INPLASY

Effects of blood flow restriction training on health-related physical fitness in untrained participants: a systematic review and meta-analysis

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None.

ADMINISTRATIVE INFORMATION

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 18 February 2025 and was last updated on 18 February 2025.

INTRODUCTION

Review question / Objective PICOS: (P)healthy young people aged 18 and above(I)Any types of BFR intervention(C)BFR vs. non-BFR group; comparisons among different types of BFR groups (O) Articles that focused on the analysis of physical performance-related variables (i.e,including physical fitness,body composition, weight status, BMI, body fat, cardiorespiratory fitness, muscle strength, muscle endurance, flexibility, pliability) wereincluded.(S)Randomized controlled trials.

Rationale In modern society, due to changes in lifestyle, such as long – term sedentary work and lack of regular exercise, the overall physical fitness level of people shows a downward trend. Physical fitness is a key factor in maintaining physical health and quality of life, and is closely related to the risk of various chronic diseases such as cardiovascular diseases and metabolic syndrome. Therefore, it is of great importance to explore effective methods for improving physical fitness.

At present, although traditional exercise training methods can improve physical fitness, for some people, such as those with limited time, poor physical fitness foundation, or in the rehabilitation period of sports injuries, it may be difficult to adhere to or not applicable. Blood flow restriction training, as an emerging training method, has gradually come into people's view. It applies certain pressure on the limbs to restrict the inflow of arterial blood and the outflow of venous blood, enabling muscles to produce physiological responses similar to high – intensity exercise under low – intensity exercise.

However, there are still many deficiencies in current research on the impact of blood flow restriction training on the health – related physical fitness of untrained participants. There are significant differences in training programs (such as pressure magnitude, training frequency, duration, etc.), measurement indicators, and the

selection of research subjects among different studies. This leads to a lack of consistency and comparability in research results, making it difficult for us to comprehensively and accurately evaluate the true effect of blood flow restriction training on improving the physical fitness of untrained participants.

In view of this, this study aims to comprehensively integrate existing research through systematic review and meta – analysis, and deeply explore the impact of blood flow restriction training on the health – related physical fitness of untrained participants. We hope that through this study, we can clarify the effectiveness and safety of blood flow restriction training in improving the physical fitness of untrained participants, provide evidence – based basis for formulating scientific and reasonable physical fitness training programs, promote the application of blood flow restriction training in a wider range of people, and thus contribute to improving the health level of the public.

Condition being studied In modern society, the decline in health – related physical fitness among the general population, especially among untrained individuals, has become a prominent issue. Health – related physical fitness, which is composed of elements such as cardiovascular endurance, muscular strength and endurance, flexibility, and body composition, is the foundation for maintaining good health and preventing chronic diseases. Epidemiological evidence shows that due to sedentary lifestyles, such as long – term sitting in offices and lack of regular physical activity, a large proportion of the population, including those who have not engaged in systematic physical training, have experienced a decline in physical fitness levels. This decline is associated with an increased risk of various health problems, including cardiovascular diseases, metabolic disorders, and musculoskeletal issues.

Traditional methods of enhancing physical fitness, such as high – intensity aerobic exercises and strength – training programs, have always been the mainstream approaches. However, these methods often pose challenges for untrained participants. High – intensity exercises may be too strenuous for those with a poor fitness foundation, leading to difficulties in adherence and an increased risk of injury. In addition, for people with limited time, such as busy office workers or students, the time – consuming nature of traditional training regimens can be a significant obstacle.

Blood flow restriction training (BFRT) has emerged as a new alternative. Blood flow restriction training refers to applying a certain amount of controllable pressure to the limbs to restrict blood flow. This method enables muscles to experience metabolic stress similar to that of high – intensity exercise while performing low – intensity physical activities. For untrained participants, blood flow restriction training has many advantages. It can be completed with minimal equipment in a shorter time, making it more accessible. Moreover, the low – intensity nature of blood flow restriction training reduces the risk of injury, making it suitable for those who are new to exercise or have physical limitations.

Despite the potential of blood flow restriction training, there is currently a lack of a comprehensive understanding of its impact on the health – related physical fitness of untrained participants. Existing studies have shown inconsistent results due to differences in training protocols, measurement indicators, and subject selection. Therefore, it is crucial to conduct a systematic review and meta – analysis to comprehensively evaluate the impact of blood flow restriction training on the health – related physical fitness of untrained individuals, with the aim of providing evidence – based guidance for the application of blood flow restriction training in fitness training and health promotion.

METHODS

Search strategy Search databases: SCOUPS、Web of Science Core Collection、PubMed、EBSCOHOST、Google Scholar

Search terms: (“physical fitness” OR “body composition” OR “body weight status” OR “body mass” OR “BMI” OR “body fat” OR “cardiorespiratory fitness” OR “cardiorespiratory endurance” OR “muscular fitness” OR “musculoskeletal fitness” OR “muscular strength” OR “muscular endurance” OR “flexibility”) AND (“blood flow restriction” OR “occlusion training” OR “vascular occlusion” OR “KAATSU” OR “ischemia* training”) AND (“female”).

Participant or population The age range of the participants is from 18 to 34 years old. Among the 336 participants, there are 201 males and 135 females. All the participants included in the study are healthy young people with no injuries.

Intervention Intervention Types:(Combination of Low – intensity Aerobics and BFR:Most of the experimental groups adopted the model of combining low – intensity aerobic exercise with BFR. Slow walking was the main exercise method. Participants wore adjustable – pressure inflatable cuffs as BFR devices and walked slowly at a moderate speed on a treadmill or outdoors. During the training, they maintained a stable pace and

rhythm, and controlled the degree of blood flow restriction by adjusting the cuff pressure, aiming to improve the participants' cardiopulmonary function and aerobic endurance.Combination of Low – intensity Resistance Training and BFR:Some experimental groups carried out low – intensity resistance training with elastic bands or lightweight dumbbells and combined with BFR. For example, they performed movements such as elastic – band squats and dumbbell bicep curls. During the training, the BFR pressure was adjusted to enhance the participants' muscle strength and muscle mass.Multi – combination Comparative Experiments:Comparative experimental groups with different intensities of BFR and different training intensities were set up. Combinations such as low – intensity training with low – pressure BFR, low – intensity training with high – pressure BFR, and high – intensity training with low – pressure BFR were respectively set. The high – intensity training adopted the intensity of conventional resistance training. By comparing the physical changes of participants under different combinations, the effect differences of different intervention combinations were analyzed in detail.)Intervention Measurement Indicators: (Aerobic Capacity Assessment:Directly adopt the VO2peak test. Use professional gas metabolism analysis equipment to accurately measure the oxygen uptake of participants during exercise, which is used as a key indicator of aerobic capacity. At the same time, supplementary assessment is carried out by measuring the 6 – minute walking distance. Observe the maximum distance that participants can walk within 6 minutes to reflect the level of aerobic endurance from the perspective of actual exercise performance.Muscle Strength Measurement:Use the 1RM test. For typical strength training movements such as squats and bench presses, determine the weight that participants can bear when completing one maximum repetition to accurately evaluate the maximum muscle strength. Use ultrasound imaging or magnetic resonance imaging technology for the muscle CSA test to measure the cross – sectional area of specific muscles such as the quadriceps femoris and biceps brachii, directly reflecting the increase in muscle mass. In addition, use an isokinetic muscle strength testing device to measure the torque at different joint angles of the knee and elbow joints to comprehensively understand the muscle strength performance of muscles in different exercise states.Physical Function Performance Assessment:Select the TUG test. Record the time it takes for participants to stand up from a chair, walk a specified distance, and return to the chair to evaluate the body's agility and balance ability. Through the STS30 test, count the number of sit – to – stand movements that participants can complete within 30 seconds to measure the lower – limb muscle strength and endurance. Use the sit – and – reach test to measure the distance that participants' fingers can extend forward when they bend forward in a sitting position to evaluate the body's flexibility.)Intervention Frequency and Duration:(Duration:Three different training cycles of 6 weeks, 10 weeks, and 12 weeks were set. The 6 – week cycle is used to initially observe the short – term impact of BFR training on participants' physical fitness and obtain basic data and preliminary effects. The 10 – week cycle further explores the development and change trend of BFR training effects under a medium – length training period. The 12 – week cycle deeply analyzes the comprehensive impact of long – term BFR training on participants' health – related physical fitness, including the stability and sustainability of physical fitness improvement.Intervention Frequency:Set it to 2 – 4 times a week. A frequency of 2 times a week is suitable for participants with limited time, exploring the effect of BFR training on physical fitness with a relatively small number of training sessions. A frequency of 4 times a week is used to study the impact of a higher – frequency training on the health – related physical fitness of untrained participants, observing the speed, magnitude of physical fitness improvement under intensive training stimuli, as well as the training adaptation and potential risks.Duration of Each Training Session:It is adjusted reasonably according to the training type and intensity. For the experimental group with high – intensity training combined with BFR, the training duration is controlled within 20 – 30 minutes to ensure training safety and avoid over – training injuries. For the experimental group with low – intensity training combined with BFR, the training time is extended to 30 – 50 minutes to ensure sufficient training stimuli and promote effective physical fitness improvement. During the training process, closely monitor the physical reactions of participants and flexibly adjust the training plan according to the actual situation to ensure the safety and feasibility of the intervention.)

Comparator As for the experimental group, blood flow restriction training should be applied. As for the control group, conventional training or other types of training can be applied.

Study designs to be included Only randomized controlled trials were included in the article.

Eligibility criteria Study Population：(Participants must be untrained individuals, defined as those who have not engaged in regular structured exercise (at least 3 times per week for at least 30 minutes per session) for a period of at least 3 months prior to the study.The age of participants should be within the range of 18 years or older, covering various age groups of adults.Both male and female participants are eligible, without any restrictions based on gender.Participants from different ethnic and cultural backgrounds are included to ensure the generalizability of the findings.) Intervention： (The intervention must involve blood flow restriction training. BFR can be achieved using various devices such as inflatable cuffs, elastic bands, or other commercially available BFR equipment, with adjustable pressure settings to control the degree of blood flow restriction.The BFR training can be combined with different types of exercise, including but not limited to low-intensity aerobic exercise (e.g., slow walking, cycling at a low resistance), low-intensity resistance training (e.g., using elastic bands or light dumbbells for exercises like squats, bicep curls), or other forms of physical activities.The intervention duration should be clearly reported, with a minimum of at least 4 weeks of training to observe meaningful changes in health-related physical fitness.) Comparison： (Comparisons in studies should include two groups or multiple – group trials. By setting up control groups, such as non – BFR training groups or training groups with different BFR parameters, it helps to clarify the true effects of BFR training and distinguish the changes brought about by BFR training from those caused by other factors.) Outcome： (The study results must include at least one physical performance indicator, such as muscle strength, aerobic capacity, physical function performance, etc. These indicators are crucial for measuring the effectiveness of BFR training and can directly reflect the impact of BFR training on the physical performance of older adults.) Study Design： (Articles must be randomized controlled trials. Randomized controlled trials can effectively reduce the impact of selection bias and confounding factors, making the research results more reliable and persuasive. This ensures that the research conclusions can accurately reflect the relationship between BFR training and the physical performance of young people.) 17.A total of 502 literatures were retrieved from four databases, namely SCOUPS, Web of Science Core Collection, PubMed, and EBSCOHOST. The academic search engine Google Scholar was utilized to effectively supplement the information acquisition channels and avoid the omission of important literatures. As a result, 9 important experimental articles were retrieved.

Information sources Prominent academic databases, including Ebscohost, Scopus, Pubmed, and Web of Science, were considered for searching relevant content. At the same time, a thorough search was conducted on Google Scholar and reference materials up to January 2025.

Main outcome(s) Blood flow restriction training can effectively improve physical performance in terms of aerobic capacity, strength, and physical functional performance.

Quality assessment / Risk of bias analysis Quality assessment of each study based on the PEDro scale. Nine studies scored between 4 and 7 points on the PEDro rating scale, and one study scored 9 points. Ten studies provided detailed descriptions of the source of participants and inclusion criteria. Ten studies clearly used random methods for participant allocation, and one of these studies mentioned the use of allocation concealment. Due to the criteria related to blinding of participants, assessors, and intervention implementers, deductions were made for ten studies. Eight studies clearly mentioned the number of participants in the post-trial assessment. All studies were rated for all other items of the PEDro scale.

Strategy of data synthesis None.

Subgroup analysis None.

Sensitivity analysis None.

Country(ies) involved China.

Keywords Blood Flow Restriction Training；Untrained youths；Physical fitness.

Contributions of each author

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