Blood flow restriction training on hypertesive subjects: a systematic review

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Summary

Introduction: Systemic arterial hypertension has been growing worldwide, causing thousands of deaths and large expenses in this condition treatment. Currently, resistance training (RT) is widely prescribed as a non-pharmacological option for blood pressure control, but there are some individuals with intolerance to high load of RT. Hence, blood flow restriction is a method created to stimulate high level of physiological adaptations with low resistive load. However, there are uncertainties about safety and efficacy of this method.
Objective: The present study aimed to investigate the safety and efficacy of blood flow restriction training in hypertensive individuals.
Material and method: The research was carried out through a systematic review within the criteria established by the PRISMA statement. Only studies about blood flow restriction in subjects with arterial hypertension were selected in the following databases: MEDLINE/PUBMED, Web of Science, SCOPUS and SPORTDiscus.
Results: Five studies (4 acute and 1 chronic effects) met the requirements for the present review, with 77 hypertensive individuals. Only one study presented levels of blood pressure above to the recommended for hypertensive subjects.
Conclusion: Even though the number of studies is still insufficient to conclude about the efficacy, the results allow concluding that resistance training with blood flow restriction is a safe alternative of exercise method to hypertensive subjects, especially for those with intolerance to high training loads.

Key words:
Blood flow restriction training. Blood pressure. Heart disease. Hemodynamics.

Entrenamiento de restricción del flujo de sangre en sujetos hipertensivos: revisión sistemática

Resumen

Introducción: La hipertensión arterial sistémica ha ido creciendo a nivel mundial, provocando miles de muertes y grandes gastos en el tratamiento de esta afección. Actualmente, el entrenamiento de fuerza se prescribe ampliamente como una opción no farmacológica para el control de la presión arterial, pero hay algunas personas con intolerancia al entrenamiento de alta intensidad. Por ello, el entrenamiento de restricción del flujo sanguíneo es un método creado para estimular los altos niveles de adaptación fisiológica con cargas de baja intensidad. Sin embargo, existen incertidumbres sobre la seguridad y eficacia de este método y no hay consenso al respecto.
Objetivo: El presente estudio tuvo como objetivo investigar la seguridad y eficacia del entrenamiento de restricción del flujo sanguíneo en individuos hipertensos.
Material y método: La investigación se realizó mediante una revisión sistemática, dentro de los criterios establecidos por la declaración PRISMA y se utilizaron las siguientes bases de datos: MEDLINE/PUBMED, Web of Science, SCOPUS y SPORTDiscus, incluyendo solo estudios con individuos con hipertensión arterial en los que se utilizó el método.
Resultados: Cinco estudios (4 efectos agudos y 1 efectos crónicos) cumplieron con los requisitos de la presente revisión, con 77 individuos hipertensos. 4 estudios evaluaron efectos agudos y 1 estudio evaluó efectos crónicos. Solo un estudio incluido presenta niveles aumentados de presión arterial por encima de los niveles recomendados en sujetos hipertensos y los otros 4 estudios demostraron la seguridad del entrenamiento de oclusión.
Conclusión: A pesar de que el número de estudios aún es insuficiente para concluir sobre su eficacia, los resultados muestran una seguridad de este método como ejercicio alternativo para sujetos hipertensos, especialmente aquellos con intolerancia al entrenamiento de cargas de alta intensidad.

Palabras clave:
Entrenamiento de restricción del flujo sanguíneo. Presión sanguínea. Cardiopatía. Hemodinámica.

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Introduction

Systemic arterial hypertension (SAH) is a chronic disease which affect approximately 1.13 billion people worldwide[1]. Its prevalence increases with aging[2] and significantly increases the risk of cardiovascular disease, which is the major cause of premature death worldwide[3]. According to American Heart Association (AHA), SAH is diagnosed when the systolic blood pressure (SBP) ≥ 140 mmHg and diastolic blood pressure (DBP) ≥ 90 mmHg, following repeated examination[4]. Additionally, AHA proposes some strategies to reduce deaths by SAH, such as lifestyle modification (e.g. physical exercise, nutrition habits) associated to pharmacological treatment[4].

Physical exercise, as a component of lifestyle changing, has been showing efficient in the treatment of arterial hypertension. Therefore, aerobic or resistance exercises are recommended as a non-pharmacological treatment for SAH[5]. Both of them can improve cardiac[6] and vascular function[7], and reduce metabolic risk[8]. According to Cornelissen *et al.*, (2013) engagement in aerobic exercise (e.g. walking, running, swimming or cycling) is recommended for patients diagnosed with SAH, at least 30 minutes/day of moderate-intensity[9], because that activity is able to reduce 8 mmHg for SBP and 5 mmHg for DBP[10]. On the other hand, International Society of Hypertension (ISH) also recommended resistance training (RT) for SAH patients, at least 2-3 days per week, for treat and control hypertension[4], and RT alone can induce a mean decrease of 8.2 mmHg for SBP and 4.1 mmHg for DBP, according to recent meta-analysis study[11]. Nevertheless, there are more scientific evidences for aerobic than RT, despite physiological benefits mediated by these exercise categories.

SAH prevalence is higher in elderly than young adults[4], and aging promotes several physiological consequences such as sarcopenia[12], dynapenia[13] and frailty[12]. Thus, RT seems to promote more powerful counter regulatory adaptations related to aging process, and could be a great non pharmacology strategy against SAH for elderly. Despite capacity of RT to reduce blood pressure, the RT load applied to promote the physiological benefits seems to be not well tolerated for elderly, sedentary young and frailty patients[14]. Then, some coaches are developing training systems and methods to reduce the training load, but preserving or improving the adaptations of conventional RT[15].

In this way, a different resistance training method known as Blood Flow Restriction (BFR) or popularly Kaatsu training, recently gained attention in scientific literature[16]. This method constitutes of the partial vascular occlusion in the muscles that will be resistance trained. According to Sumide *et al.*, (2008) vascular occlusion pressure of 50 mmHg is sufficient to improve muscle strength and endurance[17]. A recent meta-analysis conducted by Centner *et al,* (2019) conclude that low load resistance training (20-30% of 1RM) with BFR is able to induce similar muscle hypertrophy than high load resistance training (70-85% of 1RM) without BFR[18]. Consequently, BFR seems to be a great strategy to promote high anabolic stimulus with lower RT intensity for elderly, sedentary young and frailty patients[19].

There are several mechanisms involved in skeletal muscle hypertrophy induced by BFR, such as increasing in metabolic stress, cell swelling, Reactive Oxygen Species (ROS) production, hormones production and others[20]. Despite those adaptations, while some evidences show smaller increase in mean blood pressure (MAP) during RT with BFR[21,22], Domingos and Polito (2018), in a meta-analytic study, showed that RT with BFR promoted greater increase in SBP and DBP compared to RT without BFR[23]. However, those studies, including the meta-analytic review of Domingos and Polito, were not conducted in subjects with any cardiovascular condition. Thus, there is there is a lack of knowledge in the literature about the safety of this method on cardiovascular responses for SAH individuals.

In this perspective, the safety of resistance training with blood flow restriction for patients with SAH remains controversial. Therefore, the aimed of this research was investigate through a systematic review of the literature about the safety and efficacy of blood flow restriction training as a non-pharmacologic treatment for hypertensive patients.

Material and method

The procedures for this systematic review of the literature adopted followed the Guidelines of Preferred Reported Items for Systematic Reviews and Meta-Analysis (PRISMA)[24] and was registered at PROSPERO under the number 156683.

Experimental approach to the problem

The literature search was conducted in international databases, such as PubMed, Scopus, Web of Science SPORTDiscus, Science Direct, Cochrane, Physical Education Index, Scholar and CINAHL using the following search syntax: "resistance training" AND "blood flow restriction training" AND "hemodynamics" AND "hypertensive" OR "hypertensive subjects". The main purpose was to identify scientific studies related to blood flow restriction training and hypertension according to PICO strategy (patient, intervention, comparison and outcome) Patients: Hypertensive subjects; Intervention: BFR Training; Comparison: Compared to without BFR training; Outcome: Changes on blood pressure. The selection and inclusion of articles were made by 2 independent authors (TWSP and CMB)

The papers should would meet the following inclusion criteria: (a) Original articles investigating acute or chronic effects of blood flow restriction training in blood pressure; (b) Studies investigating the acute or chronic effect of blood flow restriction training in cardiac disease patients; (c) Male and/or female hypertensive subjects; (d) Studies that descript the resistance training (Frequency and duration); (e) Studies that descript the blood flow restriction (duration, pressure of occlusion and cuff type); (f) Studies published in English. To met the inclusion criteria, the included studies need to describe how subjects was diagnosed with hypertension.

Outcomes

The researchers (TWSP, CMB) evaluated independently the full-text of selected paper and conduct data extraction, such as (a) number of subjects per group, (b) duration of intervention, (c) study design, (d) intensity of exercise, (e) intensity of occlusion and (f) weekly frequency was extracted. Later, the researchers crosschecked the data to confirm their accuracy.

Risk of bias

Two expert researchers (TWSP, CMB) in exercise evaluated the methodological quality of the selected papers by TESTEX, according to Smart *et al*.,[25]. To reduce the chance of bias, only studies above 8-14 points in the TESTEX scale are included in the current systematic review.

Results

Search results

The search returned 185 articles. After the exclusion of duplicate records, and exclusion by title and abstract, there were 11 articles for reading in full. In the end, 5 studies met the eligibility criteria and were includes in this review. All steps of search results are described in Figure 1. Study quality of included studies was assessed through TESTEX scale and is described in Table 1. All studies were pointed with a quality between 8 and 14 points and the mean quality of the included studies was 10,8 points. 3 studies include range between 8-10 points (Table 1) and 2 studies range between 11-14 points (Table 1). The points between 8-10 indicates that they had moderate quality and those ranged between 11-14 indicates high quality.

Studies Characteristics

The 5 studies included in this systematic review have a total of 77 hypertension individuals and the characteristics is described Table 2. All studies reported the age as mean ± standard deviation. The age of 77 participants was between 44.9 ± 5.1 and 67.0 ± 7.0 years old. According to Body Mass Index (BMI), the participants included in all studies was classified as overweight (25.0-29.9) or obesity class 1 (30.0-34.9). All studies used subjects clinically diagnosed with hypertension. 4 studies used sedentary individuals or that were not involved in any resistance exercise program for the previous six months[26–29] and only one study used individuals with at least one year of recreational resistance exercise experience[30]. The exercise protocol of the 5 studies included was resistance training. Only one study investigated the chronic effects applying 8 weeks of resistance training[27], the others 4 studies investigated acute effects. All studies used repetition maximum (RM) to determine intensity of exercise. Three studies applied 30% of 1RM in BFR groups[26,27,30] and the others two studies used 20% of 1RM at BFR groups[28,29]. The study by Cezar *et al.*, (2016) was the only to use a control group without BFR and without resistance exercises[27] and the study by Pinto *et al*., (2018) was the only to apply BFR in one group without resistance training[29]. The others three studies randomized individuals in two groups, one with BFR and resistance training and other without BFR but with resistance training[26,28,30].

Blood flow restriction methodology

Araujo *et al*., (2014) applied a sufficient pressure to occlude totally the leg arterial blood flow. The pressure was applied in both legs with 3 minutes of break between each measurement[26]. After that, 80% of

Figure 1. Flowchart of the process to select articles for systematic review.

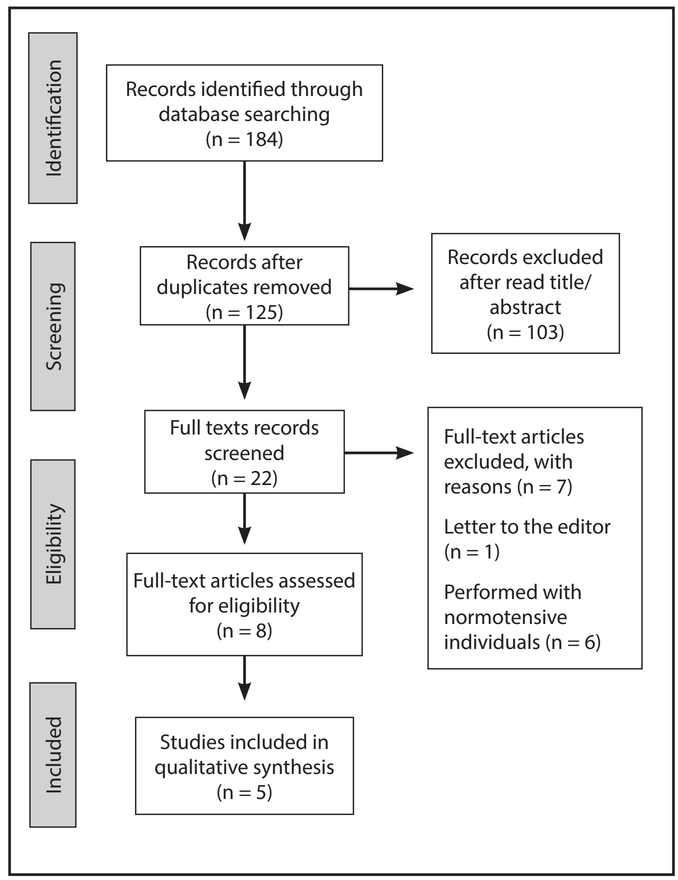

Table 1. Quality assessment of the studies using TESTEX checklist.

Study	1	2	3	4	5	6a	6b	6c	7	8a	8b	9	10	11	12	Total Score
Araújo *et al.*, (2014)	1	0	0	0	0	1	0	0	0	1	1	1	1	1	1	8
Cezar *et al.,* (2016)	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	14
Martins *et al.,* (2017)	1	0	0	1	0	0	1	1	0	1	1	1	1	1	1	10
Pinto *et al.*, (2018)	1	1	1	1	0	1	0	0	0	1	1	1	1	1	1	11
Pinto; Polito (2016)	1	0	1	1	0	1	0	0	0	1	1	1	1	1	1	10

1= Criteria met; 0= Criteria not met.

Table 2. Description of characteristics of the studies included.

Authors	Subjects/ Groups	Training Protocol	Cuff Method	Main Results
Araujo *et al.,* 2014	N = 14 Hypertensive women ST- MI (n = 7) ST-BFR (n = 7)	Acute RT-MI = 80% of 1RM RT-BFR = 30% of 1RM	Sphygmomanometers (18cm width x 80cm length)	↑SBP, DBP and HR during exercise for ST- BFR group compared to ST-MI group. ↓SBP, DBP, HR for 15, 30, 45- and 60-min post-exercise on ST-BFR. Hypotensive effect lasted for more than 60 minutes in the ST-BFR group, whereas in the ST-MI group it did not last less than 60 minutes.
Pinto and Polito., 2016	N = 12 Hypertensive women	3 randomized sessions RT-MI = 3x8, 65% de 1RM RT-BFR = 3x15, 20% de 1RM RT-LI = 3x15, 20% de 1RM	Blood pressure cuff for obese (10 cm width x 70 cm length) with a vascular doppler	↑ SBP, DBP, DP and SVR in ST-VO compared to RT-BFR with 20% of 1RM.
Cezar *et al.,* 2016	N = 23 Hypertensive women ST-HI (n = 8) ST-VO (n = 8) CTRL (n = 7)	Chronic study RT-BFR = 30%1RM RE-MI – 80%1RM	Sphygmomanometers (didn't relate measures)	↓ SBP, DBP MAP and DBP
Pinto *et al.,* 2018	N = 18 Hypertensive women	RT-MI = 3x15, 65%1RM RT-BFR = 3x15, 20%1RM Control = only BFR	Cuff + Vascular doppler (10cm width x 90 cm length)	↓ cardiac output, systemic vascular resistance and blood lactate in ST-VO, compared to ST-HI.
Martins *et al.*, 2017	N=10 Hypertensive men	2 sessions RT-BFR = 3 set at a concentric failure, 30% of 1 RM. RT-MI = 3 set at a concentric, 70%1RM	Elastic Belt (100mm width x 800mm length) with pneumatic bag	Both training protocols showed a significant decrease in SBP, DBP and HR after 10 min to 60 min, showing a greater reduction in ST-VO after 20 min post-exercise, compared to ST-HI.

ST: Strength training; MI: Moderate intensity; BFR: Blood Flow Restriction; CTRL: Control; 1RM: One Repetition Maximum; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; HR: Heart Rate.

the pressure to totally occlusion was calculated and used. Cezar *et al.*, (2016) calculated the occlusion using 70% of SBP basal values[27]. Martins *et al*., (2018) determined the SBP values at supine position and applied a pressure of 20 mmHg upper SBP values. The mean pressure of arterial occlusion was 159.2 ± 12.9 mmHg[30]. Pinto and Polito (2016) applied a pressure until the moment that the sound of blood flow could not be heard by a doppler equipment and this pressure was used at exercise protocol[28]. Pinto *et al*., (2018) used 80% of the pressure necessary to full blood flow interruption[29].

Basal systolic blood pressure values

Of the studies included, all of them used individuals which underwent an anti-hypertensive therapy but only one study informed that individuals used Angiotensin II receptor class of medicaments[24].

The baseline hemodynamics value were reported by 3 studies[27–29]. The study by Cezar *et al*., (2016) randomized individuals in three groups and the basal SBP value was 147.7 ± 2.84 mmHg for the group who received BFR and resistance training, 142.5 ± 3.46 mmHg for the group without BFR but with resistance training and 131.43 ± 4.44 mmHg for the control group[27]. The study done by Pinto and Polito (2016) recruited individuals with 128.7 ± 11.3 mmHg of SBP basal value[28]. And Pinto *et al.*, (2018) used individuals with 120.2 ± 3.4 mmHg of basal SBP[29].

Basal diastolic blood pressure values

For DPB values, Cezar *et al*., (2016) used individuals with 92.75 ± 2.17 mmHg at BFR group resistance training, 89.25 ± 3.27 mmHg at group without BFR but with resistance training and 85.14 ± 3.29 mmHg at control group[27]. The basal values of DBP at Pinto and Polito (2016) study was 77.4 ± 9.7 mmHg[28] and at Pinto *et al*., (2018) was 69.3 ± 1.8 mmHg[29].

Basal heart rate values

For Heart Rate values, only the same three studies report them. At Cezar *et al.,* (2016) study, individuals had 81.5 ± 4.93 BPM at BFR group and resistance training, 75.0 ± 3.78 BPM at the group without BFR but with resistance training and 71.4 ± 4.0 BPM at control group[27]. The study by Pinto and Polito (2016) used individuals with 76.6 ± 9.7 BPM[28] and the study by Pinto *et al.*, (2018) used individuals with 78.4 ± 2.1 BPM[29].

Effect of blood flow restriction on systolic blood pressure

Araujo *et al.*, (2014) measure hemodynamics values at pre-exercise and during the first, second and third set and 15, 30, 45 and 60 minutes post exercise[26]. For SBP values, was observed an increase in second set compared to first for group with BFR and during all moments of exercise the group with BFR had higher SBP valued than group without BFR. Cezar *et al.,* (2016) observed that after 8 weeks of training, only BFR was able to induce reduction in SBP (Pre moment: 145.75 ± 2.84 vs. Post moment: 129.75 ± 2.25)[27] Martins *et al.*, (2018) measured hemodynamics values at rest in supine position and after exercise with 10 minutes interval between measures until 60 minutes[30]. As observed by authors, immediately after exercise, SBP increased significantly but not differ between groups and 10 minutes after exercise, SBP returned to basal values and remained. The authors calculated the effect size of the results and only for BFR group was observed moderate or large reduction for SBP values at 20 and 40 minutes, respectively[30]. Pinto and Polito (2016) observed that the BFR induced an increase in SBP values when compared to a group without BFR and only the BFR induce increase in SBP during the rest between[28]. Pinto *et al.*, (2018) observed that during 3 sets the group with BFR had higher values of SBP than the group without BFR but after exercise they observed a significant reduction[29].

Effect of blood flow restriction on diastolic blood pressure

At the study of Araujo *et al.,* (2014) the DBP was higher during exercise for BFR group than for the group without BFR. But only at the second set was observed a statistical significance but only at the second set was observed statistical difference[26]. Cezar *et al.*, (2016) observed a significative reduction in DBP after 8 weeks of BFR resistance training[27]. Martins *et al.,* (2018) shown that immediately after exercise DBP increased significantly but not differ between groups and 10 minutes after exercise, DBP returned to basal values but only after 20 minutes of exercise DBP significantly reduced compared to basal values[30]. Pinto and Polito (2016) observed that the BFR induced an increase in DBP values when compared to a group without BFR and only the BFR induce increase in DBP during the rest between sets[28]. Pinto *et al.*, (2018) observed that DBP increase during 3 sets of resistance training with BFR compared to a group without BFR but similar to SBP, the levels of DBP significantly reduced after exercise[29].

Effect of blood flow restriction on heart rate

Only 4 studies reported the effects of BFR on Heart rate. At the study of Araujo *et al*., (2014) A significant increase in Heart Rate was observed between first and second set for the group with BFR[26]. Cezar *et al.*, (2016) observed that 8 weeks of resistance training with BFR was able to reduce heart rate values[27]. Pinto and Polito (2016) shown that BFR induced an increase in Heart Rate during 3 sets and returned to basal levels after exercise[28]. The study by Pinto *et al.,* (2018) reported an increase in heart rate during 3 sets with BFR but with a hypotension effect after exercise[29].

Discussion

To our acknowledgment, this is the first systematic review that investigated the blood flow resistance training safety on hypertensive subjects. The objective of this systematic review was to investigate the effects of BFR as another viable alternative in the treatment of systemic arterial hypertension. The studies about BFR in normotensive individuals demonstrated positive effects on blood pressure. Crisafulli *et al*., (2018) investigated the effects of 4 weeks of handgrip exercise with 40% of 1RM with BFR and was observed by authors that BFR were able to induce a reduction of mean arterial pressure response during handgrip exercise after 4 weeks[31]. The same results were observed by Neto *et al.,* (2015) which realize a study with 24 normotensive individuals submitted to a resistance exercise program and an hypotensive effect was observed after 30 minutes after resistance training with BFR[32]. According to authors, the hypotensive effect of BFR possible was mediated by a modification in baroreflex activity, with increased efficiency in buffering sympathetic activity[31] and an increase in nitric oxide production which was able to induce vasodilatation[32].

Despite these positive effects on normotensive individuals, until this review there is a lack of knowledge about the safety and efficacy of the BFR on SAH individuals. And according to our results, the major finding in this systematic review was the safety of BFR method applied in SAH individuals. As observed in included studies by Araujo *et al.*, (2014), Pinto *et al.*, (2018)[29], Martins *et al*., (2018)[30] and Pinto and Polito (2016)[28], there is an acute increase in SBP, DBP and HR levels during the sets of resistance exercise with BFR, but only in the study by Pinto and Polito (2016)[28] there is an increase in SBP and DBP higher than the increase in the group without BFR. These results could be explained because the authors used only 30 seconds of interval between 3 sets of 15 repetitions with BFR. So, this methodology of exercise with short rest interval (≤30 seconds) probably increased the accumulation of metabolites which is able to alter muscle recruitment and increase blood pressure mediated by exercise pressor reflex[33]. So, according to these results, for hypertensive individuals is not recommended use short rest intervals between sets when using BFR. But, based on the included studies, the BFR method with >40 seconds of rest interval between sets is safe for individuals with SAH.

Another acute positive effect of BFR method was the post-exercise hypotension. The study by Araujo *et al*., (2014), presented hypotensive effects 15, 30, 45 and 60 minutes after resistance training with BFR compared to a group without BFR[26]. And according to Martins *et al.,* (2018), 40 minutes after resistance training with BFR resulted in a reduction of DBP and SBP with a large effect size[30]. Unfortunately, these results were not supported by Pinto *et al.,* (2018)[29] and Pinto and Polito (2016)[28] which didn't present hypotensive effect after BFR training. These discrepancies in results could be explained by the rest interval used in Pinto and Polito (2016)[28] study and by the velocity of repetition used in Pinto *et al.,* (2018)[29] study which the authors used 2 seconds of concentric and 2 seconds of eccentric contractions. According to Apkrarian (2019) longer cadence of resistance exercise can increase hemodynamics value if compared to faster cadences[34].

But, despite these difference in methodology, Pinto and Polito (2016)[28] and Pinto *et al*., (2018)[29] compared the group with BFR to a group without BFR and loads of 65% of 1RM. According to the results, the increase in hemodynamics variables were similar between the groups. So, the resistance training with BFR did not increase the risk of cardiac events in patients with Hypertension.

Beside these acute results, one study included evaluated the chronic effects of BFR on SAH individuals. According to Cezar *et al*., (2016) only the group submitted to a BFR training regimen for 8 weeks presented a reduction in hemodynamic variables. Additionally, the reduction in blood pressure after 8 weeks of BFR resistance training is due to an increase in vagal activity mediated by a hypoxia-induced oxidative stress, which is probably able to induce a chronic reduction in mean arterial blood pressure[27].

Some mechanisms could explain the benefits for blood pressure induced by low loads BFR training. When blood flow is restricted, there is a reduction in oxygen and energetic substrates delivery to the muscle. This delivery reduction is able to increase the levels of vascular endothelial growth factor and neuronal and inducible nitric oxide synthase[35]. These genes are responsible for angiogenesis[36] and this pro-angiogenic stimulus might reduce the progression of hypertension[37].

In another perspective, some cares need to be taken. For example, during the sets of resistance training with BFR was observed an increase in blood pressure as a consequence of the increased metabolites production and muscle metaboreflex[38]. So, in individuals with uncontrolled hypertension, is not recommended BFR training, mainly for the more pronounced increase in blood pressure. But, with pharmacological anti-hypertensive therapy and with controlled blood pressure, is safety to use BFR training.

Unfortunately, there are some limitations in this systematic review that must be highlighted: the number of studies about the effects of Blood flow restriction on individuals with SAH is scarce, mainly studies about chronic effect. Due to this, even with the studies included in this systematic review obtaining good methodological classification evaluated through of the TESTEX scale we cannot conclude about efficacy of the BFR in hypertensive individuals. In addition, there is still no standardization of the pressure exerted on the joints through the specific cuffs for the practice of BFR in hypertensive patients, each researcher used a means to determine the pressure exerted on the joints used in the exercises with BFR.

Conclusions

Through this systematic review, we can conclude that low load BFR training can be an alternative method of exercise for individuals with SAH, especially, in individuals with some frailty or some moderate and high load intolerance. Nevertheless, as consequence of the reduced numbers of studies included, we cannot conclude about the efficacy of the BFR on treatment of SAH. As future direction, studies comparing hemodynamic effects of small and large muscle groups with BFR and evaluating the metabolite levels after acute BFR in hypertensive individuals still needed. Another future direction is the urgence in chronic studies to understand the efficacy of this method to an alternative treatment for hypertension.

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Conflict of interest

The authors do not declare a conflict of interest.

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