University of South Australia

Staying strong: Improving health for Rheumatoid Arthritis using Blood Flow Restriction.

Arthritis Australia Grant in Aid: Lay report.

Title:

Staying strong: Improving health for Rheumatoid Arthritis using Blood Flow Restriction.

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Executive Summary:

There were two key aims for this body of research, addressed through two parts.

- Part one aimed to assess beliefs about, and practices around, exercise in individuals with Rheumatoid Arthritis (RA), while also surveying their willingness to engage in blood flow restricted (BFR) exercise.
- Part two aimed to examine the effect of a BFR exercise intervention on measures of upper and lower body strength, pain, and function, in a small sample of individuals diagnosed with RA, while also investigating its acceptability.

Results indicated that BFR exercise is not only appealing to individuals with RA, but can be implemented with high acceptability and adherence, and lead to improvements in strength, function, and pain.

Background:

Rheumatoid Arthritis (RA) is the second most common form of arthritis in Australia and negatively impacts quality of life and functional capacity for approximately 2% of the total adult population.[1] Typified by gradual joint degradation, RA is known to lead to reductions in activities of daily living and a loss of muscle mass and strength, with functional deficits as high as 70% in patients with severe RA.[2] Loss of muscle size and quality leads to complications including metabolic disease, loss of independence, and risk of falls and fractures, which all contribute to the risk of morbidity.[3] Importantly, the number of people with RA in Australia is projected to increase from 422,309 in 2015 to 579,915 in 2030,[4] highlighting the need for practical ways of improving health and function in this population. Advancements in RA medication do not address loss of strength and function, with resistance training considered to be the most effective exercise to increase strength and counteract muscle loss.[5] While performing resistance training with relatively heavy loads optimises improvements in strength and stimulates the development of muscle tissue[6], this is problematic for some RA patients due to pain, fatigue, and the risk of joint injury.[7] Blood Flow Restriction (BFR) training is an alternative to traditional high-load resistance training that involves performing resistance training with very low loads while wearing an inflatable pneumatic cuff on the proximal portion of the working limb.[8] This cuff is inflated to a pressure that allows blood flow *into* the limb but delays its exit *from* the limb. BFR creates a metabolic environment within the muscle that contributes to the development of muscle strength and size without the need for heavy loads, suggesting suitability for RA. Low-load BFR training has been shown to be a safe and effective method for improving strength and function across a myriad of clinical populations, including patients with osteoarthritis,[9] suggesting possible application in RA.

Activities Undertaken:

This project was comprised of two parts:

- Part one was a cross sectional online survey that assessed the beliefs about, and practices around, exercise in individuals with RA, while surveying their interest in BFR exercise.
- Part two was a single group intervention study that examined the effect of a BFR exercise intervention on measures of upper and lower body strength, pain, and function, in a small sample of individuals diagnosed with RA, while also investigating its acceptability.

Methodology:

Part one:

A total of 97 individuals diagnosed with RA completed an online survey to examine the exercise preferences and pain of individuals diagnosed with RA. The study was granted ethical approval by the University of South Australia Human Research Ethics Committee (Protocol Number 205828), and all participants provided informed consent to participate.

Participants provided information on their age, gender, the country they live in, employment status, duration since being diagnosed with RA, current medication regime, and exercise habits. They also completed the Rheumatoid Arthritis Pain Scale (RAPS), a self-reported pain assessment scale comprised of 24 disease-specific questions designed to measure pain in adult RA patients,[10] whereby a higher total RAPS score is indicative of greater pain (highest score=144). To evaluate preferences towards exercise, participants were asked questions regarding their willingness to engage with an exercise program, preferred type, frequency, intensity, and duration of exercise, preferred exercise location and delivery method, whether they prefer to exercise alone or with others, and how far they would be willing to travel to participate in an exercise program. Lastly, participants were asked to watch a short video depicting BFR exercise (https://tinyurl.com/BFRRTvideo), and then respond to questions regarding their level of interest and concern associated with engaging in a BFR exercise intervention, as well as the extent to which they perceived it to be suitable for individuals with RA.

Part two:

A single group intervention examined the effects of a low load BFR exercise intervention on muscle strength, size, functional capacity, quality of life, and pain in a small cohort (n=12) patients diagnosed with RA. The acceptability of the intervention via exit surveys was also examined. Ethical approval was initially approved through University of South Australia Human Research Ethics Committee (protocol number: 205066). However, due extremely low recruitment rates, additional ethical approval was sought to recruit through the Royal Adelaide Hospital (Adelaide, 5000, South Australia) from the Central Adelaide Local Health Network Research Services (protocol number: 1823).

Primary outcome measures were taken the week prior to starting the intervention (baseline), and the week following the completion of the intervention (post-intervention). These measures included:

- **Muscle Strength**: Grip strength (kg), leg press strength (kg), knee extension strength (kg), hamstring curl strength (kg), tricep pressdown strength (kg), and bicep curl strength (kg).
- **Physical performance**: Four-meter gait speed test (normal speed and walking as fast as possible).
- **Self-reported functional capacity**: Health Assessment Questionnaire Disability Index (HAQ-DI).[11]
- **Self-reported quality of life**: The Rheumatoid Arthritis Quality of Life Questionnaire (RAQoL).[11]
- **Pain**: Rheumatoid Arthritis Pain Scale (RAPS).[10]

At the completion of the intervention, a questionnaire with both open- and closed-questions was provided to each participant to gain insight into the acceptability of the intervention. Close ended questions used Likert scales (1-5) to explore the level of agreement regarding different statements on acceptability on aspects of the intervention. Open ended questions sought to obtain information regarding specific aspects of the intervention that participants liked and disliked. The perceived difficulty of each training session was also obtained using the Borg CR10 ratings of perceived exertion scale, to examine the difficulty of the intervention.[12] Intervention adherence was also monitored to provide an indication of the feasibility of the intervention.

The exercise intervention was performed in a gym located at the University of South Australia city east campus (Adelaide, 5000, South Australia), and consisted of two sessions per week, performed for a total of eight weeks duration (16 total sessions). All sessions commenced with a 5-minute warmup, and finished with a 5-minute cool down, consisting of low intensity aerobic exercise. All sessions were conducted one-on-one by third year clinical exercise students under the supervision of an experienced Exercise and Sport Science Australia (ESSA) accredited Clinical Exercise Physiologist.

The BFR intervention was comprised of the same five strength exercises tested before and after the intervention. Exercises commenced in the first week using loads corresponding to 20% of the participants individual's one repetition maximum (1RM), estimated from baseline testing. Load was progressed over the 8-week duration and finished on 35% of 1RM during the final week of the intervention. Each exercise was performed for four sets. The first set was performed for 30 repetitions, and the remaining three sets performed for 15 repetitions, with 60s rest between sets. Each lower body exercise was performed with a pneumatic inflatable air cuff placed at the proximal thigh, and each upper body exercise with a cuff at the proximal portion of the arm. The cuff was inflated to 70% of arterial occlusion pressure (AOP; the minimum pressure required to occlude arterial flow into the limb) for lower body exercises and 40% of AOP for upper body exercises. The cuff remained inflated during the rest periods of each exercise, but deflated for 3-5 minutes between exercises.[8] Session time including warm up and cool down was ~60 minutes.

Research Findings:

Part one:

A total of 97 participants completed the survey (female = 85 [88%], male = 9 [9%], non-binary = 3 [3%]) with an average age of 50.1 ± 15.5 years (range 22 − 83 years). The average time since RA diagnosis was 114.1 ± 123.8 months (range 1 – 600 months). A total of 35 participants were from Australia, 31 from America, six from the United Kingdom, five from Canada, two from New Zealand, and one each from Cambodia, Netherlands, Lithuania, Norway, Spain, and South Africa, while 12 did

not report their primary country of residence. Within the sample, 89 participants were currently taking prescribed medication for their RA. Thirty-two participants were currently employed full time, 26 were retired, 13 working part-time, eight were employed on a casual basis, while 17 were currently unemployed. The average RAPS score was 74.4 ± 35.4 (range 0 – 144).

More than 72% participated in at least two sessions of physical activity per week, with the most common duration of physical activity session being 31 – 40 minutes. Of those who exercise regularly, 58% conducted resistance training as part of their normal exercise routine. With respect to exercise preferences, 61% were interested in conducting a formal exercise program, 60% felt they could currently partake in an exercise program, and 87% indicated they would be willing to engage in an exercise program if it improved their quality of life. One fifth (19%) of participants indicated they would prefer exercising at home with the guidance from a program, although 16% also indicated they would prefer to exercise at a gym facility under supervision. Majority of participants (51%) highlighted that they would prefer to conduct a combination of aerobic and resistance exercise, of a low (35%) or moderate (45%) exercise intensity, and by themselves rather than in a group (47%). Most participants indicated that three or fewer sessions per week of exercise would be achievable (58%), with only 6% stating they would be willing to travel more than 30 minutes to participate in an exercise program.

Table 1 outlines the participants openness to participating in BFR exercise. The group indicated they were interested in conducting an exercise intervention that used this mode of training (median score = 4 out of 5). However, they also expressed some concerns that it may cause pain or make their symptoms worse (median score = 3 out of 5). The results of this survey suggested that they would be more inclined to conduct BFR exercise if it was under the supervision of an exercise professional (median score = 4 out of 5), rather than alone (median score = 3). The responses indicated that participants did not consider BFR exercise to be unsafe, scary, or beyond their current levels of fitness (all median score = 1 out of 5).

Table 1: Participants openness to BFR exercise

Question	Median (IQR)
How interested would you be in conducting an exercise program using the above method of exercise (0 = not at all, 5 = extremely interested)	4 (3)
I am concerned blood flow restricted exercise will cause me pain (0 = strongly disagree, 5 = strongly agree)	3 (2.75)
I am concerned blood flow restricted exercise will make my symptoms worse (0 = strongly disagree, 5 = strongly agree)	3 (3)
Blood flow restricted exercise isn't safe for me (0 = strongly disagree, 5 = strongly agree)	1 (3)
I would only perform blood flow restricted exercise under supervision from a professional (0 = strongly disagree, 5 = strongly agree)	4 (3.75)
I would be happy to perform blood flow restricted exercise on my own (0 = strongly disagree, 5 = strongly agree)	3 (3.5)
Blood flow restricted exercise would improve my quality of life (0 = strongly disagree, 5 = strongly agree)	3 (2)
Blood flow restricted exercise looks scary (0 = strongly disagree, 5 = strongly agree)	1 (3.5)
I am not fit enough to complete blood flow restricted exercise (0 = strongly disagree, 5 = strongly agree)	1 (3)
Blood flow restricted exercise looks fun (0 = strongly disagree, 5 = strongly agree)	3 (2)

BFR = blood flow restricted, IQR = interquartile range

Part two:

A total of 12 participants completed the intervention (female = 11; age = 58.3 ± 5.7 years; height = 165.5 ± 7.3 cm; mass = 81.0 ± 20.4 kg; BMI = 29.6 ± 7.3 kg/m^2). All measures of strength increased significantly across the intervention period, with moderate and large effect sizes suggesting meaningful changes from baseline (Table 1; Figure 1). There was a significant and large improvement in walking speed when performed at a normal speed, but no change observed when walking as fast as possible. Of the perceptual measures, participants reported a significant reduction in perceived pain as indicated by the RAPS (Table 1; Figure 1), but no changes in self-reported quality of life or functional capacity (Table 1).

***Table 2**: Changes in primary outcomes pre- and post- intervention (pre and post measures presented as mean (SD); change score presented as mean difference (95% CI); effect size estimate presented as d (95% CI)).*

Outcome	Pre	Post	Change	P=	*d*=	Effect size descriptor
Body mass (kg)	81.0 (20.4)	80.9 (20.7)	-0.1 (-1.2, 1.1)	0.931	0.0 (0.0, 0.0)	*Trivial*
Arm circumference (mm)	338.3 (46.0)	338.2 (46.1)	-0.1 (-2.4, 2.0)	0.883	0.0 (0.0, 0.0)	*Trivial*
Thigh circumference (mm)	597.9 (94.8)	595.4 (94.6)	-2.5 (-8.2, 3.2)	0.391	0.0 (-0.1, 0.0)	*Trivial*
Handgrip right (kg)	28.6 (6.2)	30.2 (6.7)	1.6 (-0.0, 3.3)	0.057	0.3 (-0.3, 0.8)	*Small*
Handgrip left (kg)	24.8 (5.9)	26.5 (6.7)	1.7 (0.1, 3.4)	0.042*	0.3 (-0.3, 0.9)	*Small*
Leg press 1RM (kg)	89.9 (31.7)	133.7 (53.3)	43.7 (23.3, 64.2)	<0.001*	1.4 (-1.4, 4.2)	*Large*
Hamstring curl 1RM (kg)	33.2 (12.0)	43.5 (15.3)	10.3 (6.3, 14.3)	<0.001*	0.9 (-0.9, 2.6)	*Large*
Knee extension 1RM (kg)	32.8 (15.2)	48.5 (20.4)	14.7 (10.4, 18.9)	<0.001*	1.0 (-1.0, 2.9)	*Large*
Tricep pressdown 1RM (kg)	24.2 (11.7)	30.0 (14.4)	5.8 (4.2, 7.9)	<0.001*	0.5 (-0.5, 1.5)	*Moderate*
Bicep curl 1RM (kg)	22.5 (6.4)	29.9 (9.6)	7.4 (3.9, 11.0)	<0.001*	1.2 (-1.2, 3.5)	*Large*
Normal gait speed (s)	3.48 (0.42)	3.11 (0.37)	-0.36 (-0.58, -0.15)	0.001*	-0.9 (-2.6, 0.9)	*Large*
Fast gait speed (s)	2.45 (0.26)	2.40 (0.28)	-0.05 (-0.17, 0.07)	0.414	-0.2 (-0.6, 0.2)	*Trivial*
HAQ-DI	0.27 (0.43)	0.26 (0.47)	-0.01 (-0.11, 0.08)	0.823	0.0 (-0.1, 0.0)	*Trivial*
RAQol	6.3 (7.9)	4.8 (5.7)	-1.5 (-3.2, 0.2)	0.079	-0.2 (-0.6, 0.2)	*Trivial*
RAPS	46.9 (37.1)	35.0 (30.7)	-11.9 (-23.3, -0.6)	0.040*	-0.3 (-1.0, 0.3)	*Small*

1RM = one repetition maximum, kg = kilogram, mm = millimeter, HAQ-DI = health Assessment Questionnaire Disability Index, RAQoL = Rheumatoid arthritis quality of life questionnaire, RAPS = Rheumatoid arthritis pain scale, s = seconds, d = standardized mean difference.
*P=<0.05 (i.e., a statistically significant difference from baseline.

Participants attended an average of 81.3 ± 16.6% of sessions, and the average perceived difficulty of the intervention was 5.1 ± 1.6 out of 10 (which corresponds with “hard” on the CR10 scale). Closed ended responses to the exit survey indicated that 100% of participants liked the program, 92% perceived it to be acceptable for them as an individual, and 83% perceived it to be suitable for individuals with RA. In conjunction with high measures of acceptability, 50% believed the program improved their RA, while 66% indicated that it required high effort to complete.

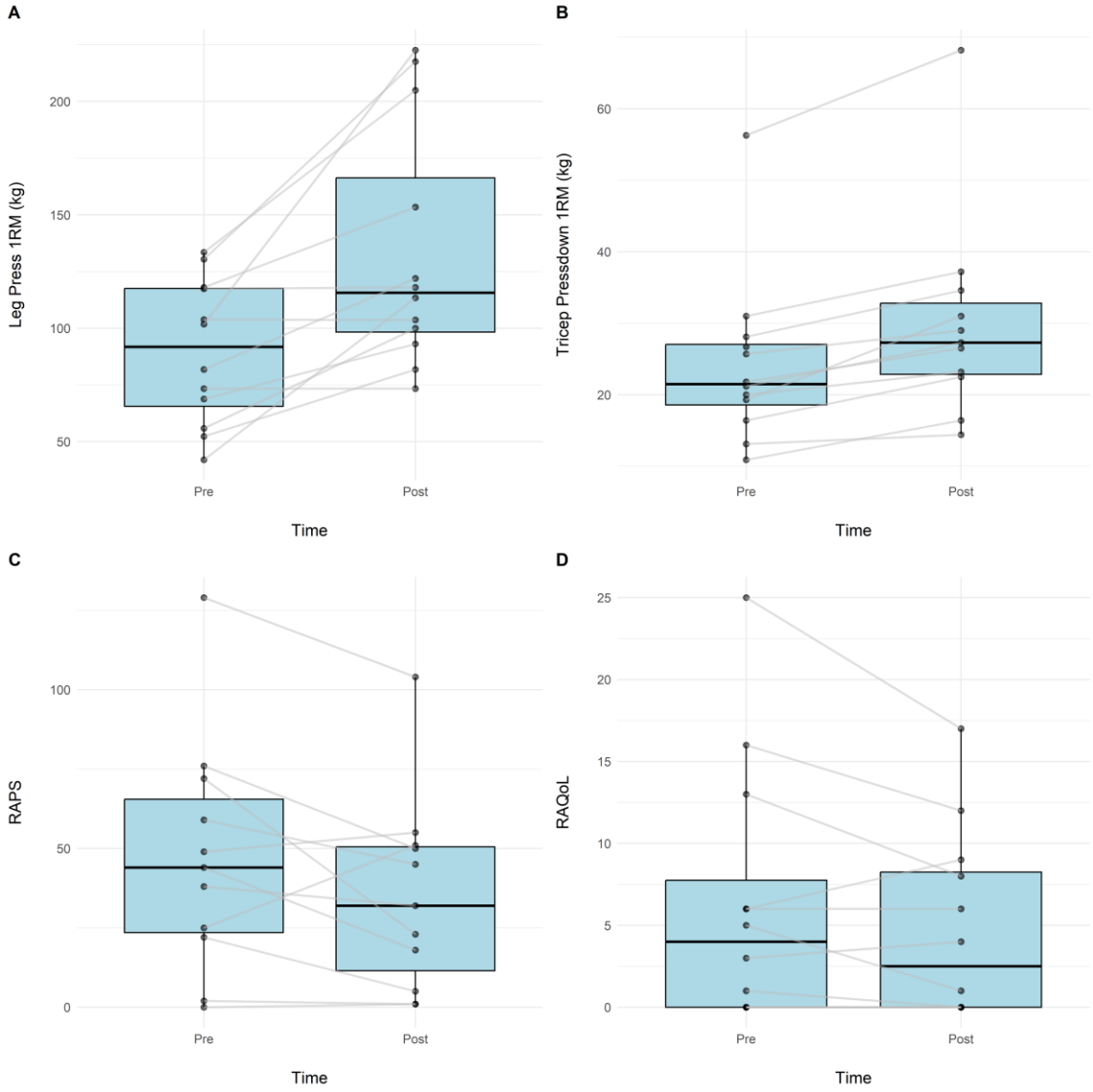

Figure 1: Pre and post intervention changes in A) Leg press strength, B) Tricep pressdown strength, C) rheumatoid arthritis pain scale (RAPS) score, and D) rheumatoid Arthritis Quality of Life (RAQoL) questionnaire.

Thematic analysis identified two main themes with respect to what participants enjoyed about the program. The first theme related to “strength progress,” with participants clearly stating that they enjoyed (and in some cases were motivated by) seeing their strength improve across the intervention period. The second related to “service,” with several participants stating that they enjoyed contributing to research that could help other individuals diagnosed with RA in the future.

Practial implications:

The results of the present study indicate that BFR-RT is viewed positively as a health promoting intervention for individuals diagnosed with RA, and when delivered in a way that aligns with their preferences is acceptable, has high adherence, and has the capacity to improve strength and function and reduce pain.

Future Research outputs:

The results from the present research are soon to be submitted for publication as a single journal article in an exercise science journal. It will also be submitted for an oral presentation at the Australian Rheumatology Association 2025 Annual Scientific Meeting (Adelaide, May 2025).

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