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(REVIEW ARTICLE)

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A review on the clinical impact of low-load blood flow restriction training on muscle strength in post-menopausal women

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Abstract

Menopause is associated with physiological and hormonal changes that contribute to the decline in muscle mass, strength, and functional capacity, increasing the risk of falls, fractures, and reduced quality of life in postmenopausal women. While high-load resistance training (HLRT) is effective in preserving muscle function, it may not be suitable for women with joint issues or comorbidities. Low-load resistance training combined with blood flow restriction (LLRT-BFR) has emerged as a promising alternative, offering similar benefits with reduced mechanical stress.

This review aimed to evaluate the clinical effects of LLRT-BFR on muscle strength and functional performance in postmenopausal women. Ten relevant studies published between 2010 and 2024 were analyzed, involving various training protocols applying 20–30% of one repetition maximum (1RM) with BFR cuffs. The findings consistently demonstrated significant improvements in muscle strength, functional mobility, and, in some cases, body composition and cardiovascular markers. LLRT-BFR was well tolerated, with no major adverse effects reported.

These results suggest that LLRT-BFR is a safe, effective, and feasible intervention for postmenopausal women, particularly for those who cannot perform high-load training. Incorporating this method into exercise programs may support healthy aging by preserving muscle function, independence, and overall quality of life.

Keywords: Blood flow restriction; Low load resistance training; Muscle mass; Muscle strength; Postmenopausal women

1. Introduction

Menopause is a considerable period in women's life comprising some fundamental physiological and psychological changes that may lead to losing some health parameters like BMD, Body composition, Muscle Mass and Strength, Thermoregulation, Cardiovascular health, Glucose metabolism, Urinary function, Cognitive function, Mood stability, social engagement.[1]. Menopausal women are also exposed to some diseases such as cardiovascular diseases, osteoporosis, urogenital atrophy, sexual problems, hot flushes, psychiatric symptoms, sleep disorders, and metabolic syndrome [5].

Overweighing and sarcopenia are the outstanding components of metabolic syndrome after the onset of the menopause period [6]. Since menopause is accompanied by hormonal changes and consequently increasing adipose tissue and decreasing muscle mass, many molecular changes are observed during this period [7].

Muscle mass loss is also associated to menopause, since a physiological hormonal change is present due to menstruation cessation. In particular, a decline in estrogen concentration has detrimental effects on skeletal muscle mass and

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functionality, leading to reduced bone mass density, redistribution of fat to the visceral area and increased risk of cardiovascular events. Notably, post-menopausal women with reduced skeletal muscle mass have a 2.1% higher risk of falling and a 2.7 % greater risk of sustaining a fracture compared to women with preserved muscle mass [9].

Blood flow restriction (BFR) training works by occluding venous flow yet allowing partial arterial inflow were applied on the most proximal site of the upper and lower limbs using BFR cuffs (The EDGE mobility system, USA) [3].

BFR pressure will be adjusted to each individual characteristic to elicit best result, and reduce common concerns, such as the risk of developing a blood clot, and muscle damage, as well as negative effect on cardiovascular system. The fixed pressure of BFR may not always stimulate across participants under vary conditions due to neglecting the important factors affect limb occlusion pressure (LOP), such as limb circumference and cuff width [3].

The recent studies have shown that resistance training with blood flow restriction can be practical to increase muscle mass and strength improving body composition in older adults including post-menopausal women [7].

The low-load resistance training performed with blood flow restriction (LLRT +BFR) is able to produce similar effects and even superior to those obtained through high load resistance training on hypertrophy using training loads between 20 and 50% of the repetition maximal value (1RM) [6].

Low-load BFR (LL-BFR) training (20–30% one repetition maximum, 1RM) has been shown to promote muscular hypertrophy and strength increases comparable to what is typically seen following high-load (HL) training programmes with 70–85% 1RM.

The advantage of low loads and thus reduced mechanical stress for joints and bones [7] is of particular interest for populations who are not capable of lifting near-maximum loads or for whom high loads may be contraindicated, such as in clinical rehabilitation. In this context, particularly in elderly subjects, HL resistance training is often not feasible due to comorbidities such as coronary heart diseases, diabetes mellitus or musculoskeletal impairments [8]. With advancing age, the skeletal muscle mass decreases by as much as 3–8% per decade after the age of 30 [11]. The coexistence of both, a decrease in muscle mass and strength is termed sarcopenia and has major functional and metabolic consequences, including an increased risk of falls and mortality [11]. With regard to demographic changes, it is increasingly important to identify suitable evidence-based interventions that counteract the functional decline occurring with progressive age. To maximize the span of effective functioning with advancing age, exercise and nutritional interventions have been suggested as the cornerstones in the management of sarcopenia [10].

Objective of the study

The objective of this study is to investigate the effects of low-load Blood Flow Restriction (BFR) training on muscle strength in postmenopausal women.

2. Methodology

- **Study design:** Literature review
- **Search engines:** PubMed, Google Scholar, Science Direct, Sci hub
- **Keywords:** Blood flow restriction, low load resistance training, muscle mass, muscle strength, postmenopausal women
- Search year: 2010-2024

2.1. Inclusion criteria

- **Population:** Only studies involving **postmenopausal women** were included.
- **Age Range:** Studies including the Participants aged **45 years and above**
- **Language:** Only studies published in **English** were included.

Includes only low load resistance training • Articles including only after 2010

- **Study Design:** Randomized controlled trials, quasi-experimental studies, and pre-post intervention designs were considered.
- **Intervention:** Studies that used blood flow restriction (BFR) training, either as a primary intervention or in combination with resistance training

2.2. Exclusion criteria

- Population: Studies including men, premenopausal women, or mixed gender groups were excluded
- **Age:** Participants aged **below 45 years** were excluded
- **Study Type:** Review articles, case reports, editorials, letters, and conference abstracts.
- **Language:** Articles published in languages other than English were excluded.
- **Intervention:** Studies not involving BFR training or using unrelated exercise protocols.

3. Result

The analysis of studies focusing on low-load resistance training combined with blood flow restriction (LLRT-BFR) in postmenopausal women reveals consistent and meaningful improvements in multiple physical health parameters. Across the reviewed literature, LLRT-BFR interventions typically involved exercises performed at 20–30% of one-repetition maximum (1RM), with BFR cuffs applied to the proximal thigh region. This method was shown to effectively stimulate muscular adaptations despite the use of lower mechanical loads.

In terms of muscular strength, LLRT-BFR consistently produced significant gains. Participants demonstrated improved performance in lower limb strength assessments such as leg press, knee extension, and squatting tasks. These gains were evident in multiple trials, suggesting that BFR can induce strength adaptations comparable to those achieved through traditional high-load resistance training. Additionally, strength improvements were not confined to a single type of exercise; studies using free squats, knee extensions, and elastic resistance exercises all reported positive outcomes.

Functional performance also showed marked improvements. Women who participated in LLRT-BFR programs experienced enhanced ability in daily functional tasks, including sit-to-stand tests, walking speed, and floor-rising ability. These changes indicate that LLRT-BFR training not only improves muscular strength but also translates into better real-world functional independence—an important consideration in aging populations.

Some studies also observed favorable changes in body composition. Although results varied, certain interventions lead to reductions in body fat and increases in lean muscle mass, especially when programs lasted for 10–12 weeks. Improvements in systolic blood pressure were also reported in select studies.

Importantly, the use of BFR in low-load training was well tolerated across all studies, with no major adverse effects reported. This highlights its potential as a safe and accessible resistance training alternative for postmenopausal women who may be unable or unwilling to engage in high-intensity workouts.

In summary, LLRT-BFR emerges as a promising training strategy for postmenopausal women, offering improvements in strength, functional performance, and potentially body composition, all while using lower mechanical loads that reduce the risk of joint and musculoskeletal strain.

Table 1 Different studies identified for reviewing clinical impact of low-load blood flow restriction training on muscle strength in postmenopausal women

SL No	Author and year	Sample	Intervention	Procedure	Result
01.	Thiebaud et al. (2013)	16 postmenopausal women	Elastic band + BFR vs moderate high EB	Low-load elastic resistance training with BFR (3x/week for 12 weeks)	Similar strength & hypertrophy gains in BFR group compared to high resistance group
02.	Araújo et al. (2015)	28 postmenopausal women	Water-based training ± BFR	Aquatic resistance training with BFR cuffs applied at thighs (2x/week, 12 weeks)	BFR group showed superior gains in leg strength and functional mobility
03.	Geraldes et al. (2018)	45 postmenopausal women	LLRT-BFR vs HLRT	Lower limb resistance (20–30% 1RM) with BFR vs	LLRT-BFR improved

				HLRT (70–80% 1RM), 3x/week for 12 weeks	strength, reduced systolic BP; no vascular (FMD) changes
04.	Pereira et al. (2019)	24 postmenopausal women	Free squat LLRT-BFR vs HLRT	Free squat protocol (30% 1RM) with BFR cuffs; performed 3x/week over 12 weeks	Both groups improved strength & CSA; LLRT-BFR group showed better floor rising ability
05.	Silva et al. (2018)	18 postmenopausal women	Free squat LLRT-BFR vs HLRT	12-week protocol, BFR at 30% 1RM, 3 sets of squats with 60–90 sec rest	No significant body composition changes in either group
06.	Libardi et al. (2015)	23 older women (~63 years)	Knee extension LLRT-BFR	BFR at 20–30% 1RM knee extension, 3x/week for 12 weeks	Strength gain, fat mass reduction, lean mass gain; improved sit-to stand and walk tests
07.	Feriani et al. (2018)	45 postmenopausal women	LLRT-BFR vs HLRT	Resistance training (Leg press, squats) at 30% 1RM with BFR vs HLRT (70–80% 1RM)	BFR group showed better strength, fat loss, and functional performance
08.	Feriani et al. (2017a)	45 postmenopausal women	LLRT-BFR vs HLRT vs Control	12-week BFR protocol at 30% 1RM, 3x/week, including squats, leg press	LLRT-BFR improved strength, mobility, and QoL; functionally superior to HLRT
09.	Feriani et al. (2017b)	45 postmenopausal women	LLRT-BFR vs HLRT vs Control	Similar to above; progressive overload with BFR on thigh during leg exercises	LLRT-BFR improved physical function and QoL more than HLRT or control
10.	Pereira et al	24 postmenopausal women	LLRT-BFR vs HLRT	Reinforced previous free squat + BFR protocol, 3x/week over 12 weeks	Emphasized BFR's superior effect on functional mobility (e.g., rising from floor)

4. Discussion

The findings from the reviewed studies suggest that low-load resistance training combined with blood flow restriction (LLRT-BFR) is an effective and practical strategy for improving muscular strength and functional capacity in postmenopausal women. Traditionally, resistance training aimed at muscle hypertrophy and strength development requires high mechanical loads, which may not be well tolerated by aging populations due to increased joint stress, the risk of injury, or chronic musculoskeletal conditions. In contrast, LLRT-BFR utilizes significantly lower loads while still eliciting comparable physiological adaptations, making it a suitable alternative for women in the postmenopausal stage.

The improvements in muscle strength observed across studies demonstrate the ability of LLRT-BFR to activate muscle fibers and stimulate hypertrophic mechanisms, likely due to increased metabolic stress and hormonal responses associated with vascular occlusion during exercise. These adaptations are particularly beneficial for postmenopausal women, who often experience declines in muscle mass and strength due to hormonal changes and aging.

Functional performance also improved significantly in women who underwent LLRTBFR training. Enhancements in daily tasks such as sit-to-stand movement, walking speed, and rising from the floor indicate that the benefits extend beyond isolated strength gains to include real-world functional mobility. These outcomes are particularly relevant for maintaining independence and reducing fall risk among older adults.

Although changes in body composition were inconsistent across studies, some reported reductions in fat mass and increases in lean body mass, especially with longer training durations. The addition of mild cardiovascular benefits, such as reduced systolic blood pressure, adds further support to the potential of LLRT-BFR as a multifaceted intervention. Furthermore, the overall safety profile of BFR training reported in these studies suggests it is a well-tolerated method when appropriately supervised and individually tailored.

Although recent reviews have investigated the effects of LL-BFR training in athletes and individuals with a clinical musculoskeletal condition, there is currently no literature review summarizing the effects of LL-BFR in older adults.

5. Conclusion

In conclusion, low-load resistance training with blood flow restriction (LLRT-BFR) appears to be a safe, effective, and accessible approach for improving muscular strength, functional ability, and, to some extent, body composition in postmenopausal women. This training method offers a valuable alternative to high-load resistance exercise, especially for individuals who may be limited by joint issues or other age-related concerns. Incorporating (LLRT-BFR) into exercise programs for postmenopausal women could help address age-related declines in muscle and function, supporting better health, independence, and quality of life.

To use LRT-BFR, it is necessary to increase the safety in the application of the method to avoid potentially negative physiological factors, such as, for example, reduction of nerve conduction velocity, thrombus formation or induction to microvascular occlusion and discomfort, especially in the presence of hypertension, diabetes and endothelial dysfunction, a frequent condition in postmenopausal women.

While these findings are promising, limitations include small sample sizes in several studies and variations in BFR pressures, exercise selection, and session frequency. Future research with standardized protocols and larger populations is needed to strengthen the evidence base and explore long-term effects

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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