart, H., Kasper, N., Lacey, R., López, D., & Baker, L. (2023). Use of a handheld Doppler to measure brachial and femoral artery occlusion pressure. *Frontiers in Physiology*, *14*. https://doi.org/10.3389/fphys.2023.1239582