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ORIGINAL RESEARCH

No acute differences in anaerobic performance following autoregulated vs non-autoregulated blood flow restricted resistance exercise

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Abstract

This study aimed to investigate the acute effects of autoregulated and non-autoregulated blood flow restricted resistance exercise on Wingate anaerobic performance test metrics. Fifteen recreationally active male individuals (age: 19.67 ± 1.54 years; height: 179.3 ± 7.65 cm; weight: 76.04 ± 13.97 kg) were involved in the study. Subjects performed Wingate anaerobic tests before the experimental session and data were recorded as baseline measurements. Then, a randomised counterbalanced crossover design was adopted to compare the acute effects of autoregulated and non-autoregulated BFR by performing back squat exercise (40% 1RM, 4x15 reps). After completing the back squat exercise, subjects rested for fifteen minutes and performed Wingate anaerobic performance tests with resistance of 7.5% body mass. GraphPad Prism 10 was used to analyse the data. Significance was set at $p < 0.05$. No significant difference was found in Peak Power (W) F(2,42):0.1509, p:0.86, pη2:0.007 and Average Power (W) F(2,42):0.0014, p:0.99, pη2:0.00006 between conditions. No significant difference was found in Fatigue Index (%) F(2,42):0.9396, p:0.39, pη2:0.0042 and Power Drop(W) F(2,42):0.5860, p:0.56, pη2:0.027 between conditions. This study suggests that performing both autoregulated and non-autoregulated BFR did not show significant differences between the two conditions and compared to baseline test results. It should be noted that our study only looked at autoregulation in one specific device. Therefore, findings should be interpreted with caution, as they may not be representative of other BFR systems that use autoregulation modes.

Introduction

Blood flow restriction (BFR) training has emerged as a training modality to improve strength and hypertrophy during exercise by partially restricting arterial inflow and occluding venous outflow through tourniquets or pneumatic cuffs (de Queiros et al., 2024a; Patterson et al., 2019; Pignanelli et al., 2021). Applied pressure can be adjusted with fixed pressures (non-autoregulated BFR), however, advancements in science and technology now enable autoregulated pressure systems that dynamically adjust pressure based on muscle contraction (Jacobs et al., 2023; Rolnick et al., 2023).

Studies have shown that BFR training with low loads/intensities led to metabolic accumulation by creating a hypoxic environment (Chua et al., 2022; Loenneke et al., 2012a). However, the results are divergent when BFR was applied at a fixed pressure during anaerobic activities such as repeated sprints. Studies suggest that performance outcomes such as total work might be reduced during BFR conditions compared to non-BFR, potentially due to limited oxygen delivery and accelerated metabolite accumulation (Chua et al., 2022). Furthermore, research showed that both the BFR and control groups did not enhance their anaerobic performances, which were measured by a basketball-specific suicide test, after 12 sessions of repeated sprint test (Elgammal et al., 2020).

BFR methodology has been investigated, especially in terms of autoregulated modes (Jacobs et al., 2023; Rolnick et al., 2024). Autoregulated BFR devices adjust

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the pressure automatically within the cuff during an inflation cycle, while non-autoregulated BFR devices do not automatically adjust pressure during the inflation cycle. Autoregulated BFR has shown positive results in reducing adverse cardiovascular responses during resistance exercise; it has been reported that an increase in a marker of arterial stiffness compared to the significant increases observed with non-autoregulated BFR (Rolnick et al., 2024).

Some of the autoregulated BFR devices are portable, however, these devices are quite bulky and heavy, which can make them harder to use in everyday settings. In contrast, non-autoregulated BFR devices are typically small, lightweight, and easy to carry around. These types of BFR devices work either with batteries or manually, and don't need to be plugged into a power outlet. This makes them a more flexible and practical option for different people and places, whether it's in a clinic or at a gym (Clarkson et al., 2024).

Wingate Anaerobic Test has been used for assessing anaerobic performance mainly in high-intensity and short-time efforts (i.e., 30 seconds) (Sofuoğlu et al., 2025). Wingate Anaerobic test gives us reliable measures such as average power, fatigue index, peak power and power drop (Bar-Or, 1987). All these metrics serve as indicators of neuromuscular capacity in healthy populations (Barfield et al., 2002; Zupan et al., 2009). However, little is known about how acute single BFR exercise (i.e. multi multi-joint), either autoregulated or non-autoregulated, affects anaerobic performance outcomes in recreationally active individuals; therefore, this study aimed to address a gap, direct comparisons between autoregulated and non-autoregulated BFR modes in acute anaerobic performance metrics. We hypothesized that both autoregulated BFR and non-autoregulated BFR modes would have similar anaerobic performance outcomes, and no differences would be observed between the two conditions.

Methods

Participants

This study involved 15 recreationally trained males (age: 19.67 ± 1.54 years; height: 179.3 ± 7.6 cm; weight: 76.04 ± 13.97 kg), each with a maximum of three years of lower body resistance training experience. Participants were excluded if they had orthopaedic conditions that hindered resistance exercise, had hypertension (140/90 mmHg), or had a BMI exceeding 30 kg/m^2. A sample size calculation was performed using G*Power (version 3.1.9.7) based on previous studies examining BFR training effects on anaerobic performance. Assuming a moderate effect size of 0.5, an alpha level of 0.05, and a power of 0.80, a minimum of 12 participants was required (Faul et al., 2007). However, we recruited 15 recreationally trained males (aged 18–25 years) to account for potential dropouts. This study was approved by the local University Ethics Committee (2025-626 / E-77082166-604.01-1217852). Participants provided written informed consent before participation, and the study design and procedures conformed to ethical standards and the principles outlined in the Declaration of Helsinki.

Experimental Design

This study used a randomized, counterbalanced crossover design to compare the acute effects of autoregulated and non-autoregulated BFR modes on Wingate anaerobic performance. Participants first completed Baseline measurements, and then were randomized to Autoregulated BFR (Auto-BFR) and non-autoregulated BFR (non Auto-BFR) conditions in a counterbalanced order, with a 72-hour washout period between sessions to minimize residual fatigue effects. All participants performed a familiarization session 72 hours before the first experimental session. During this session, participants were introduced to the BFR equipment and procedures, including determining their limb occlusion pressure (LOP) in supine position by using automatic BFR leg cuffs (Fit Cuffs BFR Unit V4, Denmark), anthropometric measurements and performing the 1RM squat test (Figure 1). Single-bladder designed cuffs (width: 10 cm) were used in this study (Hughes et al., 2025). Participants also performed practice trials of the Wingate anaerobic performance test to minimize the impact of learning effects during the experimental trials. Participants completed two experimental sessions involving back squat exercise under autoregulated (Auto-BFR) and non-autoregulated (Non-auto-BFR) conditions. In the autoregulated condition, BFR pressure was dynamically adjusted based on muscle contraction. Targeted BFR pressure (70% LOP) was maintained throughout the exercise. On the other hand, in the non-autoregulated condition, BFR pressure was set at 70% LOP and remained constant throughout the exercise session. In the Baseline session, participants only performed Wingate anaerobic performance test. Participants performed four sets of 15 reps of back squat exercise at 40% 1RM with a 60-second inter-set rest period. Tempo was adjusted to be 1 second eccentric and 1 second concentric (1-0-1-0) with high bar squat technique and supervised by the researcher. BFR cuffs were applied to the proximal thigh using an automatic cuff system. Participants rested for 15 minutes post-exercise before performing the Wingate anaerobic performance tests (Boullosa, 2021; Wilson et al., 2013). All trials were conducted at the same time of day to control for potential variations due to circadian rhythms.

Procedures

Wingate Anaerobic Performance

Participants performed a 30-second maximal cycling sprint using a Monark Ergomedic 843E cycle ergometer (Monark, Vansbro, Sweden) against a resistance of 7.5% body mass. Peak power (W), mean power (W), power drop (W) and fatigue index (%) were recorded. Anaerobic power output was assessed by the 30-second Wingate Anaerobic Test (WAnT) (Bar-Or, 1987). Participants remained in a seated position throughout the test. Power output data were sampled at 10 Hz throughout the test. The largest power value recorded in the 1-second interval was defined as maximum power. The average power output was defined as the average output over the 30-second duration of the test. The smallest power value recorded in the 1-second interval was defined as the minimum power. The difference in values between time intervals was expressed as a power drop (Dotan & Bar-Or, 1983).

Back Squat 1 Repetition Maximum (1RM) Test

The one-repetition maximum (1RM) for the back squat was assessed using a standardized protocol. Before the test, subjects performed a 10-minute warm-up of self-selected cycling on a cycle ergometer (Indoor cycle, Life Fitness, Rosemont, IL, USA). Following a 5-minute rest period, subjects completed 5 to 10 repetitions at loads ranging from 50% to 70% of their estimated 1RM (Profitness 1030, Türkiye), with a 2-minute rest interval between each load. After a 3-minute rest period, subjects performed a single repetition at 90% of their estimated 1RM. If successful, the load was increased based on the subject's feedback from the previous attempt. If the increased load attempt was unsuccessful, the last successful attempt was recorded as the subject's 1RM (Haff & Triplett, 2015). A rest period of 72 hours was provided between the 1RM testing and the first data collection session (Figure 1).

Heart Rate and Blood Pressure

OMRON M4 Intelli HEM-7155T (Omron Healthcare Co. Ltd., Kyoto, Japan) was used to measure both blood pressure (BP) and resting heart rate (RHR). The subjects' left arm was used to test their blood pressure after they had been sitting on a chair for five minutes at room temperature. The measurement was made twice, one minute apart, and the average was expressed in mmHg. A third measurement was taken and the average of the two closest measurements was noted if the results were not within 5 mm Hg (Loenneke et al., 2013).

Rating of perceived exertion (RPE) and Rating of perceived discomfort (RPD)

RPE for each condition was collected at the end of every vertical jump performance by Borg (6-20) scale (Foster et al., 2021). The RPD scale ranged from 0 "no discomfort" to 10 "maximal discomfort" and was used to evaluate the rating of perceived discomfort (Borg, 1998). RPE/RPD was only assessed immediately after the back squat exercise with the cuffs inflated for both autoregulated and non-autoregulated BFR modes.

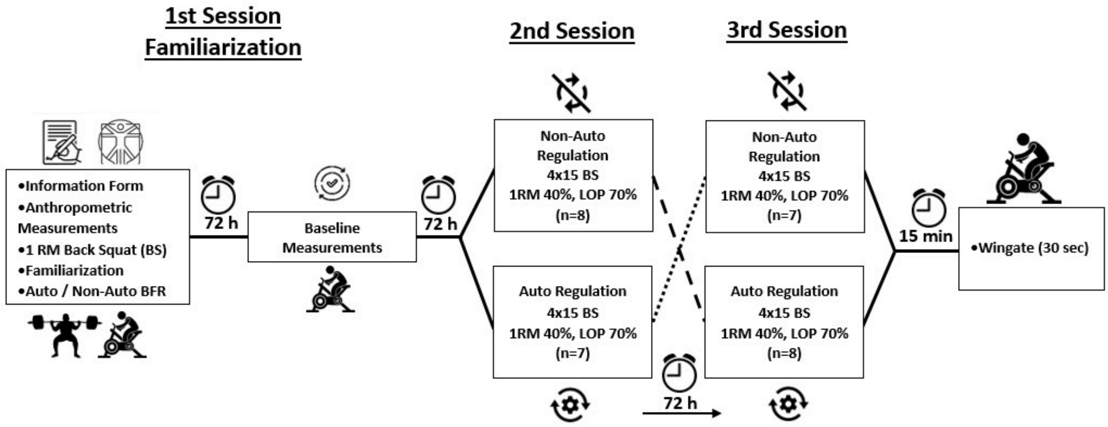

Figure 1. Experimental design of the study.

Statistical Analysis

Data are presented as mean and standard deviation with 95% confidence intervals. The normality of the data was checked using the Shapiro-Wilk test. A one-way repeated measures analysis of variance (ANOVA) was used to determine whether the condition factor had a significant impact on the performance metrics of the WAnT outcomes. Post-hoc pairwise comparisons were conducted with Tukey correction when a significant interaction was found. A t-test was used to compare RPE and RPD values between autoregulated and non-autoregulated BFR modes. The effect sizes of the main effects were determined using partial eta squared (pη2), with interpretations categorized as small (0.01), medium (0.06), and large (0.14) effects (Bakeman, 2005). The Cohen's d effect size ranges were categorized as 0.2, indicating a small effect, 0.5 representing a medium effect, and 0.8 or higher signifying a large effect (Cohen, 1988). GraphPad Prism 10 (GraphPad Software Inc., San Diego, CA, USA) was used to analyse and present the data. Significance was set at $p < 0.05$.

Results

Table 1 shows the descriptive characteristics of the participants (Table 1).

Peak power (W) and Average Power (W)

No significant difference was found in Peak Power (W) $F_{(2,42)}$:0.1509, p:0.86, $p\eta^2$:0.007 and Average Power (W) $F_{(2,42)}$:0.0014, p:0.99, $p\eta^2$:0.00006 between conditions (Figure 2 and Table 2). These results suggest that the intervention had no statistically or practically significant effect on peak anaerobic power output.

Fatigue Index (%) and Power Drop (W)

No significant difference was found in Fatigue Index (%) $F_{(2,42)}$:0.9396, p: 0.39, $p\eta^2$:0.0042 and Power Drop(W) $F_{(2,42)}$:0.5860, p.0.56, $p\eta^2$:0.027 between conditions (Figure 3 and Table 2).

Rating of perceived exertion (RPE) and Rating of perceived discomfort (RPD)

RPE was significantly higher in Auto-BFR (MD = 1.53 ± 0.51, 95% CI (0.47–2.59), p = 0.0063, Cohen’s d: 0.85) compared to the non-Auto BFR (Figure 4). RPD was also significantly higher in Auto-BFR compared to non-Auto BFR (MD = 1.06 ± 0.45, 95% CI (0.12–2.07), p = 0.0276, Cohen’s d: 1.08).

Table 1
Descriptive characteristics of the subjects.

Variables	Mean ± SD
Age (year)	19.67 ± 1.54
Height (cm)	179.3 ± 7.65
Weight (kg)	76.04 ± 13.97
BMI (kg/m^2)	23.53 ± 3.34
SBP (mmHg)	119.5 ± 7.09
DBP (mmHg)	69.87 ± 9.72
RHR (bpm)	82.53 ± 9.69
LOP	
Right (mmHg)	178.0 ± 15.7
Left (mmHg)	180.3 ± 17.8
Targeted LOP (70%LOP)	
Right (mmHg)	124.6 ± 11.04
Left	126.2 ± 12.5
1 RM (kg)	114.3 ± 27.51

BMI: Body mass index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; RHR: Resting Heart Rate; bpm: beats per minute; LOP: Limb Occlusion Pressure; RM: Repetition Maximum.

Table 2
Performance Metrics for Wingate anaerobic performance test scores.

Variables	Conditions			ANOVA		
	Baseline	Auto-BFR	Non Auto-BFR	F	p	η_p^2
PP (W)	911 ± 193.4 (803.9 - 1018)	886.2 ± 205.6 (772.3 - 1000)	924.1 ± 176.4 (826.4 - 1022)	0.1509	0.86	0.007
AP (W)	623.7 ± 127.8 (553 - 694.5)	625 ± 127.6 (554.3 - 695.7)	626.2 ± 116.3 (561.7 - 690.6)	0.0014	0.99	0.00006
FI (%)	63.78 ± 5.88 (60.53 - 67.04)	61.32 ± 8.57 (56.56 - 66.07)	66.06 ± 12.72 (59.02 - 73.1)	0.9396	0.39	0.042
PD (W)	584.5 ± 153.2 (499.7 - 669.3)	548.6 ± 165.5 (456.9 - 640.2)	613.6 ± 175 (516.7 - 710.5)	0.5860	0.56	0.027

Data are presented as mean ± standard deviation with 95% confidence interval; Auto-BFR: Autoregulated Blood flow restriction; non Auto-BFR: non Autoregulated Blood flow restriction; PP: Peak power; AP: Average power; PD: Power drop; FI: Fatigue Index.

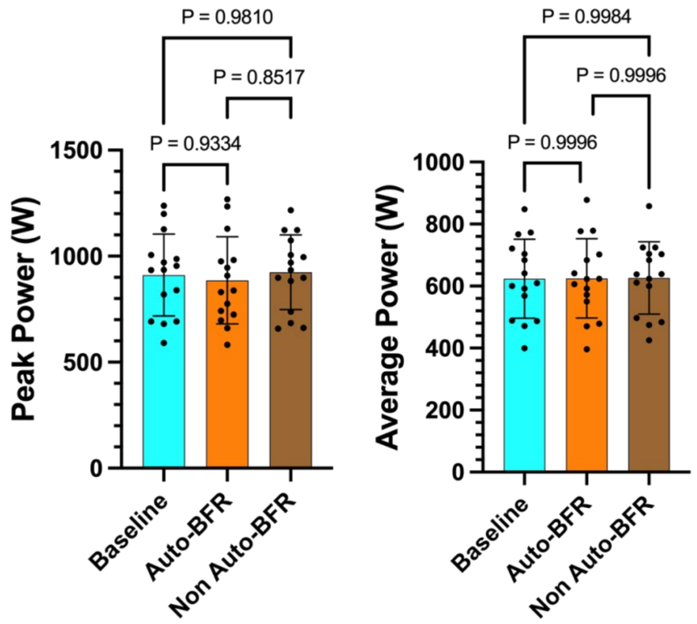

Figure 2. Graphical presentation of the Peak power (W) and average power (W).

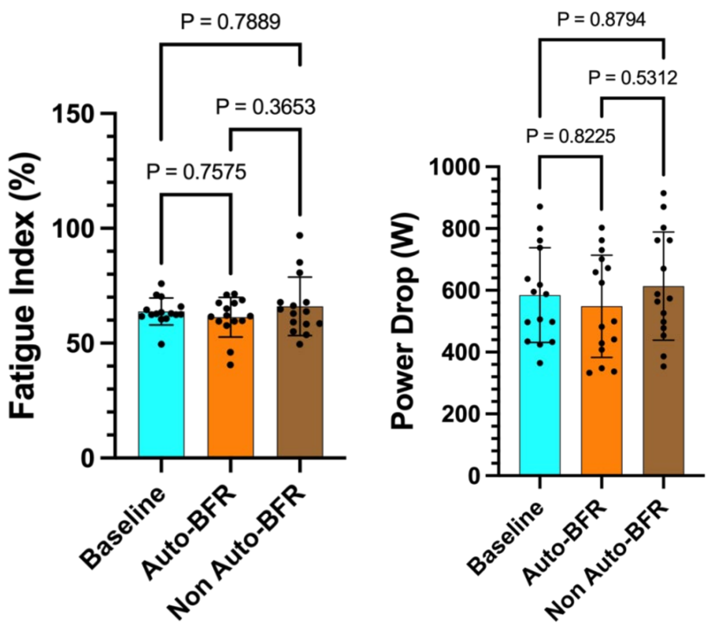

Figure 3. Graphical presentation of the Fatigue index (%) and Power drop (W).

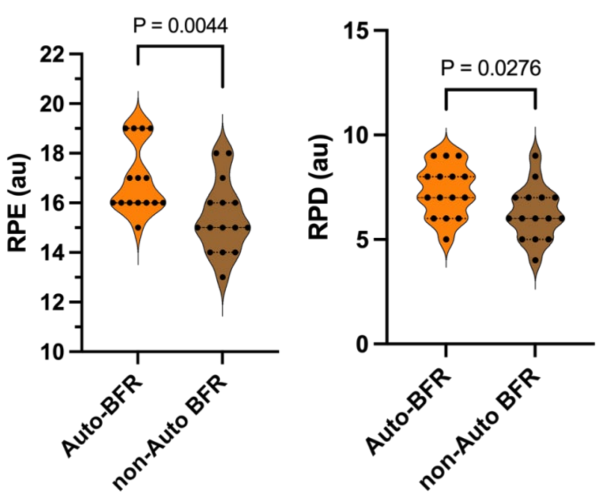

Figure 4. Comparison of the RPE and RPD (au: arbitrary units).

Discussion

This study aimed to investigate the acute effects of autoregulated and non-autoregulated Blood flow restricted resistance exercise on Wingate anaerobic power performance test. The primary finding of this study was that there were no differences between the autoregulated and non-autoregulated BFR modes on Wingate anaerobic power performance metrics when using the Fitcuffs BFR device.

Previous studies have shown that BFR training can enhance muscle strength, aerobic, anaerobic and athletic performance in both men and women participants (Amani-Shalamzari et al., 2019; Kamiş et al., 2024a; Kamiş et al., 2024; Korkmaz et al., 2022; Pişkin et al., 2022); however, these studies typically focused on chronic adaptations rather than acute responses. Our study does not align with findings by Rolnick et al. (2024), who reported that no differences between autoregulated and non-autoregulated in perceptual response (RPE/RPD) in physically active individuals. This may be explained by the specific features of the device and cuffs used in the studies.

When considering both BFR conditions, it was also crucial that subjects performed low-load resistance exercise (40% 1RM), which may not have produced adequate neuromuscular fatigue to differentiate between the two different BFR modalities. Furthermore, in a study that was conducted by Pearson and Hussain in 2015, the authors concluded that low-load BFR exercise can show comparable muscle activation and hormonal responses compared to high-load resistance exercise (Pearson & Hussain, 2015) ; however, acute anaerobic performance metrics may be more sensitive to the level of hypoxia.

Another study that was conducted by Jacobs et al. (2023), investigated the acute responses of the autoregulated and non-autoregulated BFR modalities on both performance and perceptual outcomes. The subject evaluated the performance metrics by repetitions of the exercise performed. The authors have concluded that participants performed more repetitions in each set in the autoregulated BFR modality compared with the non-autoregulated BFR modality (Jacobs et al., 2023). Even though no statistical differences were found in our study, findings suggest that individual responses to the two different BFR modalities may vary considerably. This variability is consistent with the studies reporting differences in limb occlusion pressure, assessment of position and cuff widths (de Queiros et al., 2024b; Kamiş et al., 2024b; Loenneke et al., 2012b). This can be explained by the cuffs' design, types, shapes and cuff width and also the position of the limb occlusion pressure assessments.

As for perceptual responses, similar to our findings, Dancy et al. (2023) have concluded that no differences have occurred when comparing three different cuff devices (Delfi, B-strong, SmartCuffs). The authors have found that all devices were safe and were able to reduce repetitions compared to biceps curl exercise without BFR cuffs. However, the autoregulated device produces significantly higher RPE in the second set compared to other devices (Dancy et al., 2023). In contrast to our study, Jacobs et al. 2023 have found that RPE was lower in the autoregulated condition compared to the non-autoregulated one (Jacobs et al., 2023). Perceptual responses can be influenced by the cuff width, shape and also the autoregulation device feature. In our study, we used the Fitcuffs BFR device; therefore, the lack of difference in RPE between conditions in our study may be interpreted as a device-specific outcome.

The present study has some limitations. First, we only included recreationally active male subjects; therefore, future studies can also include female participants and highly trained athletes. Second, we allocated only 15 minutes to assess their anaerobic performance to ensure practical applicability in research settings. Third, we investigated the autoregulation effect only in one specific device (Fit Cuffs BFR device). Therefore, findings should be interpreted with caution, as they may not be representative of other BFR devices that use autoregulation modes. Lastly, participants performed only a single bout of exercise. Moreover, although the Wingate anaerobic performance test was a valid method, additional outcomes, such as blood lactate levels would provide more comprehensive results for each BFR modality.

Conclusion

In conclusion, our findings show that recreationally active individuals can use the Fit Cuffs BFR device in either autoregulated or non-autoregulated modes. It should be noted that our study only looked at autoregulation in one specific device (Fit Cuffs BFR device). Therefore, these findings should be used cautiously, as the device's features can influence both acute anaerobic performance and perceptual responses. Moreover, additional factors such as exercise type (i.e., aerobic), volume, intensity and cuff pressure should be considered when prescribing BFR exercises. However, future studies should investigate whether these findings are applicable to chronic adaptations and specific populations, such as females or highly trained male or female athletes.

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Authors' Contribution

Study Design: OK; Project administration: OK, KK, NA; Data Collection: NA, CS; Statistical Analysis and Visualization: OK; Writing – original draft: OK; Review & editing: OK, KK, NA; All authors discussed the results and contributed to the final manuscript.

Ethical Approval

This study was approved by the Gazi University Ethics Committee (2025-626 / E-77082166-604.01-1217852). Participants provided written informed consent before participation, and the study design and procedures conformed to ethical standards and the principles outlined in the Declaration of Helsinki.

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Conflict of Interest

No conflict of interest was reported.

References

Amani-Shalamzari, S., Rajabi, S., Rajabi, H., Gahreman, D. E., Paton, C., Bayati, M., Rosemann, T., Nikolaidis, P. T., & Knechtle, B. (2019). Effects of blood flow restriction and exercise intensity on aerobic, anaerobic, and muscle strength adaptations in physically active collegiate women. *Front Physiol*, *10*, 810. doi: 10.3389/fphys.2019.00810

Bakeman, R. (2005). Recommended effect size statistics for repeated measures designs. *Behav Res Methods*, *37*(3), 379-384. doi: org/10.3758/BF03192707

Bar-Or, O. (1987). The Wingate anaerobic test. An update on methodology, reliability and validity. *Sports Med*, *4*(6), 381-394. doi: 10.2165/00007256-198704060-00001

Barfield, J. P., Sells, P. D., Rowe, D. A., & Hannigan-Downs, K. (2002). Practice effect of the Wingate anaerobic test. *J Strength Cond Res*, *16*(3), 472-473.

Borg, G. (1998). *Borg's perceived exertion and pain scales*. Human Kinetics.

Boullosa, D. (2021). Post-activation performance enhancement strategies in sport: a brief review for practitioners [journal article]. *Human Movement*, *22*(3), 101-109. doi: 10.5114/hm.2021.103280

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 Med Open*, *8*(1), 122. doi: 10.1186/s40798-022-00506-y

Clarkson, M. J., McMahon, B., & Warmington, S. A. (2024). Comparing adaptations from blood flow restriction exercise training using regulated or unregulated pressure systems: A systematic review and meta-analysis. *Clin Rehabil*, *38*(11), 1446-1465. doi: 10.1177/02692155241271040

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge. doi: 10.4324/9780203771587

Dancy, M. E., Alexander, A. S., Abbas, M. J., Rolnick, N., Alder, K. D., Lu, Y., & Okoroha, K. R. (2023). No differences in exercise performance, perceptual response, or safety were observed among 3 blood flow restriction devices. *Arthrosc Sports Med Rehabil*, *5*(6), 100822. doi: 10.1016/j.asmr.2023.100822

de Queiros, Rolnick, N., Schoenfeld, B. J., de França, I. M., Vieira, J. G., Sardeli, A. V., Kamis, O., Neto, G. R., Cabral, B. G. d. A. T., & Dantas, P. M. S. (2024a). Hypertrophic effects of low-load blood flow restriction training with different repetition schemes: a systematic review and meta-analysis. *PeerJ*, *12*, e17195.

de Queiros, V. S., Rolnick, N., Kamiş, O., Formiga, M. F., Rocha, R. F. C., Alves, J. C. M., Vieira, J. G., Vianna, J. M., Wilk, M., Fostiak, K., Cabral, B. Guilherme d. A. T., & Dantas, P. M. S. (2024b). Body position and cuff size influence lower limb arterial occlusion pressure and its predictors: implications for standardizing the pressure applied in training with blood flow restriction. *Front Physiol, 15*. doi: 10.3389/fphys.2024.1446963

Dotan, R., & Bar-Or, O. (1983). Load optimization for the Wingate Anaerobic Test. *Eur J Appl Physiol Occup Physiol*, *51*(3), 409-417. doi: 10.1007/bf00429077

Elgammal, M., Hassan, I., Eltanahi, N., & Ibrahim, H. (2020). The effects of repeated sprint training with blood flow restriction on strength, anaerobic and aerobic performance in basketball. *International Journal of Human Movement and Sports Sciences*, *8*(6), 462-468. doi: 10.13189/saj.2020.080619

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods*, *39*(2), 175-191. doi: 10.3758/BF03193146

Foster, C., Boullosa, D., McGuigan, M., Fusco, A., Cortis, C., Arney, B. E., Orton, B., Dodge, C., Jaime, S., Radtke, K., van Erp, T., de Koning, J. J., Bok, D., Rodriguez-Marroyo, J. A., & Porcari, J. P. (2021). 25 years of session rating of perceived exertion: historical perspective and development. *Int J Sports Physiol Perform*, *16*(5), 612-621. doi: 10.1123/ijspp.2020-0599

Haff, G. G., & Triplett, N. T. (2015). *Essentials of strength training and conditioning 4th edition*. Human kinetics.

Hughes, L., Rolnick, N., Franz, A., Owens, J., Swain, P. M., Centner, C., Loenneke, J. P., & Warmington, S. A. (2025). Blood flow restriction: methods and apparatus still matter. *Br J Sports Med*, 59(9), 623-625. doi: 10.1136/bjsports-2024-109365

Jacobs, E., Rolnick, N., Wezenbeek, E., Stroobant, L., Capelleman, R., Arnout, N., Witvrouw, E., & Schuermans, J. (2023). Investigating the autoregulation of applied blood flow restriction training pressures in healthy, physically active adults: an intervention study evaluating acute training responses and safety. *Br J Sports Med*, *57*(14), 914-920. doi: 10.1136/bjsports-2022-106069

Kamiş, O., Gürses, V. V., Şendur, H. N., Altunsoy, M., Pekel, H. A., Yıldırım, E., & Aydos, L. (2024a). Low-load resistance exercise with blood flow restriction versus high-load resistance exercise on hamstring muscle adaptations in recreationally trained men. *J Strength Cond Res*, *38*(10), e541-e552. doi: 10.1519/jsc.0000000000004870

Kamiş, O., Kurt, M., Blaisdell, R., Macdonald, C., & Nobarı, H. (2024). Effect of bodyweight squat exercise with blood flow restriction on sprint and jump performance in collegiate soccer players. *Pamukkale Journal of Sport Sciences*, *15*(3), 632-648. doi: 10.54141/psbd.1516188

Kamiş, O., Rolnick, N., de Queiros, V., Akçay, N., Keskin, K., Yıldız, K., Sofuoğlu, C., Werner, T., & Hughes, L. (2024b). Impact of limb occlusion pressure assessment position on performance, cardiovascular, and perceptual responses in blood flow restricted low-load resistance exercise: A randomized crossover trial. *J Sports Sci*, 1-9. doi: 10.1080/02640414.2024.2422205

Korkmaz, E., Dönmez, G., Uzuner, K., Babayeva, N., Torgutalp, Ş. Ş., & Özçakar, L. (2022). Effects of blood flow restriction training on muscle strength and architecture. *J Strength Cond Res*, *36*(5), 1396-1403. doi: 10.1519/jsc.0000000000003612

Loenneke, J., Fahs, C., Thiebaud, R., Rossow, L., Abe, T., Ye, X., Kim, D., & Bemben, M. (2012a). The acute muscle swelling effects of blood flow restriction. *Acta Physiol Hung*, *99*(4), 400-410. doi: 10.1556/aphysiol.99.2012.4.4

Loenneke, J., Fahs, C. A., Rossow, L. M., Sherk, V. D., Thiebaud, R. S., Abe, T., Bemben, D. A., & Bemben, M. G. (2012b). Effects of cuff width on arterial occlusion: implications for blood flow restricted exercise. *Eur J Appl Physiol*, *112*(8), 2903-2912. doi: 10.1007/s00421-011-2266-8

Loenneke, J. P., Thiebaud, R. S., Fahs, C. A., Rossow, L. M., Abe, T., & Bemben, M. G. (2013). Blood flow restriction does not result in prolonged decrements in torque. *Eur J Appl Physiol*, *113*(4), 923-931. doi: 10.1007/s00421-012-2502-x

Patterson, S. D., Hughes, L., Warmington, S., Burr, J., Scott, B. R., Owens, J., Abe, T., Nielsen, J. L., Libardi, C. A., Laurentino, G., Neto, G. R., Brandner, C., Martin-Hernandez, J., & Loenneke, J. (2019). Blood flow restriction exercise: considerations of methodology, application, and safety. *Front Physiol*, *10*. doi: 10.3389/fphys.2019.00533

Pearson, S. J., & Hussain, S. R. (2015). a review on the mechanisms of blood-flow restriction resistance training-induced muscle hypertrophy. *Sports Med*, *45*(2), 187-200. doi: 10.1007/s40279-014-0264-9

Pignanelli, C., Christiansen, D., & Burr, J. F. (2021). Blood flow restriction training and the high-performance athlete: science to application. *J Appl Physiol, (1985)*, *130*(4), 1163-1170. doi: 10.1152/japplphysiol.00982.2020

Pişkin, N. E., Aktuğ, Z. B., İbiş, S., & Aka, H. (2022). The effect of the combined application of blood flow restriction-theraband training to lower and upper extremities on to athletic performance. *Journal of Human Sciences*, *19*(1), 69-83. doi: 10.14687/jhs.v19i1.6267

Rolnick, N., Kimbrell, K., & de Queiros, V. (2023). Beneath the cuff: Often overlooked and under-reported blood flow restriction device features and their potential impact on practice—A review of the current state of the research. *Front Physiol*, *14*. doi: 10.3389/fphys.2023.1089065

Rolnick, N., Licameli, N., Moghaddam, M., Marquette, L., Walter, J., Fedorko, B., & Werner, T. (2024). Autoregulated and non-autoregulated blood flow restriction on acute arterial stiffness. *Int J Sports Med*, *45*(1), 23-32. doi: org/10.1055/a-2152-0015

Sofuoğlu, C., Fujita, R. A., Keskin, K., Kamiş, O., & Akçay, N. (2025). Acute electrical muscle stimulation effects on strength and anaerobic power in soccer players. *Int J Sports Med,* 6(7), 501-509. doi: 10.1055/a-2563-9289

Wilson, J. M., Duncan, N. M., Marin, P. J., Brown, L. E., Loenneke, J. P., Wilson, S. M., Jo, E., Lowery, R. P., & Ugrinowitsch, C. (2013). Meta-analysis of postactivation potentiation and power: effects of conditioning activity, volume, gender, rest periods, and training status. *J Strength Cond Res*, *27*(3), 854-859. doi: 10.1519/JSC.0b013e31825c2bdb

Zupan, M. F., Arata, A. W., Dawson, L. H., Wile, A. L., Payn, T. L., & Hannon, M. E. (2009). Wingate Anaerobic Test peak power and anaerobic capacity classifications for men and women intercollegiate athletes. *J Strength Cond Res*, *23*(9), 2598-2604. doi: 10.1519/JSC.0b013e3181b1b21b