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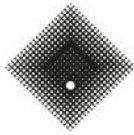
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Is there rationale for the cuff pressures prescribed for blood flow restriction exercise? A systematic review

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Key words: Blood flow restriction exercise, exercise training, cuff pressure, BFR exercise, kaatsu training

Abstract

Background: Blood flow restriction exercise has increasingly broad applications among healthy and clinical populations. Ensuring the technique is applied in a safe, controlled, and beneficial way for target populations is essential. Individualised cuff pressures are a favoured method for achieving this. However, there remains marked inconsistency in how individualised cuff pressures are applied.

Objectives: To quantify the cuff pressures used in the broader blood flow restriction exercise literature, and determine whether there is clear justification for the choice of pressure prescribed.

Methods: Studies were included in this review from database searches if they employed an experimental design using original data, involved either acute or chronic exercise using blood flow restriction, and they assessed limb or arterial occlusion pressure to determine an individualised cuff pressure. Methodologies of the studies was evaluated using a bespoke quality assessment tool.

Results: Fifty-one studies met the inclusion criteria. Individualised cuff pressures ranged from 30% to 100% arterial occlusion pressure. Only 7 out of 52 studies attempted to justify the individualised cuff pressure applied during exercise. The mean quality rating for all studies was 11.1 ± 1.2 out of 13.

Conclusions: The broader blood flow restriction exercise literature uses markedly heterogeneous prescription variables despite using individualised cuff pressures. This is problematic in the absence of any clear justification for the individualised cuff pressures selected. Systematically measuring and reporting all relevant acute responses and training adaptations to the full spectrum of BFR pressures, alongside increased clarity around the methodology used during blood flow restriction exercise is paramount.

1. Introduction

Blood flow restriction (BFR) exercise has become an increasingly popular research focus over the last 20 years. The technique involves exercising with partially inflated cuffs or tourniquets applied proximal to the muscle group being trained to moderate the blood flow to that muscle group¹. Both low-load resistance exercise (20-40% one-repetition maximum [1RM]) and low-to-moderate intensity aerobic exercise (such as walking at 3.5-4.5 km.h⁻¹) when combined with BFR, predominately elicit beneficial adaptations in muscle size and strength¹. Additional benefits may present regarding transient increases in muscle blood-flow due to reactive hyperaemia, possibly indicative of enhanced vascular capacity², physical function³, and improved early-stage musculoskeletal rehabilitation^{4,5}. There is also strong evidence supporting the use of BFR across multiple populations ranging from athletic, healthy adults^{6,7} to older adults^{8,9}.

Despite the popularity of BFR as a technique, a common limitation in the field is the inconsistency in the methodology used when applying the technique¹⁰. Similarly, and despite the broad spectrum of exercise modalities to which BFR can be applied, there is a paucity of exercise prescription guidelines for tailoring BFR exercise programs to targeted populations. A recent position stand is perhaps the best source for such guidelines to-date, but still provides only generalised, rather broad prescription ranges for training variables applicable to generally healthy populations¹. The suggestion is made that variables may need to be adjusted among individuals, for example if load is in the lower end of the suggested range, cuff pressure may need to be increased¹. However, the specificity of such adjustments remains difficult to discern based on the existing evidence.

The growth in practitioner use of BFR exercise in general strength and conditioning as well as rehabilitation settings has also facilitated research in clinical populations such as chronic obstructive pulmonary disorder¹¹, end-stage kidney disease¹², ischemic heart disease¹³, and sporadic inclusion body myositis¹⁴. These clinical populations require numerous considerations to account for altered haemodynamic responses, co-morbidities, and contraindications inherent to each individual condition when compared with healthy populations. As such, it is necessary to ensure that the methodologies used among these populations are precise and consistent in order to account for any condition-specific considerations that may be affected by the application of BFR. This is also relevant for the broader consistency of BFR application across all populations, particularly in research settings, to reduce the heterogeneity that makes comparisons between studies problematic³. For example, individualised applied pressures during BFR exercise can be derived from measures of limb occlusion pressure (LOP) or arterial occlusion pressure (AOP), usually as a percentage of this value¹⁵. These individualised pressures are favourable when applying cuff pressure during BFR exercise, as they help address some of the variability in restriction caused by differences in the equipment used, such as differing cuff widths, when set at the same absolute pressure¹⁶. Still, only recently has research begun to define

minimal threshold pressure ranges suitable to attain the relevant acute effects needed for muscular adaptation to BFR exercise ¹⁷. However, with significant heterogeneity of applied pressures across the broader BFR exercise literature, and even the recently published position stand on BFR exercise suggesting a large pressure range (between 40% - 80% of AOP or LOP), there is still no clear consensus on ideal individualised pressures during BFR ¹. There does not appear to be a dose-response relationship between applied pressure and exercise-related outcomes, acute or chronic, although, to the best of our knowledge, this has yet to be the focus of a review or independent study.

The prescribed pressure application is a primary variable in the application of BFR, making it of particular importance, and more so for clinical populations when vascular impairments must be considered. This is also relevant to ensure that discomfort caused by the compression of active musculature is minimised without compromising the efficacy of the technique ¹⁸⁻²⁰. However, the issue still remains that pressure is inconsistently applied. Some studies apply arbitrary pressures ^{21,22} compared with others using variable percentages of measured occlusion pressures ^{8,12,23,24}; some studies use static cuffs while others use dynamic cuffs ^{23,25}; and some studies apply pressures derived from estimation equations based on individual participant characteristics ²⁶. It is also unclear if there is substantive reasoning for why studies choose to employ specific individualised pressures during BFR. Thus, the objective of the present review was to quantify the individualised cuff pressures being applied during BFR exercise in the broader literature and determine whether there is clear justification for why the prescribed individualised cuff pressures were used.

2. Methods

2.1 Study design

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

2.2 Search strategy

The electronic database search included Medline, Embase, CINAHL, Springer, and SPORTDiscus. Search strategy utilised the search strings identified in the supplementary material. Search terms were derived from ‘limb occlusion pressure’, ‘blood flow restriction’, and ‘exercise’ (Table 1). References were also identified in the reference lists of previous systematic reviews in addition to the results of our electronic database search. Search results were filtered within the database where possible for the filters ‘Human’, ‘English’, ‘academic journals’, ‘research article’ and/or ‘full text’. Search results included dates from inception until the date of the search (15th October 2019).

2.3 Participants, interventions, comparators

Database search results were imported into Endnote X9 (Thompson Reuters, Philadelphia, Pennsylvania, USA). Duplicates were removed, and screening was completed by title, abstract, and full text. Excluded articles were sorted into individual folders indicating the reason for exclusion until only articles for inclusion remained. This process was completed by two researchers independently. The relevant inclusion criteria are identified below and reasons for exclusions noted in the PRISMA flow chart (Figure 1):

1. Language: only studies published in English were included in this review.
2. Study Design: only studies that employed an experimental design were included. Systematic reviews, narrative reviews, conference abstracts, editorials, letters or publications not inclusive of original data were excluded.
3. Exercise component: studies must have included either an acute exercise bout during which BFR was employed or an exercise training intervention. Exercise training interventions must have included chronic aerobic, resistance, combined, or alternative types of progressive exercise training over multiple weeks in conjunction with BFR.
4. Measurement of occlusion pressure: studies included in this review must have conducted assessments of total LOP or total AOP (this does not include systolic blood pressure). A pressure derived from this assessment must have been prescribed during the exercise component of the study.

2.4 Assessment of included study quality

The quality and risk of bias of included studies was independently evaluated by two reviewers (MJC, AKM). As no suitable published assessment criteria were available to directly assess the variable study designs and outcomes of the studies in this review, specific criteria were developed. These criteria were broadly adapted from tools utilised by the Cochrane Group for quality assessments in both screening and diagnostic tests and risk of bias in interventions^{27,28}. These included assessment of the level of evidence as defined by the Oxford Centre for Evidence-Based Medicine²⁹, and reporting of the design, selection criteria, setting, participant description, and transparency of methodological reporting. Scores were allocated based on how well each criterion was covered in the included studies, up to a maximum possible score of 13 (low risk of bias/high quality). Contention between quality assessments was resolved through follow up consultation between reviewers. Studies with an assessed rating below 7 (<50% of maximum) were considered poor quality, or high risk of bias. This did not prohibit or invalidate the discussion points in the present review, it merely highlights the methodological quality in individual blood flow restriction exercise studies, and the potential reporting short-falls including the consistency and clarity surrounding the assessment, equipment used, and reporting of applied BFR pressures.

2.5 Data extraction

Following the initial screening, information from the included studies was extracted, including basic study characteristics, mean participant age, sample size, acute exercise or exercise training intervention prescription, justification for prescribed restriction pressure or lack thereof, and details of the blood flow restriction equipment and assessment used.

3. Results

3.1 Literature search

A total of 3139 articles were retrieved from searches including those from inception to 11th March 2020 from Medline (446), Embase (2287), CINAHL (93), Springer (181), and SPORTDiscus (132). Duplicates were removed, refining the total number of articles for screening down to 2696. Of these results, 2495 were excluded based on title or abstract, and the full texts of the remaining 188 articles were evaluated using the inclusion criteria for this review. Articles removed in this manner are outlined in the PRISMA flow chart (Figure 1). Two studies were removed for utilising the same data set as another included study. An additional 5 studies that fulfilled the inclusion criteria were identified from the reference lists of prior reviews related to the topic of blood flow restriction exercise and were approved for inclusion among the original search results. Subsequently, the total number of studies included for review was 52. The assessment of the methodological quality of the included studies is shown in Table 2, with the mean quality rating of included studies being 11.1 ± 1.2 out of 13.

3.2 Study characteristics

Information extracted from studies included in this review are summarised in Table 3. This included population evaluated, sample sizes, whether the study was acute or chronic (training), exercise modality employed, the degree of restriction used, justification for the pressure applied during the study, and details of the BFR equipment used. The 52 studies included a total of 1133 participants. Sample sizes, excluding the one individual case study, ranged from $n = 8$ ^{25,30} to $n = 137$ ³¹.

The populations examined were relatively heterogeneous between studies, with the most common population being healthy non-resistance trained but recreationally active adults, examined in 23 of the 52 included studies^{17,24,31-51}. Other populations included resistance-trained adults, adults with musculoskeletal or soft tissue injuries, older adults, or adults with hypertension. There were far more studies (26 of 52) examining only male participants^{17,24,25,30,32-38,41-43,46,48,50-59}, compared with just 8 of 52 examining only female participants^{40,49,60-65}, leaving 18 studies examining both of these genders^{8,19,20,39,44,45,47,66-75}.

The majority of the included studies were acute studies, with only 16 of the 52 included studies assessing adaptations to BFR exercise training^{8,35,38,39,41,44,48,50,51,56,59,62,64-66,74}. Most studies employed traditional upper or lower body resistance exercise protocols, commonly utilising elbow flexion, leg press, or knee extension exercises. Only six studies employed aerobic or alternative exercise protocols, namely cycling³⁷, walking^{8,46}, repeated sprint training³⁰, and water aerobics^{64,65}.

Sixteen of the 52 included studies applied multiple different cuff pressures as a means of comparing acute responses or chronic adaptations to different applied pressures^{17,20,31,32,36,39,43,44,48,54,67,68,70,72,73,75}. Among the remaining 36 studies using a single individualised pressure for their application of BFR, 13 studies used 80% AOP/LOP^{24,37,40,49,50,57,61,62,64-66,71,74}, 7 studies used 60% AOP/LOP^{8,33,34,38,46,52,56}, 5 studies used 50% AOP/LOP^{25,41,42,59,60}, 4 studies used 100% AOP^{47,51,58,63}, 4 studies used 40% AOP/LOP^{19,30,45,69}, and 3 studies used 30% AOP^{35,53,55}. The technique and postures used to determine each of these individualised restriction pressures was similarly variable. Upper limb restriction was generally measured using either the radial or brachial arteries, and lower body restriction measured in one of the tibial arteries, or the popliteal artery. The posture in which assessment of occlusion pressure was conducted was not reported in 15 of the 52 included studies^{24,30,32,34,35,43,47,49,51,53,58,61-63,74}. Among those reporting participant posture during assessment, supine^{17,36,37,40,42,48,50,54,56,57,59,64,65} or standing^{8,19,20,31,41,44,46,52,69,70,72,73,75} were each chosen in 13 studies, and sitting was used in 11 studies^{25,33,38,39,45,55,60,66-68,71}.

Of the 16 studies examining multiple cuff pressures none provided clear justification for the selection of pressures they included. Among the 36 included studies that utilised a single individualised pressure when applying BFR, only 7 provided justifications of pressure used^{19,41,46,53,55,66,71}. The remaining 29 either provided no reasoning for the pressure selection, or only cited the pressure having been used in a previous study. The reasons provided for pressure selection included: to occlude venous flow during expected increased blood pressure⁵³; lower pressures reduce the risk of autonomic dysreflexia and deep vein thrombosis⁵³; pressures greater than 30% AOP not being required to produce training adaptations or targeted increases in total muscle work⁵⁵; higher pressures maximise fast twitch fibre recruitment and strength adaptations to BFR training^{66,71}; the lowest pressure possible to minimise client discomfort but also provide a similar level of restriction to higher pressures^{19,41,46}.

The equipment used to apply BFR was described in all but 5 of the included studies. Cuff dimensions were described in 47 studies, with mean cuff width being 11 ± 5 cm and ranging from 3 cm¹⁹ to 18 cm⁵⁸. However, this was affected by whether the cuffs were designed for upper limb (mean width 7 ± 4 cm) or lower limb (mean width 14 ± 4 cm) application. Cuff material was described in 19 of the 52 studies, with most being nylon, and others being elastic. Seventeen of the included studies reported using a 'standard sphygmomanometer' to apply BFR, rather than a dynamic pneumatically regulated system. The pattern of inflation was described in 43 out of the 52 included studies, with 38 studies using continuous inflation across the full duration of exercise (multiple sets and repetitions)^{8,17,25,31-36,38,39,42,43,46-50,52-54,56-65,67-71,74}, only 3 studies using an intermittent inflation pattern whereby cuffs were deflated between sets of each exercise^{37,51,55}, and 2 studies including both continuous and intermittent inflation patterns in separate experimental groups^{24,40}.

4. Discussion

The present review highlights a clear lack of consistency among the individualised cuff pressures used in the BFR exercise literature, and even more concerning is the absence of a clear justification for the pressure selection by the vast majority of studies. The purpose of utilising individualised cuff pressures is to overcome the variability in magnitude of limb blood flow that is restricted when using arbitrary pressures or a percentage of measured systolic blood pressure due to individual participant differences in body composition and haemodynamics^{1,15,76}. These individualised cuff pressures are attained through direct measurement of the pressure required to completely occlude limb blood flow (i.e. AOP/LOP), and then using a percentage of AOP/LOP that is expected to allow arterial inflow, but restrict venous outflow at rest¹. This reduction in resting venous outflow is largely overcome during exercise by the mechanics of skeletal muscle contraction (the skeletal muscle pump)¹. Even though there is a plethora of studies employing this method, the percentage of AOP or LOP utilised is markedly variable, ranging from 30% to 100% of AOP/LOP across studies with no clear justification for the pressures selected. Moreover, although a recent BFR exercise position stand recommends a very broad range of individualised restriction pressures to employ (40-80% AOP/LOP), 12% of included studies in the present review applied pressures outside of this range mostly without clear reasoning to support this^{1,35,47,51,55,58,63}. This is an area of concern that needs to be further explored in order to provide clear reasoning for how the technique should be applied by practitioners.

Out of 52 studies included in this review, only 7 studies provided a justification for their selection of restriction pressures^{19,41,46,53,55,66,71}. Even then, among the 7 studies providing a justification, reasons were sometimes vague, such as “*to selectively occlude venous flow during periods of expected increases in blood pressure*”⁵³, or simply based on other studies having shown a certain pressure to be effective in producing a particular outcome⁴⁶ even though the underlying mechanism was not well understood^{41,46,53}. More valuable reasoning may be derived from those studies that alluded to mitigation of adverse events (autonomic dysreflexia and deep vein thrombosis, albeit specific to participants who had incomplete spinal cord injuries and a greater established risk of these adverse events), or to a balance of participant comfort with lowest established pressure for producing favourable adaptations to BFR training^{19,53,55}. This emphasis on lower pressures to balance comfort and efficacy is a direct contrast to included studies that justified their use of a high pressure as having been shown to maximise fast twitch fibre recruitment and strength adaptations to BFR training^{66,71}.

This highlights the lack of a clear rationale underpinning the selection of restriction pressures based on physiological measurements alone. Instead, it is likely that decisions around prescribed restriction pressures are multifaceted. It is a logical approach to minimise participant discomfort while still obtaining a large degree of the physiological benefit that can be achieved through BFR exercise training. However, it is also valid to try to maximise the physical benefit that can be gained from using BFR

exercise. Perhaps it is not so much a question as to which of these options is better, but more so a matter of when one of these options is more applicable than the other. If the target population is likely to report an elevated degree of discomfort, display significant fear avoidance with exercise or is intrinsically lacking in motivation to exercise in the first place, reducing pressure to minimise discomfort is likely to be more valuable. This would be particularly relevant for clinical populations, such as those with end-stage kidney disease known to be markedly physically inactive and report elevated difficulty and discomfort with exercise^{8,77,78}. This would also apply to generally sedentary populations, who may not have been exposed to the level of exertion intrinsically required during exercise, and thus may be deterred with unnecessarily elevated discomfort. Conversely, in healthy, physically active populations, particularly those that are resistance trained, the most commonly examined population among the included studies in this review^{17,19,20,24,25,31-52,55,57,58,67-70,72,73,75}, maximising the physiological benefits of BFR may be preferable, despite potentially elevated discomfort. Regular exercise has also been shown to have a chronic-acute analgesic effect and reduce nociceptor excitability, suggesting that physically active populations may be less prone to exercise-induced discomfort^{79,80}. This approach implies that the justification for an ‘ideal’ individualised pressure may be dependent on the population being examined, and there may be validity in both high and low-to-moderate pressures being employed in different situations.

One factor that prevents the identification of any one specific ideal pressure is the absence of a comprehensive understanding of all the physiological responses to specific individualised restriction pressures. Among the included studies in this review, sixteen studies examined how several different individualised pressures affected various outcome measures, although there was still no reasoning provided for why each of the pressures examined were selected^{17,20,31,32,36,39,43,44,48,54,67,68,70,72,73,75}. In general, it could be assumed that assessing the effect of a low, a moderate and a high pressure provides some indication as to how increasing the applied pressure affects physiological responses. While this may narrow down the range of pressures that are deemed to be more appropriate than others, it still does not pinpoint any single individualised pressure as being the ‘ideal’ balance of comfort, safety, physiology, or ability to induce training adaptations. Nevertheless, this is the type of research that is needed most in order to help refine our understanding of how differences in pressure can enhance or detract from the efficacy of BFR as a technique.

An ongoing limitation with blood flow restriction exercise research is the inconsistency in the equipment that is used to induce BFR, while the absence of this information being reported is common. Narrower cuff widths require higher pressures to fully occlude limb blood flow, as do elastic cuffs compared with nylon cuffs^{19,76,81}, so reporting only the pressure used without indication of percentage AOP/LOP or the equipment employed makes reproducibility impossible. However, this problem is mitigated with the use of individualised pressures, provided that the measure of LOP or AOP uses the same cuff as that employed during the exercise itself^{19,76}. Similarly, continuous compared with

intermittent inflation patterns have been shown to impose greater discomfort, higher double product and elevate lactate accumulation^{82,83}, although continuous inflation has also been shown to produce similar oxidative stress⁸⁴, and even a reduction in haemodynamic stress⁸⁵ despite this seeming to oppose those studies indicating an increase in double product. This discrepancy is the result of different pressure applications for studies producing these conflicting results. While one study reported a greater double product with continuous inflation using the same pressure for both intermittent and continuous protocols⁸³, another study observed lower haemodynamic stress with continuous inflation when using a lower pressure for the continuous protocol⁸⁵. This further emphasises the need for transparency in reporting applied pressures and justifying those choices for individualised pressure.

In the present review, cuff-width was reported in 90% of the included studies, and while positive, this is largely overcome with individualised pressures and so may be less important than cuff material (reported in only 36% of studies), and inflation pattern (reported in 83% of studies). The inflation pattern most commonly employed was continuous inflation, with only 5 studies using intermittent inflation^{24,37,40,51,55}. Among these 5 studies using intermittent inflation, 4 employed higher restriction pressures (80-100% AOP)^{24,37,40,51}, which may suggest that intermittent inflation patterns require increased pressures. This would align with the previous study suggesting that continuous inflation patterns, and thus a lower but persistent cuff pressure evoked reduced haemodynamic stress⁸⁵. This may also support why 88% of the studies in this review reporting inflation pattern employed continuous inflation instead of intermittent inflation.

A final consideration identified as a part of this review is the type of device used to apply BFR, where seventeen of the included studies report using a 'standard sphygmomanometer' to apply BFR, rather than a dynamic pneumatically regulated system. Static cuffs do not adjust the pressure of the cuff in response to muscular contractions occurring under the cuff, and thus are likely to induce elevations in pressure, and subsequently increase haemodynamic stress, as well as increase levels of discomfort and RPE⁷¹. Not having a regulated pressure may create increased unpredictability and reduced control of the acute responses to BFR exercise, and while these differences warrant greater exploration, the recommendation should likely remain that dynamic pneumatically regulated systems be used in future BFR exercise studies.

4.1 Limitations of the review

Due to the differences in study design, populations examined, exercise modality and prescription variables, the outcomes of each of the included studies were not reported in this review. While this was outside the scope of the present review, which was concerned with the rationale for prescribed cuff pressure, it may have provided insight as to whether certain pressures were more consistent in achieving

positive outcomes. However, given the variable number of studies examining each of the individualised cuff pressures identified in this review, it would also have made any direct comparisons difficult.

4.2 Conclusion and Perspective

The current preference in BFR exercise research is for the use of individualised cuff pressures that account for differences in equipment such as cuff width and material, and reduce the inter-participant variability in acute responses to BFR exercise that occur when using a set arbitrary pressure value. Despite this preference when prescribing BFR exercise, there remains a lack of consistency among restriction pressures applied within the literature. Even more problematic is the absence of any clear justification for the selected BFR pressures in the vast majority of BFR exercise studies. Given the inconsistencies in methodology, populations examined and reporting of BFR equipment, it is apparent from this review that significant emphasis needs to be placed on systematically measuring and reporting all relevant acute responses and training adaptations to the full spectrum of BFR pressures, and preferably using the same equipment. Only with this degree and depth of data can “ideal” restriction pressures be ultimately justified for any specific populations.

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Figure Legends

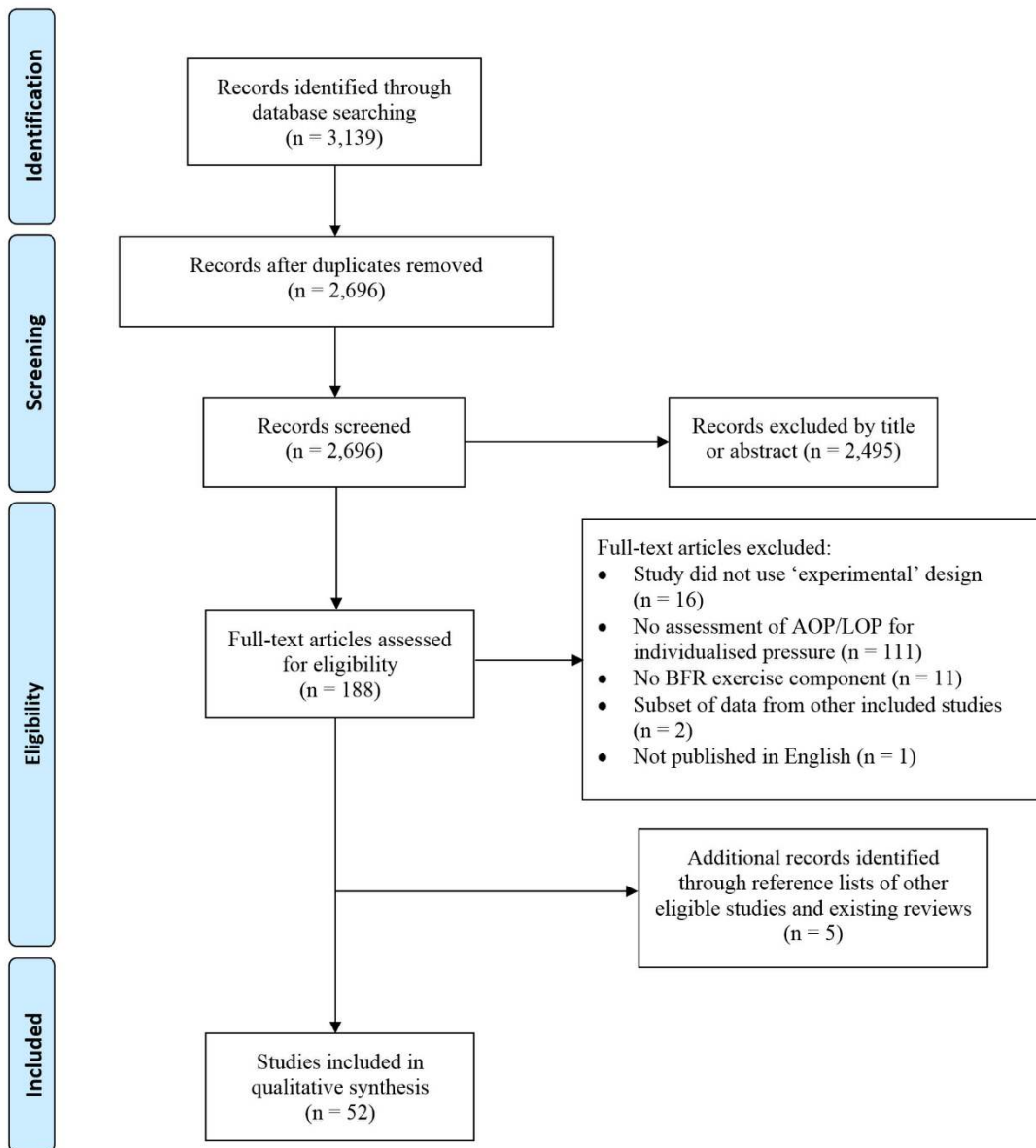


Fig. 1 PRISMA flow chart of study selection process.

Table 1: Search strategy by database.

| Search strings used for CINAHL, Medline, SPORTDiscus, and SpringerLink | |
|--|--|
| 1. Limb occlusion pressure | “limb occlusion” OR “arterial occlusion” OR “venous occlusion” OR “pressur*” OR “arterial restrict*” OR “venous restrict*” |
| 2. Blood flow restriction | “blood flow restrict*” OR “restrict blood” OR “vascular occlusi*” OR “vascular restrict*” OR “occlud*” OR “kaatsu” OR “cuff*” |
| 3. Exercise | “acute” OR “chronic” OR “train*” OR “exercis*” OR “resistance” OR “resistive” OR “resistance train*” OR “weight train*” OR “strength train*” OR “weight lift*” OR “circuit train*” OR “aerobic” OR “endurance” OR “walk*” OR “run*” OR “cycling” |
| 4. Terms excluded in search | NOT “mouse” NOT “mice” NOT “rat” NOT “rodent” NOT “animal*” NOT “precondition*” NOT “fetal” NOT “foetal” NOT “altitude” |
| 5. Filters manually applied | <i>English, Academic Journals, Full text, Journal article, Human</i> |
| Search strings used for EMBASE | |
| 1. Limb occlusion pressure | 'limb occlusion' OR 'arterial occlusion' OR 'venous occlusion' OR 'pressur*' OR 'arterial restrict*' OR 'venous restrict*' |
| 2. Blood flow restriction | 'blood flow restrict*' OR 'restrict blood' OR 'vascular occlusi*' OR 'vascular restrict*' OR 'occlud*' OR 'kaatsu' OR 'cuff*' |
| 3. Exercise | 'acute' OR 'chronic' OR 'train*' OR 'exercis*' OR 'resistance' OR 'resistive' OR 'resistance train*' OR 'weight train*' OR 'strength train*' OR 'weight lift*' OR 'circuit train*' OR 'aerobic' OR 'endurance' OR 'walk*' OR 'run*' OR 'cycling' |
| 4. Terms excluded in search | NOT 'mouse' NOT 'mice' NOT 'rat' NOT 'rodent' NOT 'animal*' NOT 'precondition*' NOT 'fetal' NOT 'foetal' NOT 'altitude' |
| 5. Filters | ([article]/lim OR [article in press]/lim) AND [humans]/lim AND [english]/lim AND [embase]/lim |

Table 2: Quality assessment of included studies.

| Study | Level of evidence ^a | Selection criteria ^b | Setting ^c | Demographic information ^d | Regional Anthropometric data ^e | BFR method ^f | Pressure quantified ^g | Pressure rationale ^h | Missing data reporting ⁱ | Total Score (max = 13) |
|-------------------------------------|--------------------------------|---------------------------------|----------------------|--------------------------------------|---|-------------------------|----------------------------------|---------------------------------|-------------------------------------|------------------------|
| Valenzuela et al. ³⁰ | 5 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 10 |
| Reis et al. ³² | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 11 |
| Petrick et al. ³³ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 11 |
| Montgomery et al. ³⁴ | 5 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 10 |
| Ilett et al. ¹⁷ | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 12 |
| Hughes et al. ⁶⁶ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 12 |
| Chulvi-Medrano et al. ³⁵ | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 11 |
| Centner et al. ⁵² | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 11 |
| Jessee et al. ⁶⁷ | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 12 |
| Kilgas et al. ³⁶ | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 12 |
| Dankel et al. ⁶⁸ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 11 |
| Thomas et al. ³⁷ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 11 |
| Stavres et al. ⁵³ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 12 |
| Soligon et al. ⁵⁴ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 11 |
| Scott et al. ⁶⁰ | 5 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 10 |
| Pinto et al. ⁶¹ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 11 |
| Picón et al. ⁵⁵ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 12 |

| | | | | | | | | | | | |
|-------------------------------|---|---|---|---|---|---|---|---|---|----|----|
| May et al. ³⁸ | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 12 |
| Letieri et al. ⁶² | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 10 | |
| Ladlow et al. ⁵⁶ | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 12 | |
| Jessee et al. ⁶⁹ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 12 | |
| Jessee et al. ³⁹ | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 11 | |
| Jessee et al. ⁷⁰ | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 11 | |
| Hughes et al. ⁷¹ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 12 | |
| Curty et al. ⁵⁷ | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 12 | |
| Buckner et al. ⁷² | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 11 | |
| Bell et al. ⁷³ | 5 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 10 | |
| Tennent et al. ⁷⁴ | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 10 | |
| Neto et al. ⁴⁰ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 11 | |
| Mouser et al. ³¹ | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 12 | |
| Mattocks et al. ²⁰ | 5 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 10 | |
| Kim et al. ⁴¹ | 5 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 12 | |
| Ferreira et al. ⁴² | 5 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 10 | |
| Dankel et al. ⁷⁵ | 5 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 10 | |
| Clarkson et al. ⁸ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 11 | |
| Buckner et al. ¹⁹ | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 13 | |

| | | | | | | | | | | |
|---------------------------------|---|---|---|---|---|---|---|---|---|----|
| Poton and Polito ⁵⁸ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 11 |
| Pinto and Polito ⁶³ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 11 |
| Neto et al. ²⁴ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 11 |
| Fatela et al. ⁴³ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 11 |
| Counts et al. ⁴⁴ | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 12 |
| Barnett et al. ⁴⁵ | 5 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 11 |
| Staunton et al. ⁴⁶ | 5 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 11 |
| Poton and Polito ⁴⁷ | 5 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 10 |
| Moriggi Jr et al. ²⁵ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 11 |
| Lixandrão et al. ⁴⁸ | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 12 |
| Araújo et al. ⁶⁴ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 11 |
| Araújo et al. ⁶⁵ | 5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 11 |
| Santos et al. ⁵⁹ | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 5 |
| Araújo et al. ⁴⁹ | 5 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 10 |
| Laurentino et al. ⁵⁰ | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 12 |
| Laurentino et al. ⁵¹ | 5 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 12 |

Abbreviations: BFR – Blood flow restriction.

- a. Oxford Centre for Evidence Based Medicine level of evidence (Level 1 = 5 points; level 2 = 4 points; level 3 = 3 points; level 4 = 2 points; level 5 = 1 point).
- b. Inclusion and exclusion criteria clearly described (1 point)
- c. Enough information provided to identify the general setting, or reproducible conditions (1 point)
- d. Age and gender reported (1 point)

- e. Relevant region-specific participant anthropometric data (regional or limb-specific body composition or size, not general body mass or body mass index alone) provided (1 point)
- f. Description of pressure assessment, method of application (continuous or intermittent) and equipment sufficient to allow replication (1 point)
- g. For applied pressure, mean or median and variance provided in absolute pressure (mmHg) (1 point).
- h. Attempted to rationalise or describe choice of applied pressure (1 point)
- i. All included participants measured and, if appropriate, missing data or withdrawals from study reported or explained (1 point)

Table 3: Summary of included study characteristics.

| Author | Year | Sample (Population, age, gender) | Study <i>N</i> | Acute or training study | Modality | Details of AOP/LOP assessment (artery/limb + posture) | % AOP/LOP in BFR trial/s | Justification of pressure (Y/N) + detail | BFR details (cuff width, material, inflation pattern) |
|---------------------------------------|------|---|--|-------------------------------|--|---|-----------------------------|--|---|
| Valenzuela et al. ³⁰ | 2019 | Elite male badminton players, 20 ± 2 years | 8 | Acute | Repeated Sprint Training | Posterior tibial artery; Posture not reported | 40% AOP | N | 13 cm width, material not reported, continuous inflation |
| Reis et al. ³² | 2019 | Physically active young males, 24 ± 5 years | 13 | Acute | Resistance – Unilateral knee extension | Posterior tibial artery; Posture not reported | 0%, 40%, 60%, 80% AOP | N | 13 cm width, material not reported (inflation system model reported), continuous inflation |
| Petrick et al. ³³ | 2019 | <i>In vivo</i> study: Healthy males, 24 ± 1 years <i>In vitro</i> study: Healthy males, 25 ± 2 years | <i>In vivo</i> study: 10 <i>In vitro</i> study: 6 | Acute | Resistance – Single-leg squats to volitional fatigue | BFR machine function; Seated | 60-70% LOP | N | 11 cm cuff, material not reported (inflation system model reported), continuous inflation |
| Montgomery et al. ³⁴ | 2019 | Healthy males 21 ± 1 years | 9 | Acute | Resistance – Unilateral knee extension | Posterior tibial artery; Posture not reported | 60% LOP | N | Width and material not reported, continuous inflation |
| Ilett et al. ¹⁷ | 2019 | Physically inactive males, 25 ± 6 years | 10 | Acute | Resistance – Isometric unilateral knee extensions | BFR machine function; Supine | 40%, 60%, 80% LOP | N | 10.5 cm width, material not reported (inflation system model reported), continuous inflation |

| | | | | | | | | | |
|-------------------------------------|------|--|----|----------|---|---------------------------------------|--|---|---|
| Hughes et al. ⁶⁶ | 2019 | Anterior cruciate ligament repair patients, 29 ± 6 years (23 male, 7 female) | 28 | Training | Resistance – Unilateral leg press | BFR machine function; Seated | 80% LOP | Y – To maximise fast twitch fibre recruitment | 11.5 cm width, nylon, inflation pattern not reported |
| Chulvi-Medrano et al. ³⁵ | 2019 | Healthy male college students, 23 ± 3 years | 15 | Training | Resistance – Elbow flexion | Brachial artery; Posture not reported | 30% LOP | N | 9 cm width, material not reported, continuous inflation |
| Centner et al. ⁵² | 2019 | Healthy resistance trained males, 25 ± 4 years | 15 | Acute | Resistance – Isometric squat with whole body vibration | Posterior tibial artery; Standing | 60% AOP | N | 12 cm width, nylon, continuous inflation |
| Jessee et al. ⁶⁷ | 2019 | Healthy resistance trained young adults 22 ± 3 years | 12 | Acute | Resistance – Unilateral knee extensions to volitional failure | Posterior tibial artery; Seated | 40%, 80% AOP | N | 10 cm width, nylon, continuous inflation |
| Kilgas et al. ³⁶ | 2019 | Physically active males, 27 ± 4 years | 10 | Acute | Resistance – Unilateral handgrip exercises | Brachial artery; Supine | 0%, 60%, 80%, 100%, 120% AOP (reported as LOP) | N | 10 cm width, nylon, continuous inflation |
| Dankel et al. ⁶⁸ | 2019 | Resistance trained adults, 22 ± 2 years (12 male, 11 female) | 23 | Acute | Resistance – Unilateral knee extension | Posterior tibial artery; Seated | 40%, 80% AOP | N | 10 cm width, nylon, continuous inflation |

| | | | | | | | | | |
|------------------------------|------|---|----|-------|--|--|-------------------------------|--|---|
| Thomas et al. ³⁷ | 2018 | Males, 23 ± 3 years | 18 | Acute | Cycling | Tibial artery; Supine | 80% AOP | N – Only referenced Loenneke et al. ⁷⁶ | 10 cm width, material not reported (inflation system model reported), intermittent inflation (pressure released in rest intervals) |
| Stavres et al. ⁵³ | 2018 | Males with chronic incomplete spinal cord injury, 63 ± 12 years | 9 | Acute | Resistance – Unilateral knee extension | Popliteal vein and artery; Posture not reported | 30% AOP | Y – To occlude venous flow during expected increased blood pressure. Lower pressures also selected to reduce risk of autonomic dysreflexia and deep vein thrombosis | Width and material not reported, continuous inflation |
| Soligon et al. ⁵⁴ | 2018 | Untrained males, 24.5 ± 1.5 years | 12 | Acute | Resistance – Bilateral knee extension | Tibial artery; Supine | 40%, 50%, 60%, 70%, 80% | N | 17.5 cm width (94 cm length), standard sphygmomanometers, continuous inflation |
| Scott et al. ⁶⁰ | 2018 | Non-resistance trained older females, 67 ± 4 years | 15 | Acute | Resistance – Bilateral leg press and knee extension | Posterior tibial artery; Recumbent | 50% AOP | N | 10 cm width, material not reported (inflation system model reported), continuous inflation (pressure released between exercises) |
| Pinto et al. ⁶¹ | 2018 | Sedentary older females, 67 ± 2 years | 18 | Acute | Resistance – Bilateral knee extension | Tibial artery; Posture not reported | 80% AOP | N | 18 cm width (90 cm length), material not reported, continuous inflation |

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| Picón et al. ⁵⁵ | 2018 | Resistance trained males, 24 ± 4 years | 24 | Acute | Resistance – Unilateral plantar flexion (on leg press) | Popliteal artery; Seated on leg press machine | 30% AOP | Y – Pressures greater than 30% AOP are not necessary to achieve strength + hypertrophy ⁴⁴ , increases total muscle work ⁸⁶ | 9 cm width (57 cm length), standard sphygmomanometer, intermittent inflation (pressure released between sets) |
| May et al. ³⁸ | 2018 | Recreationally active, non-resistance trained young adult males, 22 ± 3 years | 24 (12 in BFR group) | Training | Resistance – Bilateral knee flexion and extension | BFR machine function; Seated | 60% LOP | N – The pressure was used previously ⁴⁶ | 10.5 cm width (8 cm bladder width), material not reported (inflation system model reported), continuous inflation |
| Letieri et al. ⁶² | 2018 | Non-resistance trained older females, 69 ± 5 years; | 56 (11 in BFR group) | Training | Resistance – Squat, bilateral leg press, knee extension and knee flexion | Tibial artery; Posture not reported | 80% AOP | N – Referenced Loenneke et al. ²⁶ (determined via either direct measurement or predictive equation) | Width not reported, pneumatic sleeves, continuous inflation (pressure released between exercises) |
| Ladlow et al. ⁵⁶ | 2018 | Males with lower limb musculoskeletal injuries, 31 ± 7 years | 28 (14 in BFR group) | Training | Resistance – Bilateral leg press and knee extension | Posterior tibial or dorsalis pedis artery; Supine | 60% AOP | N – Referenced Scott et al. ⁸⁷ | 10 cm width, material not reported (cuff model reported), continuous inflation (pressure released between exercises) |
| Jessee et al. ⁶⁹ | 2018a | Resistance trained adults, 22 ± 3 years (11 male, 13 female) | 24 | Acute | Resistance – Unilateral elbow flexion | Radial artery; Standing | 40% AOP | N | 5 cm width, nylon, continuous inflation |

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| Jessee et al. ³⁹ | 2018b | Untrained adults, 21 ± 2 years (20 male, 20 female) (sex of participants in specific groups not reported) | 40 | Training | Resistance – Unilateral knee extension | Posterior tibialis artery; Seated | 0%, 40%, 80% AOP | N | 10 cm width, nylon, continuous inflation |
| Jessee et al. ⁷⁰ | 2018c | Resistance trained adults, 22 ± 1 years (22 male, 7 female) | 29 | Acute | Resistance – Unilateral elbow flexion | Radial artery; Standing | 0%, 10%, 20% 30%, 50%, 90% AOP | N – Lower pressures not previously examined | 5 cm width, nylon, continuous inflation |
| Hughes et al. ⁷¹ | 2018 | Anterior cruciate ligament repair patients, 29 ± 6 years (23 male, 7 female) | 30 (6 male, 4 female patients in ACL BFR group; 10 males in healthy BFR group) | Acute | Resistance – Unilateral leg press | Trained leg; Seated on leg press machine | 80% LOP | Y – Based on previous evidence suggesting high pressures maximise fast twitch fibre recruitment and strength adaptations to BFR training ^{48,88,89} | 11.5 cm width (86 cm length, 5.5 cm thickness), nylon (contoured), continuous inflation |
| Curty et al. ⁵⁷ | 2018 | Resistance trained males, 26 ± 3 years | 9 | Acute | Resistance – Eccentric unilateral elbow flexion | Radial artery; Supine | 80% AOP | N | 14 cm width (52 cm length), standard sphygmomanometer, continuous inflation |
| Buckner et al. ⁷² | 2018 | Resistance trained adults, 22 ± 2 years (12 male, 10 female) | 22 | Acute | Resistance – Unilateral elbow flexion | Radial artery; Standing | 0%, 40%, 80% AOP | N | 5 cm width, nylon, inflation pattern not reported |

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| Bell et al. ⁷³ | 2018 | Resistance trained adults, 22 ± 3 years (12 male, 10 female) | 22 | Acute | Resistance – Unilateral elbow flexion | Radial artery; Standing | 0%, 40%, 80% AOP | N | 5 cm width, nylon, inflation pattern not reported |
| Tennent et al. ⁷⁴ | 2017 | Post-non-reconstructive knee arthroscopy patients, 38 ± 4 years (12 male, 5 female) | 17 (7 male, 3 female in BFR group) | Training | Resistance – Unilateral leg press, knee extension, reverse press (also other non-BFR treatments) | Artery not reported; Posture not reported | 80% AOP | N – To achieve venous but not arterial occlusion | Width and material not reported (inflation system model reported) (varying cuff length based on participant thigh size, contoured), continuous inflation |
| Neto et al. ⁴⁰ | 2017 | Untrained females with regular menstrual cycles, 22 ± 3 years | 30 (10 in BFR group) | Acute | Resistance - Bilateral elbow flexion and knee extension | Radial and tibial artery; Supine | 80% AOP | N | 6 cm (arm) and 10 cm (leg) width (47 cm and 54 cm length, respectively), standard sphygmomanometers, both continuous and intermittent inflation (pressure released between sets) |
| Mouser et al. ³¹ | 2017 | Recreationally active adults, 22 ± 2 years (64 male, 73 female) | 137 (42 males and 48 females in BFR groups) | Acute | Resistance – Unilateral elbow flexion | Radial artery; Standing | 0%, 40%, 80% AOP | N | 5 cm width, nylon, continuous inflation |
| Mattocks et al. ²⁰ | 2017 | Resistance trained adults, 22 ± 1 years (20 male, 6 female) | 26 | Acute | Resistance – Unilateral elbow flexion | Radial artery; Standing | 0%, 10%, 20%, 30%, 50%, 90% AOP | N – Lower pressures not previously examined | 5 cm width, nylon, inflation pattern not reported |

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| Kim et al. ⁴¹ | 2017 | Untrained males, 23 ± 5 years | 14 (9 in BFR group) | Acute and training | Resistance – Unilateral elbow flexion | Radial artery; Standing | 50% AOP | Y – 50% assessed to determine if sufficient restriction to augment muscle adaptations | 5 cm width, nylon, inflation pattern not reported |
| Ferreira et al. ⁴² | 2017 | Untrained males, 48 ± 1 years | 15 | Acute | Resistance – Leg press and knee extension (uni- or bilateral not reported) | Tibial artery; Supine | 50% AOP | N | 17.5 cm width (92 cm length), standard sphygmomanometer/s, continuous inflation |
| Dankel et al. ⁷⁵ | 2017 | Resistance trained adults, 25 ± 4 years (11 male, 3 female) | 14 | Acute | Resistance – Unilateral elbow flexion | Radial artery; Standing | 40%, 80% AOP | N – Selected based on a previous study ⁴⁸ | 5 cm width, nylon, inflation pattern not reported |
| Clarkson et al. ⁸ | 2017 | Sedentary older adults, 69 ± 6 years (11 male, 8 female) | 19 (6 male, 4 female in BFR group) | Training | Walking | BFR machine function; Standing | 60% LOP | N | 10.5 cm width, material not reported (inflation system model reported), continuous inflation |
| Buckner et al. ¹⁹ | 2017 | Resistance trained adults, 25 ± 2 years (12 male, 3 female) | 15 | Acute | Resistance – Unilateral elbow flexion | Radial artery; Standing | 40% AOP | Y – The lowest pressure examined that appears to elicit similar muscle activation and growth in the upper body as higher pressures ⁴⁴ | Cuff 1: 5 cm width, nylon; Cuff 2: 3 cm width, elastic; Inflation pattern not reported |
| Poton and Polito ⁵⁸ | 2016 | Resistance trained males, 23 ± 4 years | 12 | Acute | Resistance – Unilateral knee extension | Tibial artery; Posture not reported | 100% AOP | N – Aim appeared to be inducing total blood flow occlusion | 18 cm width (90 cm length), standard sphygmomanometer, continuous inflation, |

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| Pinto and Polito ⁶³ | 2016 | Hypertensive women, 57 ± 7 years | 12 | Acute | Resistance – Bilateral leg press | Tibial artery; Posture not reported | 100% AOP | N | 18 cm width (70 cm length), standard sphygmomanometers, continuous inflation |
| Neto et al. ²⁴ | 2016 | Recreationally active males, 22 ± 3 years | 24 | Acute | Resistance – Bilateral elbow flexion & extension, knee flexion & extension | Radial and tibial artery; Posture not reported | 80% AOP | N | AOP measured with standard sphygmomanometers, BFR applied with ‘specially designed elastic cuffs’, both intermittent and continuous inflation |
| Fatela et al. ⁴³ | 2016 | Untrained males, 25 ± 5 years | 14 | Acute | Resistance – Unilateral knee extension | Tibial artery; Posture not reported | 40%, 60%, 80% AOP | N | 13 cm width (124 cm length, material not reported (cuff model stated), continuous inflation |
| Counts et al. ⁴⁴ | 2016 | Acute study – Resistance trained adults, 24 ± 3 years (10 male, 4 female) Training study – Untrained adults, 23 ± 3 years (5 male, 3 female) | Acute study – 14 Training study – 8 | Acute and training | Resistance – Unilateral elbow flexion | Radial artery; Standing | 40%, 50%, 60%, 70%, 80%, 90% AOP | N | 5 cm width, nylon, inflation pattern not reported |
| Barnett et al. ⁴⁵ | 2016 | Adults, 23 ± 3 years (19 male, 12 female) | 31 | Acute | Resistance – Unilateral elbow flexion | Radial artery; Seated | 40% AOP | N | 5 cm width, nylon, inflation pattern not reported |

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| Staunton et al. ⁴⁶ | 2015 | Non-resistance trained young male adults, 23 ± 2 years; Older males, 70 ± 5 years | 24 (11 young males, 13 older males) | Acute | Walking (treadmill) and resistance – Bilateral leg press | BFR machine function; Standing for walking trial, Supine for leg press trial | 60% LOP | Y – Within a range of absolute pressures used known to induce muscle adaptations ^{86,90,91} | 10.5 cm width (86 cm length), material not reported (inflation system model stated), continuous inflation |
| Poton and Polito ⁴⁷ | 2015 | Physically active adults, 23 ± 6 years (11 male, 6 female) | 17 | Acute | Resistance – Bilateral leg press | Tibial artery; Posture not reported | 100% AOP | N | 18 cm width (90 cm length), standard sphygmomanometers, continuous inflation |
| Moriggi Jr et al. ²⁵ | 2015 | Resistance trained males, 24 ± 4 years | 8 | Acute | Resistance – Bilateral elbow flexion, elbow extension, bench press | Brachial artery; Seated | 50% AOP | N | 15 cm width (51 cm length), standard sphygmomanometers, continuous inflation (pressure released between exercises) |
| Lixandrão et al. ⁴⁸ | 2015 | Untrained males, 28 ± 9 years | 26 | Training | Resistance – Unilateral knee extension | Tibial artery; Supine | 40%, 80% AOP | N | 17.5 cm width (9.2 cm length; likely reported incorrectly), standard sphygmomanometer, continuous inflation |
| Araújo et al. ⁶⁴ | 2015a | Middle-aged females, 54 ± 4 years | 29 (10 in BFR group) | Training | Water aerobics | Tibial artery; Supine | 80% AOP | N | 18 cm width (80 cm length), adapted sphygmomanometers, continuous inflation |
| Araújo et al. ⁶⁵ | 2015b | Post-menopausal females, 54 ± 4 years; | 28 (10 in BFR group) | Training | Water aerobics | Tibial artery; Supine | 80% AOP | N | 18 cm width (80 cm length), adapted sphygmomanometers, continuous inflation |

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| Santos et al. ⁵⁹ | 2014 | Male with inclusion body myositis 65 years | 1 | Training | Resistance – Bilateral knee extension, leg press, half-squat | Tibial artery; Supine | 50% AOP | N | 8 cm width (18 cm length; likely reported incorrectly), adapted sphygmomanometers, continuous inflation |
| Araújo et al. ⁴⁹ | 2014 | Non-resistance trained females, 46 ± 10 years | 14 (7 in BFR group) | Acute | Resistance – Bilateral knee extension | Determination site and posture not reported | 80% AOP | N | 18 cm width (80 cm length), adapted sphygmomanometers, continuous inflation |
| Laurentino et al. ⁵⁰ | 2012 | Physically active, non-resistance trained males, 21 ± 5 years | 29 (10 in BFR group) | Training | Resistance – Bilateral knee extension | Tibial artery; Supine | 80% AOP | N | 17.5 cm width (92 cm length), standard sphygmomanometers, continuous inflation |
| Laurentino et al. ⁵¹ | 2008 | Recreationally active, non-resistance trained males, 23 ± 3 year | 16 | Training | Resistance – Unilateral knee extension | Tibial artery; Posture not reported | 100% AOP | N – Likely intended to achieve full vascular occlusion during exercise | 14 cm width (90 cm length), standard sphygmomanometer, intermittent inflation (pressure released between sets) |

Abbreviations: BFR – blood flow restriction; AOP – arterial occlusion pressure; LOP – limb occlusion pressure; ACL – anterior cruciate ligament.