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Potential benefits of blood flow restriction training in patients with type 2 diabetes: A narrative literature review

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Abstract

Study aim: This narrative review aims to critically discuss the potential beneficial effects of blood flow restriction (BFR) training on physiological outcomes, including muscle metabolism, insulin sensitivity, glucose metabolism, body composition, and cardiovascular health in type 2 diabetic individuals.
Material and methods: A comprehensive literature search was conducted across PubMed, Scopus, SPORTDiscus, and Google Scholar for studies published before December 10, 2025, using key terms related to BFR and diabetes.
Results: A total of 11 studies were included in this review after screening for relevance. These studies employed various BFR protocols and examined outcomes such as glycemic control, insulin sensitivity, body composition, and cardiovascular function in individuals with type 2 diabetes. BFR training was found to improve insulin sensitivity, reduce blood glucose levels, improve muscle metabolism, and positively influence body composition in individuals with type 2 diabetes. Several studies observed significant improvements in aerobic capacity (e.g., VO_2 max) and fat mass reductions. Additionally, BFR training demonstrated improvements in blood pressure regulation. However, variability in BFR protocols and short-term study durations limit the generalizability of these findings.
Conclusions: Preliminary findings suggest that BFR training may be effective as a non-pharmacological intervention for improving determinant metabolic and cardiovascular health outcomes in type 2 diabetes individuals, including insulin sensitivity, glucose metabolism, and cardiorespiratory fitness. Further research is needed to determine this training modality's optimal BFR parameters and long-term effects in diabetic populations.

Keywords: Occlusion training – Ischemia – Fasting blood glucose – Cardiovascular fitness – Muscle strength – Fat loss

Introduction

The prevalence of type 2 diabetes has reached epidemic levels, driving the need for effective and accessible interventions that can improve metabolic health and reduce related complications. It is currently estimated that approximately 537 million adults worldwide are living with diabetes, with type 2 diabetes accounting for approximately 90% of these cases (Fini et al., 2023). The condition is characterized by insulin resistance and relative insulin deficiency, leading to chronic hyperglycemia that can result in serious complications such as cardiovascular disease, neuropathy, and retinopathy (Nascimento et al., 2022). Given the multifactorial nature of type 2 diabetes, a variety of pharmacological and non-pharmacological treatment strategies have been proposed to manage the disease and mitigate its complications (Bielitzki et al., 2021; Hedt et al., 2022; Wong et al., 2024) Pharmaco-

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logical treatments typically involve insulin therapy, oral hypoglycemic agents, and other medications aimed at improving glycemic control and reducing cardiovascular risk (Tanaka et al., 2021). However, due to the progressive nature of the disease, pharmacological interventions alone may not be sufficient to prevent its long-term consequences (Tanaka et al., 2021). Therefore, lifestyle modifications, including dietary changes, exercise interventions, and weight management, play a key role in managing and potentially reversing disease progression.

Blood flow restriction (BFR) training has emerged as a new exercise modality that allows individuals to achieve significant muscle adaptations with significantly lower training loads (Cho & Lee, 2024). This is particularly relevant for patients with type 2 diabetes, who often encounter barriers to traditional high-intensity exercise due to comorbidities or functional limitations. The physiological mechanisms of BFR, such as increased muscle metabolism, glucose uptake, and muscle strength, offer promising opportunities to manage insulin sensitivity and reduce cardiovascular risk (Nascimento et al., 2022). Therefore, understanding the efficacy, safety, and practicality of BFR in this population is critical. This narrative literature review critically examines current research on the effects of BFR on type 2 diabetes, seeking to explain how this training modality can be effectively integrated into diabetes treatment protocols (Tanaka et al., 2021).

BFR involves placing a pressure band (of varying width) on the proximal end of the limb to restrict blood flow to distal muscles, resulting in a series of adaptive changes (Wortman et al., 2021). Various physiological mechanisms have been proposed to account for the increased muscle size and strength observed in BFR training, but they remain unknown (Bielitzki et al., 2021). The consensus suggests that muscle changes occur via an indirect effect of metabolite accumulation and a hypoxic environment, resulting from greater muscle activation, fatigue, and anabolic signaling than in the case of the same exercise intensity performed without BFR (Lorenz et al., 2021). Previous studies have devoted much attention to the use of ischemia during various forms of physical activity, especially during resistance exercise (Lorenz et al., 2021; Wilk et al., 2021; Wortman et al., 2021). According to Lorenz et al. (2021), ischemia induced before or during exercise increases physical performance and stimulates physiological responses such as improved metabolic efficiency (attenuated ATP depletion), as well as glycogen depletion and lactate production (Wong et al., 2024). In addition, ischemia causes changes in systemic VO_2, muscle Hb/Mb deoxygenation, and opening of ATP-dependent K^+ channels, which may increase performance levels (Jarosz et al., 2021). BFR training can enhance muscle protein synthesis (Manini et al., 2011), increase the recruitment of fast-twitch muscle fibers (Lorenz et al., 2021), and enhance the responses of the endocrine system (Takano et al., 2005).

Recent studies have illustrated how methods such as BFR training can improve muscle strength and metabolic performance (Bielitzki et al., 2021; Hedt et al., 2022; Wong et al., 2024). However, such training may also offer promising benefits in glycemic control (AbuEid, 2024; Tanaka et al., 2021; Rodrigues et al., 2023). Therefore, this narrative review aims to critically discuss the potential benefits of BFR training to advance our understanding of type 2 diabetes. Understanding its mechanisms may be essential for developing effective strategies and interventions, such as BFR, to combat its effects.

Material and methods

The authors conducted a comprehensive review of the existing literature on BFR training. This included analyzing various studies that investigated the effects of BFR on different physiological parameters, including body composition, muscle strength, blood biomarkers, and cardiovascular function. The review highlights the gap in research explicitly focusing on BFR in type 2 diabetes.

The review highlights the potential benefits of BFR for specific populations, such as older adults, individuals with low levels of physical fitness, and individuals prone to injury. This focused approach helps to determine how BFR may be a suitable alternative for those who cannot engage in high-intensity exercise. Instead of conducting a systematic review or meta-analysis, the authors chose a narrative synthesis to discuss the effects of BFR. This approach provides greater flexibility in integrating findings from different studies and perspectives on its potential benefits for individuals with type 2 diabetes.

Search strategy and data extraction

A systematic search was conducted across the databases PubMed, Scopus, SPORTDiscus, and Google Scholar, for studies published before 10 December 2025. The search strategy incorporated the following key terms and Boolean operators:

[Title/Abstract] "Blood flow restriction" OR "BFR" OR "vascular occlusion" OR "katsu" OR "occlusion training" OR "ischemia* training"
AND
[Title/Abstract] "Diabetes"

The initial search identified 473 manuscripts, which were manually reviewed for relevance. After screening, 152 manuscripts were excluded as duplicates, and an additional 305 were excluded because they did not focus on diabetic populations. Five more manuscripts were excluded as they were reviews, leaving 11 manuscripts included in this narrative review.

Results

The included studies demonstrated various outcomes related to BFR training in individuals with type 2 diabetes, hypertension, and other conditions, focusing on cardiovascular, metabolic, and muscular responses. Across the studies, different BFR protocols were employed, including varying pressures and loads, with significant effects observed in several key health parameters (see Table 1 for more information).

Rodrigues et al. observed reductions in blood pressure (BP) and changes in pain perception and rate of perceived exertion (RPE) after BFR training in individuals with type 2 diabetes, indicating potential cardiovascular benefits and altered sensory responses to exercise. Specifically, BFR with 50% arterial occlusion pressure (AOP) reduced systolic and diastolic BP and showed a trend of blood glucose (BG) reduction. In contrast, reported that BFR led to higher BP in the intervention group than the control group, highlighting variability in BP responses to BFR in different protocols.

Metabolic outcomes, including improved glycemic control and body composition, were prominently reported in studies by AbuEid (2024), Ma et al. (2024), Fini et al. (2022), and Fini et al. (2023). In AbuEid's (2024) study on patients with type 2 diabetes, blood flow restriction (BFR) walking led to improvements in BMI, fasting glucose levels, and VO max. Similarly, Ma et al. (2024) and Fini et al. (2022) observed significant reductions in fasting plasma glucose (FPG) and HbA1c, along with enhanced muscle performance in older adults with type 2 diabetes following BFR training. Fini et al. (2023) noted changes in post-BFR red blood cell and hemoglobin concentrations, though these changes were transient.

Discussion

This narrative review critically discussed the potential benefits of BFR training for type 2 diabetes. Specifically, it synthesized the current evidence on how BFR affects various physiological outcomes, such as muscle metabolism, insulin sensitivity, and glucose metabolism, in individuals with type 2 diabetes.

Effects of BFR training on muscle metabolism

Studies by Tanaka et al. (2018) and Tanaka et al. (2021) showed that BFR, particularly when combined with electrical stimulation, preserves capillary volume and promotes angiogenesis. Angiogenesis refers to the formation of new blood vessels, critical for improving oxygen delivery to tissues, particularly in muscles subjected to intermittent blood flow restriction. These studies (Tanaka et al., 2018; Tanaka et al. 2021) demonstrated that BFR helps to maintain capillary density, which is often reduced in individuals with metabolic disorders such as type 2 diabetes (Groen et al., 2014). The preservation of capillary volume not only improves blood flow but also facilitates more efficient oxygen delivery, thereby improving physical performance during low-load resistance interventions (Dremin et al., 2025).

In addition to capillary dynamics, BFR training has been shown to influence muscle oxygenation, a key factor in energy production (Li et al., 2022; Pignanelli et al., 2021). When blood flow is restricted, muscles are forced to shift to anaerobic energy production, which relies on glycogen and glucose breakdown in the absence of oxygen (Amani-Shalamzari et al., 2019). However, BFR also stimulates the release of growth factors and hormones that can promote metabolic adaptations, such as increased mitochondrial biogenesis, increased glycogen storage, and improved lactate clearance (Saatmann et al., 2021a). These adaptations improve the muscle's ability to function efficiently under both aerobic and anaerobic conditions.

The studies by Tanaka et al. (2018) and Tanaka et al. (2021), conducted in diabetic rat models, also demonstrated that BFR can counteract some metabolic dysfunctions associated with type 2 diabetes, such as muscle atrophy and impaired capillary function. By preventing muscle atrophy and increasing angiogenesis, BFR restores standard muscle structure and function, crucial for maintaining physical activity levels and metabolic health in individuals with diabetes (Colberg et al., 2016). This is particularly important since individuals with type 2 diabetes often experience reduced muscle mass, poor muscle function, and limited exercise capacity, all of which contribute to the progression of the disease (Park et al., 2009).

Overall, training with BFR seems to induce positive changes in muscle metabolism by improving oxygen delivery, increasing energy production efficiency, and stimulating muscle adaptations that can mitigate the metabolic dysfunctions often seen in individuals with type 2 diabetes. By promoting capillary growth, increasing muscle oxygenation, and supporting energy metabolism, BFR training can potentially improve both metabolic health and physical fitness in clinical populations. These findings underline the therapeutic potential of BFR as a low-load training modality that can enhance muscle function and metabolism without the need for high-intensity, high-load exercise, making it particularly beneficial for individuals who may be unable to engage in traditional resistance training due to health conditions.

Effects of BFR training on insulin sensitivity and glucose metabolism

BFR training also has promising potential to improve insulin sensitivity and glucose metabolism, which are essential in managing type 2 diabetes (Nascimento et al., 2022). Insulin resistance is characterized by the body's diminished ability to respond to insulin in type 2 diabetes

Table 1. Demographic and methodological characteristics, and main findings of the included studies

Study	*N*	Sex	Type of population	Age	Study design	Muscles/areas analyzed	Main outcomes analyzed	Method of BFR used	Main findings
(Tanaka et al., 2018)	24 rats	M	Type 2 diabetes mellitus (spontaneously diabetic rats)	11 weeks	Randomized controlled trial	Plantaris muscle	Muscle mass, AGEs, RAGE, ERK, rpS6 phosphorylation	Pressure cuff around the thigh (80 mmHg, 5 min on, 5 min off)	Combined BFR + ES treatment prevented muscle atrophy, AGE up-regulation, and loss of rpS6 phosphorylation in diabetic rats. BFR alone and ES alone were ineffective.
(Jones et al., 2021)	N/A	N/A	Individuals with type 1 diabetes	N/A	Review	N/A	Angiogenesis, protein synthesis, glycemic control	Not specified (general BFR overview)	Resistance exercise with BFR improves protein synthesis, angiogenesis, and glycemic control at lower loads
(Tanaka et al., 2021)	24 rats	M	Type 2 diabetic rats (Goto-Kakizaki), healthy Wistar rats (controls)	11 weeks ± 3 days	Randomized controlled trial	Soleus muscle	Capillary diameter, capillary volume, angiogenic factors (e.g., IL-15, VEGF, HIF-1a), SDH activity	Pressure cuffs around thighs, 80 mmHg	Combined BFR + ES prevented DM-associated capillary regression, enhanced angiogenesis markers ($p < 0.05$)
(Rodrigues et al., 2023)	10	F	Untrained females with type 2 diabetes mellitus	56.9 ± 7.4	Randomized controlled trial	Knee extensors	Blood pressure (SBP, DBP, MBP), blood glucose	50% AOP with 20% 1RM for LL-BFR	SBP significantly decreased after LL exercise (p = 0.002); DBP decreased after LL and LL-BFR (p = 0.004, p = 0.002); BG showed a difference at the level p = 0.053

Study	N	Sex	Type of population	Age	Study design	Muscles/areas analyzed	Main outcomes analyzed	Method of BFR used	Main findings
(Fini et al., 2022)	15	F	Type 2 diabetes patients	47.6 ± 7.2	Randomized crossover trial	Knee flexion and extension	Platelet activation markers, platelet count, platelet indices	150 mmHg pressure cuff on upper thigh, 20% 1-RM, 3 sets of 15 reps	BFR induced a significant increase in platelet count (7.5%, $p < 0.05$) and plateletcrit ($p < 0.001$); no changes in platelet activation markers
(Fini et al., 2023)	15	F	Type 2 diabetes patients	Not specified	Randomized crossover trial	Knee flexion and extension	Systolic/diastolic BP, heart rate, WBC, RBC, HCT, Hb, MCH, MCHC, MCV, PV	Pressure cuff (150 mmHg)	No significant changes in BP, heart rate, and hematological indices ($P > 0.05$). RBC and Hb increased after REBFR ($P < 0.05$), returned to baseline after 30 mins.
(Martins et al., 2023)	10	F	Untrained females with type 2 diabetes mellitus	56.9 ± 7.4	Randomized crossover trial	Knee extensors	RPE, pain perception	Tourniquet at 50% of AOP	RPE increased significantly over sets for all protocols ($p < 0.05$); pain perception increased in HL and LL+BFR protocols ($p < 0.05$); LL + BFR and HL had similar RPE and pain perception, higher than LL ($p < 0.05$)
(Mondal et al., 2024)	7	M/F	Individuals aged 18–75, diagnosed with type 1/2 diabetes mellitus and/or hypertension	Not reported	Narrative review	N/A	Blood pressure, glycemic control, systemic and metabolic parameters	N/A	BFR showed a significant positive impact on managing diabetes and hypertension.

Study	N	Sex	Type of population	Age	Study design	Muscles/areas analyzed	Main outcomes analyzed	Method of BFR used	Main findings
(Şahin et al., 2024)	15	M/F	Untrained individuals with type 2 diabetes mellitus	57 (49–59)		Gastrocnemius muscle	Blood pressure (SBP, DBP, MAP), blood glucose, muscle oxygen saturation (SmO_2), heart rate, RPE	40% AOP using individualized pressure calculated based on thigh circumference with a 10-cm pneumatic cuff device	Higher BP in BFR vs. BFF (SBP: $p = 0.009$; DBP: $p = 0.031$; MAP: $p = 0.013$). No diff. in glucose or HR.
(AbuEid, 2024)	60	M	Type 2 diabetes patients	51.6 ± 6.49	Randomized controlled trial	Not specified	Insulin sensitivity, VO_2max, BMI, fasting glucose	Walking, 50% limb occlusion pressure, 3x/week, 8 weeks	BMI ↓4.10%, fasting glucose ↓7.96%, VO_2max ↑26.1% ($p < 0.001$ for all).
(Ma, Ai, et al., 2024)	98	Not spe-cified	Older adults with type 2 diabetes mellitus	60–80	Single-blind, randomized, controlled trial	Upper and lower limbs	Fasting plasma glucose (FPG), glycosylated hemoglobin (HbA1c), blood lipids, blood pressure, body composition, muscle performance	KAATSU Air Band (50% limb occlusion pressure, 20–30% 1-RM intensity, 30 s rest with inflated cuffs)	Significant improvements in FPG, HbA1c, blood lipids, diastolic BP, body composition, and muscle performance ($P < 0.05$). No significant difference in lean mass or systolic BP

RPE: rate of perceived exertion; BP: blood pressure; WBC: white blood cells; RBC: red blood cells; HCT: hematocrit; Hb: hemoglobin; MCH: mean corpuscular hemoglobin; MCHC: mean corpuscular hemoglobin concentration; MCV: mean corpuscular hemoglobin volume; PV: plasma volume; SBP: systolic blood pressure; DBP: diastolic blood pressure; MBP: mean blood pressure; AOP: arterial occlusion pressure; IL-15: interleukin 15; VEGF: vascular endothelial growth factor; HIF-1a: hypoxia-inducible factor 1-alpha; SDH: succinate dehydrogenase; AGEs: advanced glycation end products; RAGE: receptor for advanced glycation end products; ERK: extracellular signal-regulated kinase; rpS6: ribosomal protein S6; ES: electrical stimulation.

(Lee et al., 2022). Consequently, this condition impairs glucose uptake by muscle and adipose tissues, leading to elevated blood glucose levels (Lee et al., 2022). For such reasons, effective management of insulin sensitivity and glucose metabolism is crucial to preventing the progression of the disease and mitigating its associated risks, such as cardiovascular disease, neuropathy, and other complications that may arise. As BFR training induces hypoxic conditions in muscle tissues, it can significantly improve its metabolic functions, providing a promising training approach for individuals with type 2 diabetes.

For instance, the study by Rodrigues et al. (2023), demonstrated that low-load resistance exercise combined with BFR significantly decreased blood glucose levels following exercise. This reduction in blood glucose suggests that BFR training may improve glucose uptake by skeletal muscles, an imperative factor in managing blood glucose levels (Mondal et al., 2024). Similarly, AbuEid (2024) found that BFR training significantly improved insulin sensitivity in individuals with type 2 diabetes, as evidenced by reduced fasting glucose levels. Insulin sensitivity refers to the efficiency with which insulin promotes glucose uptake by cells. In individuals with type 2 diabetes, improving insulin sensitivity can be imperative, as it allows the body to utilize insulin more effectively, thereby reducing the need for higher levels of circulating insulin to manage blood glucose (Mudaliar & Edelman, 2001). By improving insulin sensitivity, BFR training helps regulate glucose metabolism, which is critical for preventing hyperglycemia and its associated long-term complications (Christiansen et al., 2019).

The mechanisms underlying the effects of BFR on insulin sensitivity and glucose metabolism are multifactorial. For instance, BFR training promotes muscle adaptation through metabolic stress, which increases glucose uptake and utilization by muscle cells (Okita et al., 2019). The restricted blood flow during BFR creates an anaerobic environment in the muscle, increasing lactate production and other metabolites (Okita et al., 2019). Then, these metabolites act as signaling molecules that stimulate insulin-like signaling pathways, increasing glucose uptake by muscle cells (Satoh, 2014). Additionally, BFR training increases muscle fiber recruitment, particularly fast-twitch fibers, which are more responsive to insulin and glucose uptake (Schoenfeld et al., 2023). Thus, this increased recruitment could further contribute to improved insulin sensitivity and glucose metabolism.

Furthermore, BFR training may increase the secretion of various hormones and growth factors, such as insulin-like growth factor (IGF-1) and vascular endothelial growth factor (VEGF), which can improve muscle health and capillary function (Park et al., 2015). Consequently, the capillary function can increase blood flow to muscles, facilitating more efficient nutrient and glucose delivery for diabetic individuals (Koutny, 2013; Park et al., 2015). The improved vascularity and the metabolic adaptations induced by BFR may improve insulin action in muscle tissues, further improving glycemic control (Park et al., 2015).

The evidence provided by the studies of Rodrigues et al. (2023) and AbuEid (2024) suggests that BFR training positively impacts insulin sensitivity and glucose metabolism in individuals with type 2 diabetes. By improving glucose uptake in muscle tissue and insulin sensitivity, BFR training can serve as a great complement to traditional diabetes management strategies. Its potential to improve glycemic control and prevent long-term complications associated with insulin resistance shows the need for further investigation of BFR as a non-pharmacological approach to managing type 2 diabetes. As BFR training can be performed at low intensities, as shown in Table 1, it offers a practical and accessible option for individuals with diabetes with limitations regarding high-intensity exercise.

Effects of BFR training on physical fitness

One of the advantages of BFR is that it allows strength and cardiovascular improvements with low-load and low-intensity exercises, which can be particularly beneficial for those with conditions such as type 2 diabetes. In patients with type 2 diabetes, muscle weakness and decreased physical performance are standard due to the metabolic dysfunction associated with the disease (Lopez-Pedrosa et al., 2024).

BFR training has been shown to improve endurance (Early et al., 2020; Saatmann et al., 2021b). This may be explained by the fact that restriction of blood flow during exercise increases the production of lactate and other metabolic byproducts, which stimulate the body to adapt by improving the efficiency of the cardiovascular system (Joyner & Casey, 2015). These adaptations improve the muscle's ability to perform work over prolonged periods, improving stamina and fatigue resistance. For individuals with type 2 diabetes, improved endurance can significantly impact their ability to engage in physical activities for longer durations without excessive fatigue (Joyner & Casey, 2015). This, in turn, can help prevent the sedentary lifestyle often associated with the disease, reducing the risk of further diabetes complications. Additionally, a study conducted by AbuEid (2024) demonstrated significant increases in VO max following BFR training in individuals with diabetes. An improvement in VO_2 max indicates improved aerobic capacity, which directly correlates with better functional capacity, particularly in activities of daily living that require sustained efforts (Strasser, 2018). For individuals with type 2 diabetes, who often experience impaired cardiovascular function and reduced exercise tolerance, an increase in VO_2 max can translate to greater independence and a reduced risk of developing further complications related to cardiovascular disease (Strasser, 2018).

Although some studies showed significant positive effects of BFR training on the strength performance of healthy individuals, there are few studies that conducted such effects on diabetic populations (Christiansen et al., 2020; Giles et al., 2017; Saatmann et al., 2021c). For patients with type 2 diabetes, the ability to participate in everyday activities with greater ease and less discomfort can have a profound impact on mental well-being. Improved strength allows diabetic individuals to maintain greater independence, participate in social activities, and improve their self-esteem (Colberg et al., 2016). Moreover, improved functional capacity can reduce the risk of disability and improve long-term health outcomes, as it enables individuals to maintain a higher level of mobility and physical activity, which is associated with better glycemic control, cardiovascular health, and overall longevity (Izquierdo et al., 2021). Therefore, future studies should focus on the effects of BFR training on the strength levels of diabetic populations, as BFR training is a promising option for such populations.

Effects of BFR training on body composition

The effects of BFR training on reducing fat mass and increasing lean muscle mass are particularly valuable for individuals with type 2 diabetes, as they address some of the critical metabolic imbalances that underline the condition, including obesity and sarcopenia (Chen et al., 2023). The study by Ma et al. (2024), included in this narrative review, supports the positive effects of BFR on body composition, demonstrating significant improvements in body composition among older adults with type 2 diabetes. Specifically, the study Clique ou toque aqui para introduzir texto documented reductions in fat mass and increases in lean muscle mass following a BFR training program. These findings are particularly significant as type 2 diabetes is often associated with an elevated risk of obesity and adiposity, which further exacerbate the disease's metabolic dysfunction (Park et al., 2009). Excess body fat, particularly visceral fat, is a significant risk factor for insulin resistance, impaired glucose metabolism, and the development of type 2 diabetes (Klein et al., 2022).

Traditional methods for reducing body fat typically rely on moderate to high-intensity exercises, which may be difficult for some individuals with diabetes due to physical limitations, joint pain, or comorbid conditions such as obesity. However, BFR training allows for fat reduction through lower-intensity exercises, making it more accessible and sustainable for a broader range of patients. The mechanism behind this is likely linked to the increased metabolic stress induced by blood flow restriction, which promotes greater fat oxidation during exercise (Saatmann et al., 2021c). The progressive loss of muscle mass is a common concern for individuals with type 2 diabetes, especially as they age (Chen et al., 2023). BFR training, by stimulating muscle hypertrophy, offers an effective strategy for reversing muscle loss. As a result, individuals with type 2 diabetes can achieve greater muscle mass and strength, which, in turn, supports overall metabolic health by improving insulin sensitivity and increasing basal energy expenditure (Chen et al., 2023).

In addition to its effects on fat and muscle mass, BFR training may also help to improve fat distribution, which is crucial for addressing the metabolic dysfunction that characterizes type 2 diabetes. Abdominal or visceral fat, in particular, is closely linked to insulin resistance, inflammation, and an increased risk of cardiovascular disease (Shah et al., 2008) Reducing visceral fat could be particularly beneficial for diabetic individuals, as it addresses one of the core drivers of the disease's pathophysiology. By improving both the quantity and distribution of body fat, BFR training may help mitigate some of the adverse effects associated with obesity and insulin resistance, including the increased risk of cardiovascular disease and other comorbidities.

Limitations

Despite the promising findings, there are several limitations to the current body of research. Many of the included studies involved small sample sizes, which may limit the generalizability of the results. Additionally, a significant portion of the studies included in this review focused on short-term outcomes, and more research is needed to understand the long-term effects of BFR training on type 2 diabetes management. Furthermore, variations in BFR protocols (e.g., cuff pressure, exercise type, and duration) make it difficult to draw definitive conclusions regarding optimal BFR parameters for diabetes patients.

Practical implications

Despite the limitations, this narrative review highlights the potential benefits of BFR training as an accessible and effective intervention for individuals with type 2 diabetes, particularly those unable to engage in high-intensity and high-load exercises due to their condition limitations. The evidence provided in this review suggests that BFR training, especially when combined with low-load resistance exercise, can lead to improvements in key physiological variables, including cardiorespiratory fitness, insulin sensitivity, glucose metabolism, and body composition.

For clinical practice, BFR could complement traditional diabetes management strategies, particularly in settings where patients face barriers to engaging in more intense exercise. Its potential to improve insulin sensitivity and glucose metabolism is particularly relevant for preventing the progression of type 2 diabetes and its associated complications, such as cardiovascular disease and neuropathy. BFR training protocols also allow healthcare providers to design interventions that better suit individual needs, optimizing the intensity and frequency of training based on each patient's condition and goals. Furthermore, BFR's ability to improve body composition is exciting, as it addresses two critical concerns in type 2 diabetes: (i) muscle loss (i.e., sarcopenia) and (ii) obesity control. Reducing fat mass through BFR training may help alleviate insulin resistance and improve overall metabolic health, while the stimulation of muscle hypertrophy supports physical function and independence in daily activities.

Conclusion

This review showed the potential of BFR training to improve insulin sensitivity, glucose metabolism, muscle strength, functional capacity, and body composition in individuals with type 2 diabetes. The effectiveness of BFR varies based on exercise type, cuff pressure, and individual health status. Clinicians may use BFR training as a complementary intervention, but individualized protocols and risk assessments are essential to ensure safety and efficacy. Large-scale, long-term studies are needed to confirm these findings and establish standardized BFR protocols for clinical application.

Conflict of interest: Author state no conflict of interest

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