Multiple Exposures to Blood Flow Restriction Walking Affects Ratings of Perceived Exertion but Not Pain

Direct Original Research

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Open Access

Published: February 18, 2026

Research in Health and Medicine: *2026, Volume 6 (Issue 1): 5*

ISSN: 3066-0777

Abstract

Introduction: Blood flow restriction (BFR) walking elicits improved fitness, but participants often report higher ratings of perceived exertion (RPE) and pain during BFR walking compared to non-BFR walking. The primary aim was to investigate how multiple BFR walking exposures might affect RPE and pain.

Methods: 14 healthy, trained participants completed three BFR walking sessions on separate days. The treadmill speed that elicited 3/10 RPE while BFR was not applied was determined and that same speed was used during all BFR walking sessions. Participants walked for 15 minutes at the predetermined speed while 60% limb occlusion pressure was applied bilaterally to the thighs. RPE (0-10) and pain (0-10) were recorded during each minute of exercise. Two-way repeated measures analysis of variance determined if session (1-3) and/or time (1-15 minutes) affected RPE or pain. Statistical significance was established at $p<0.05$.

Results: RPE was higher during session 1 compared to session 2 (minutes 8-15, 4.4±1.4 versus 3.6±0.8). RPE was higher during session 1 compared to session 3 (minutes 3-5, 3.5±0.7 versus 2.9±0.6; minutes 7-15, 4.3±1.3 versus 3.5±1.1). No significant differences were observed for pain.

Conclusion: Participants might tolerate BFR walking better after completing two BFR walking sessions as lowered RPE responses were observed.

Key Words: Aerobic Exercise, Exercise Tolerance, Exercise Familiarization

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Introduction

Previous investigations have reported improved aerobic capacity (VO_{2MAX})[1], functional ability[2], maximal minute ventilation[1], muscular strength[2–4], and muscular hypertrophy[2–5] subsequent to blood flow restriction (BFR) walking interventions. Thus, BFR walking interventions might be an attractive alternative training method that practitioners consider using when trying to improve various aspects of physical fitness with low-intensity loads. However, BFR walking has been shown to elicit higher ratings of perceived exertion (RPE)[6,7] and pain[7] responses compared to non-BFR walking. These higher RPE and pain responses could potentially decrease participant tolerance to BFR walking, possibly challenging the effectiveness of this alternative training method.

Previous investigations[6,7] have only monitored exercising RPE and pain responses during a single session of BFR walking. Therefore, it is currently unknown how exercising RPE and pain responses might change subsequent to multiple exposures of BFR walking. Therefore, the primary aim of this study was to investigate the potential effect that

multiple BFR walking exposures (three separate sessions) might have on exercising RPE and pain responses. It was hypothesized that the exercising RPE and pain responses would decrease with repeated exposures to BFR walking.

Methods

Based upon the exercising RPE results of a previous BFR walking investigation[7], an a priori power analysis indicated that six participants were needed for the present investigation (power = 0.80, alpha = 0.05). Since the current dataset came from a larger BFR walking investigation[8], fourteen healthy trained participants (8 female, 6 male; age = 22 ± 1 years; height = 1.70 ± 0.07 m; weight = 66.0 ± 9.6 kg) completed three BFR walking sessions separated by at least 48 hours. All participants provided written informed consent after having the methods and possible risks explained. The experimental protocol was approved by the Institutional Review Board for Human Subject Research and was in accordance with the Declaration of Helsinki.

At the beginning of each session, resting heart rate and resting blood pressure were measured after five minutes of seated rest. 100% limb occlusion pressure (LOP) was assessed with the participants in a standing position by placing a handheld Doppler ultrasound over the posterior tibial artery and gradually increasing the occlusion pressure of the BFR cuff (Rapid Cuff Inflation System, Hokanson, Bellevue, Washington, USA) until no auditory pulse was detected. The Doppler ultrasound remained over the posterior tibial artery after the BFR cuff was deflated to confirm that blood flow returned to the limb after cuff deflation and that the head of the Doppler ultrasound was not moved during the assessment[9]. The lowest occlusion pressure that resulted in no auditory pulse detected by the Doppler ultrasound was considered 100% LOP. The LOP was assessed while the participant was in a standing position since body position can influence the LOP measurement[10] and the participant would be in a standing position during the walking exercise.

The treadmill walking speed that elicited a 3/10 RPE without BFR was identified. Then during all three sessions, participants continuously walked for 15 minutes at the predetermined 3/10 RPE speed while 60% LOP was applied bilaterally to the proximal thighs. Exercising RPE (0 = "nothing at all", 10 = "maximal")[11] and perceived pain (0 = "no pain", 10 = "worst possible pain")[12] were recorded every minute during the walking bouts. Two-way repeated measures analysis of variance (ANOVA) was used to determine if session (1-3) and/or time (1-15 minutes) affected the exercising RPE or pain responses. When appropriate, significant main effects and/or interactions from the ANOVA were further analyzed using Tukey's post-hoc test to identify significant pairwise differences. Cohen's D equal group effect sizes (ES) were calculated as the difference in means divided by the pooled standard deviation. ES were interpreted as 0.20-0.49 = "small", 0.50-0.79 = "moderate", and >0.80 = "large". Statistical significance was established at $p<0.05$. The *a priori* power analysis was performed using G*Power 3.1.9.7[13]. All other statistical analyses were performed using Sigma Plot 14.0 (Grafiti LLC, Palo Alto, California, USA).

Results

Table 1 includes resting heart rate, resting blood pressure, resting mean arterial pressure, walking speed, 100% LOP, and 60% LOP for each of the three BFR walking sessions. RPE was higher during session 1 compared to session 2 during minutes 8-15 (4.4±1.4 versus 3.6±0.8, ES = 0.70; Figure 1). RPE was higher during session 1 compared to session 3 during minutes 3-5 (3.5±0.7 versus 2.9±0.6, ES = 0.92; Figure 1) and minutes 7-15 (4.3±1.3 versus 3.5±1.1, ES = 0.66; Figure 1). No significant difference was observed for pain between session 1 (2.2±2.2), session 2 (1.6±1.6), or session 3 (1.4±1.6).

Table 1. Resting measures, walking speed, and limb occlusion pressures

Variable	Session 1	Session 2	Session 3
Resting Heart Rate	64 ± 9 bpm	66 ± 14 bpm	69 ± 10 bpm
Resting Blood Pressure	122/76 ± 7/8 mmHg	119/70 ± 10/12 mmHg	118/75 ± 11/8 mmHg
Resting Mean Arterial Pressure	91 ± 7 mmHg	87 ± 11 mmHg	89 ± 8 mmHg
Walking Speed	4.0 ± 0.6 km/h	4.0 ± 0.6 km/h	4.0 ± 0.6 km/h
100% Limb Occlusion Pressure	232 ± 49 mmHg	220 ± 43 mmHg	212 ± 27 mmHg
60% Limb Occlusion Pressure	139 ± 30 mmHg	132 ± 26 mmHg	127 ± 16 mmHg

Data is reported as the mean ± SD.

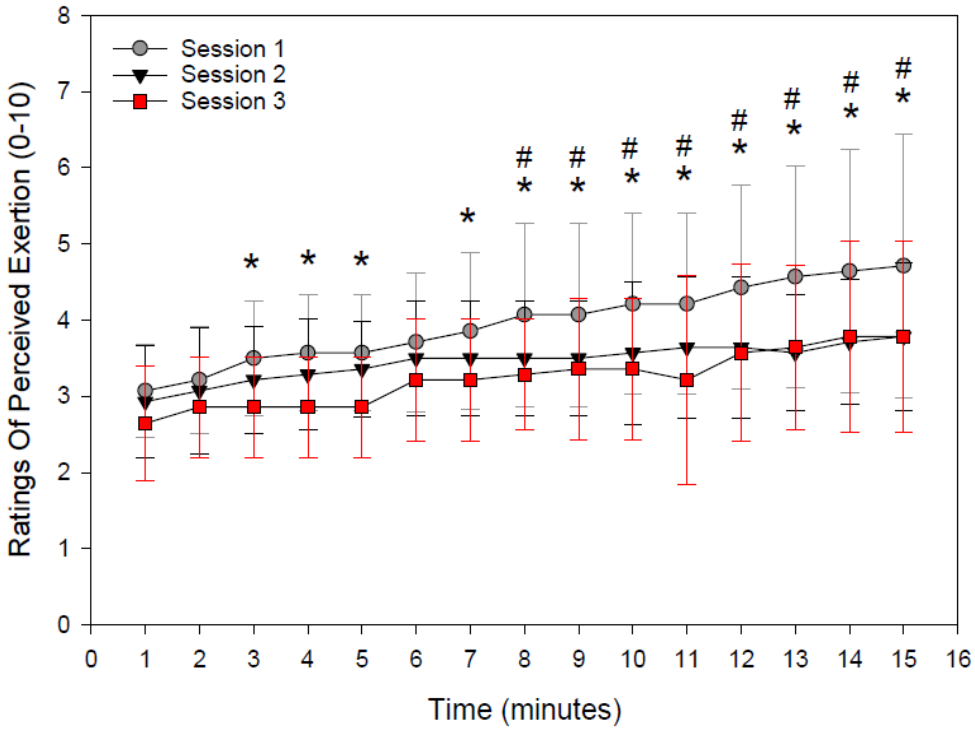

Figure 1. Exercising ratings of perceived exertion (RPE) response to blood flow restricted walking
#Session 1 is significantly different from Session 2 ($p<0.05$). *Session 1 is significantly different from Session 3 ($p<0.05$).

Discussion

The primary aim of this study was to investigate the potential effect that multiple BFR walking exposures (three separate sessions) might have on the exercising RPE and pain responses. Similar to previous BFR walking investigations[6,7], the present investigation observed RPE responses after 15 minutes of BFR (60% LOP) walking during the first exposure to be just below "heavy" intensity (5/10 or 15/20)[11]. In accordance with the hypothesis, RPE responses had a "moderate-large" (ES = 0.66-0.92) significant decrease for the majority of the 15-minute bout (minutes 3-5 and 7-15) after participants completed two BFR walking sessions (Figure 1). This novel finding that RPE significantly decreases after exposure to two BFR walking sessions in trained individuals, builds upon previous BFR walking research that has demonstrated BFR walking elicits higher RPE responses compared to non-BFR walking during a single session[6,7]. Previously, small decreases in RPE during walking have been reported in physically inactive participants after repeated exposures to non-BFR walking, potentially due to participants becoming familiarized and better tolerating the walking exercise[14]. These previous findings[14] support the possibility that the lowered RPE responses observed in the present study could be due to the participants becoming familiarized with and might have tolerated BFR walking better after completing two sessions. From a practical application perspective, the present RPE findings might help practitioners who are implementing BFR walking with trained clients as they know that their clients might better tolerate the BFR walking modality after completing two sessions as the RPE response might be lowered.

In contrast to a previous BFR walking study[7], the present study observed lower pain ratings during BFR walking. This could be due to differences in the exercise (interval walking at 5 km/h versus continuous walking at 4 km/h) and/or occlusion (absolute 200 mmHg versus 60% LOP) protocols, however the current study does not include any findings to substantiate these speculations. The absolute 200 mmHg occlusion pressure used in the previous study[7] would have corresponded to 86-94% LOP within the current study (Table 1). The present study also observed that perceived pain did not significantly change with repeated exposure to BFR walking. This could be due to the perceived pain scores remaining lower than 3/10 on the perceived pain visual analog scale, suggesting that the participants did not experience a high amount of perceived pain during BFR (60% LOP) continuous walking.

This study is not without limitations. Mainly, this study only investigated exercising RPE and pain responses following multiple exposures to BFR walking and did not include a non-BFR walking condition. This was because the present dataset is from a larger BFR walking investigation[8] that did not include multiple exposures to non-BFR walking. However, including the non-BFR walking condition in future studies could help determine if exercising RPE responses would be similar between non-BFR walking and BFR walking subsequent to participants becoming familiarized with BFR walking. Lastly, the current study investigated trained participants, therefore, the authors caution the generalizability of the present results to untrained and/or clinical populations.

Conclusions

In conclusion, the present study demonstrated that RPE responses during BFR walking decreased for the majority of the exercise bout (minutes 3-5 and 7-15) after the participants completed two BFR walking sessions (Figure 1). This finding may suggest that it takes two BFR walking sessions for a trained participant to become familiarized and potentially better tolerate the exercise modality providing a possible timeline for exercise progression. However, the present findings do not exclude the possibility that RPE responses were reduced because participants might have become familiarized with the walking exercise and not with BFR. Practitioners who decide to use BFR walking as an alternative training method might predict participant tolerance of BFR walking to improve after the first two sessions as lower RPE responses were observed.

Acknowledgements

The authors would like to sincerely thank the participants for volunteering their time and efforts to complete the study.

Conflict of Interest

The authors declare no conflicts of interest.

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