International Journal of Advanced Research in Education and TechnologY (IJARETY)

Volume 10, Issue 4, July-August 2023

Impact Factor: 6.421

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 6.421| A Bi-Monthly, Double-Blind Peer Reviewed & Referred Journal |

|| Volume 10, Issue 4, July - August 2023 ||

DOI:10.15680/IJARETY.2023.1004023

Brief Overview of BFRT in Exercise Physiology

Karan Pal Vishnoi, Dr. Sushil Kumar

Ph.D Research Scholar, Department of Physical Education, Sunrise University, Alwar (Rajasthan), India

Assistant Professor, Department of Physical Education, Sunrise University, Alwar (Rajasthan), India

ABSTRACT: Blood Flow Restriction Training (BFRT) is a modern exercise modality that induces muscle hypertrophy and strength gains using low-intensity resistance exercises combined with restricted venous blood flow to the working muscles. This method, first popularized in Japan in the 1960s as KAATSU training, has gained global recognition in the fields of sports performance, rehabilitation, and clinical exercise physiology. BFRT works by leveraging metabolic stress and hypoxia to induce physiological adaptations typically seen in traditional high-load resistance training, but without the same mechanical stress on joints and tissues. This paper explores the detailed mechanisms of BFRT, its widespread applications, its impact on various physiological systems, and its benefits and risks. Furthermore, the paper highlights recent technological advancements in BFRT equipment and explores potential future applications in exercise physiology. With increasing research, BFRT holds great promise for revolutionizing how strength, muscle mass, and recovery are addressed in both athletic and clinical settings.

KEYWORDS: Muscle Hypertrophy, Metabolic Stress, Hypoxia, Resistance Exercise, Strength Gains, Rehabilitation, Neuromuscular Adaptations.

I. INTRODUCTION

Blood Flow Restriction Training (BFRT) is an innovative exercise technique where low-intensity resistance exercises are combined with the partial restriction of venous blood flow to the working muscles. This restricted blood flow is typically achieved through the use of specialized cuffs or elastic bands that are applied to the limbs, preventing venous return while allowing arterial inflow. The restriction creates an environment of metabolic stress and hypoxia in the muscles, which stimulates muscle growth, strength gains, and other physiological adaptations, even at intensities as low as 20-30% of an individual's one-repetition maximum (1RM).

BFRT is critically important in exercise physiology due to its unique ability to induce muscle hypertrophy and strength gains without the need for heavy loads. This makes it an invaluable tool for populations such as older adults, individuals recovering from injury, or those with joint limitations who cannot perform high-load resistance training. It has also gained traction among athletes seeking performance enhancements without risking injury from overuse. BFRT's impact on metabolic stress, muscle fiber recruitment, and endocrine response has positioned it as a pivotal training tool in both clinical and fitness settings.

This research paper aims to provide an in-depth examination of BFRT's underlying physiological mechanisms, its effects on muscle hypertrophy and strength gains, its applications across different populations, and its potential risks. The paper also explores the technological advancements that have improved the safety and efficacy of BFRT, as well as the future prospects for its use in sports performance and rehabilitation.

BFRT operates on the principle of partial occlusion of venous return, which reduces the ability of blood to leave the muscle while still allowing arterial blood to flow into the working muscles. This results in the accumulation of metabolic byproducts, such as lactic acid, creating an anaerobic environment that forces the muscle to adapt by activating both slow-twitch and fast-twitch muscle fibers. The restricted blood flow leads to hypoxia, or oxygen deprivation, which further enhances the body's anabolic response, promoting muscle protein synthesis and hypertrophy.

II. ROLE OF METABOLIC STRESS AND HYPOXIA IN MUSCLE ADAPTATION

Metabolic stress is a key driver of muscle hypertrophy during BFRT. The accumulation of metabolites, such as lactate, hydrogen ions, and other byproducts, increases cellular swelling and stimulates the release of growth factors. Hypoxia further amplifies this effect by forcing the body to recruit a higher percentage of motor units, particularly type II (fast-

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 6.421| A Bi-Monthly, Double-Blind Peer Reviewed & Referred Journal |

|| Volume 10, Issue 4, July - August 2023 ||

DOI:10.15680/IJARETY.2023.1004023

twitch) fibers, which are typically engaged during high-intensity exercise. These fibers have the greatest potential for growth, making BFRT an efficient tool for inducing hypertrophy even at low loads.

One of the most critical aspects of BFRT is its ability to significantly increase the production of anabolic hormones. Research has shown that the hypoxic environment created during BFRT triggers a substantial increase in growth hormone (GH) levels—up to 290% higher than baseline in some studies. GH plays a vital role in promoting muscle growth, repair, and recovery. BFRT also stimulates the release of insulin-like growth factor 1 (IGF-1), another anabolic hormone that enhances muscle protein synthesis and tissue repair. The endocrine response from BFRT is comparable to that seen in traditional high-load resistance training, making it a powerful tool for strength and hypertrophy.

Cellular swelling, or the "pump" effect, occurs during BFRT due to the increased fluid accumulation within muscle cells as a result of the restricted blood flow. This swelling places stress on the cell membrane, signaling the body to initiate anabolic processes that lead to muscle growth. Additionally, although the loads used in BFRT are lighter than traditional resistance training, the mechanical tension created by repeated contractions under metabolic stress further stimulates muscle protein synthesis. This combination of metabolic stress, hypoxia, cellular swelling, and mechanical tension makes BFRT highly effective for inducing hypertrophy.

III. BFRT AND MUSCLE HYPERTROPHY

BFRT enhances the recruitment of muscle fibers, particularly fast-twitch fibers, which are typically only activated during high-intensity, heavy-load exercises. The hypoxic environment and metabolic stress created by BFRT force the body to recruit these fibers earlier in the workout, even with low-load exercises. This allows for significant muscle hypertrophy despite the reduced mechanical load. Fast-twitch fibers are known for their growth potential, and BFRT's ability to activate them without heavy weights is one of its primary advantages.

The ability to achieve muscle hypertrophy with low-intensity resistance exercises is one of the most significant benefits of BFRT. Research has shown that BFRT can produce similar gains in muscle size as traditional high-load training, even when using as little as 20-30% of an individual's 1RM. This makes BFRT particularly useful for populations that cannot tolerate heavy loads, such as individuals with joint issues or those recovering from surgery.

Traditional resistance training relies on mechanical tension from heavy weights to stimulate muscle hypertrophy. In contrast, BFRT uses metabolic stress, hypoxia, and mechanical tension from lighter loads to achieve similar hypertrophic effects. While traditional training may be more suitable for advanced strength athletes, BFRT offers a safer, less strenuous alternative that still promotes significant muscle growth. Studies comparing the two methods have shown that BFRT can produce comparable hypertrophic outcomes, particularly in novice or untrained individuals.
In BFRT, the volume of repetitions and the duration of time under tension are critical factors in maximizing hypertrophy. Typical BFRT protocols involve higher repetitions (e.g., 15-30 reps per set) to increase metabolic stress and maximize the time that the muscle is under tension. This extended time under tension promotes greater muscle fatigue, increases metabolite accumulation, and enhances the overall hypertrophic response.

BFRT stimulates muscle protein synthesis while reducing muscle protein breakdown, creating a net anabolic environment that promotes muscle growth. The metabolic stress and hormonal response induced by BFRT trigger pathways such as the mammalian target of rapamycin (mTOR), which regulates muscle protein synthesis. Additionally, the suppression of muscle protein breakdown ensures that more proteins are available for muscle repair and growth, leading to hypertrophy over time.

IV. IMPACT OF BFRT ON STRENGTH GAINS

One of the most remarkable aspects of BFRT is its ability to enhance muscle strength with light loads. While traditional strength training requires lifting at 70-85% of an individual's 1RM to induce significant strength gains, BFRT can achieve similar improvements using as little as 20-30% of 1RM. This makes it an attractive option for individuals recovering from injury or surgery, as well as older adults who may be at risk of injury from heavy lifting.

BFRT also induces neuromuscular adaptations that contribute to increased strength. By enhancing motor unit recruitment, BFRT improves the efficiency with which the nervous system activates muscle fibers during exercise. This increased neuromuscular efficiency translates into greater force production and improved coordination, even at lower intensities.

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 6.421| A Bi-Monthly, Double-Blind Peer Reviewed & Referred Journal |

|| Volume 10, Issue 4, July - August 2023 ||

DOI:10.15680/IJARETY.2023.1004023

BFRT affects both fast-twitch and slow-twitch muscle fibers. The slow-twitch fibers, which are typically activated during low-intensity exercise, benefit from increased endurance and oxidative capacity due to the prolonged time under tension. Fast-twitch fibers, which have the greatest potential for strength and hypertrophy, are recruited early in BFRT due to the metabolic stress and hypoxia. This dual effect on both fiber types makes BFRT a versatile training method for improving strength and muscle size.

BFRT can produce both short-term and long-term strength gains. In the short term, individuals often see rapid improvements in strength due to the immediate neuromuscular adaptations and muscle swelling. Long-term gains are achieved through consistent use of BFRT, which promotes muscle hypertrophy and structural adaptations over time. BFRT can be used as a stand-alone training method or in conjunction with traditional resistance training to amplify long-term strength development.

BFRT has been widely adopted by athletes across various sports due to its ability to improve functional strength without the need for heavy resistance. Functional strength refers to the ability to apply force in real-world or sport-specific movements, which BFRT can enhance by recruiting fast-twitch fibers, improving neuromuscular coordination, and allowing athletes to train through ranges of motion without excessive mechanical stress on their joints. This makes BFRT particularly useful during off-seasons or recovery phases, when athletes need to maintain strength without risking injury from heavy lifting.

V. APPLICATIONS OF BFRT IN EXERCISE PHYSIOLOGY

Athletes increasingly use BFRT to improve performance, maintain muscle mass, and accelerate recovery. In sports like soccer, football, and basketball, BFRT allows athletes to maintain or even build strength during times of reduced load, such as in-season periods when they aim to avoid overtraining. Additionally, BFRT has shown promise in improving endurance, as it promotes oxidative capacity in slow-twitch muscle fibers while still targeting hypertrophy in fast-twitch fibers.

BFRT's most significant application may be in rehabilitation settings. Traditionally, individuals recovering from surgeries such as ACL reconstruction, or those dealing with chronic joint issues, were limited in their ability to engage in resistance training due to the risk of re-injury. BFRT allows these patients to perform low-load exercises while still achieving strength and hypertrophy, thus minimizing muscle atrophy during the recovery period. Studies have demonstrated that BFRT can significantly reduce recovery time and help patients regain functional strength faster compared to traditional rehabilitation methods.

Aging populations experience sarcopenia, the gradual loss of muscle mass and function. BFRT offers a solution by enabling older adults to build or maintain muscle without subjecting their joints to heavy loads, reducing the risk of injury. BFRT can also improve balance, reduce the risk of falls, and enhance overall mobility, contributing to a better quality of life for older individuals. The hormonal response induced by BFRT, particularly the increase in growth hormone, is also beneficial in counteracting age-related muscle loss.

For individuals who have been deconditioned due to illness, prolonged immobility, or chronic conditions, BFRT provides a means to regain muscle strength and mass without requiring the physical capabilities needed for traditional high-intensity exercise. This makes BFRT an effective tool in reconditioning programs aimed at improving both muscular strength and endurance.

In addition to its rehabilitation benefits, BFRT can be used as a preventive measure to reduce the risk of overuse injuries in athletes and active individuals. By allowing athletes to maintain strength and hypertrophy without relying on heavy weights, BFRT helps prevent the wear and tear associated with repetitive high-load training, especially on the joints and connective tissues.

VI. BFRT AND CARDIOVASCULAR HEALTH

While BFRT is primarily known for its effects on muscle hypertrophy and strength, it also influences cardiovascular parameters such as blood pressure and heart rate. Studies have shown that during BFRT, both blood pressure and heart rate tend to increase slightly, which is a normal physiological response to the restricted blood flow. However, in the long term, BFRT may contribute to improvements in cardiovascular health by enhancing vascular function, particularly in clinical populations with compromised cardiovascular systems.

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 6.421| A Bi-Monthly, Double-Blind Peer Reviewed & Referred Journal |

|| Volume 10, Issue 4, July - August 2023 ||

DOI:10.15680/IJARETY.2023.1004023

The cardiovascular system responds to blood flow restriction with a redistribution of blood flow to non-occluded areas, which helps maintain adequate circulation throughout the body. Over time,provide detailed feedback on blood flow, occlusion pressure, and muscle oxygenation. These monitoring systems help practitioners and users ensure that blood flow restriction is applied correctly, optimizing the balance between effectiveness and safety. Some devices also measure muscle activation levels, providing insight into how well muscles are responding to the exercise. This technology has improved the precision of BFRT, making it more adaptable to individual needs and ensuring that it is safely implemented in various populations.

The future of BFRT will likely involve the integration of more sophisticated wearable technology. Innovations may include smart BFRT devices that automatically adjust pressure based on real-time feedback from the user's body, including heart rate, muscle activation, and oxygen levels. These innovations could allow for more personalized training sessions, optimizing occlusion pressure for each individual to ensure maximum effectiveness with minimal risk. Additionally, the integration of artificial intelligence could lead to devices that analyze performance data and make automatic adjustments to training protocols in real time.

Wearable technology is already beginning to play a significant role in BFRT. Devices that track muscle activity, heart rate variability, and oxygen saturation can be synced with BFRT systems, providing real-time feedback to users and practitioners. This allows for more precise control of exercise intensity and occlusion levels, improving both safety and outcomes. In the near future, wearable tech may be able to predict fatigue levels, adjust training loads, and optimize recovery strategies based on physiological data collected during BFRT sessions.

As technology improves, BFRT systems are becoming more cost-effective and accessible to a broader range of users. While early pneumatic cuffs were primarily available in clinical settings, modern devices are now being marketed to fitness enthusiasts, athletes, and rehabilitation clinics. Lower-cost alternatives, such as elastic bands with pressure indicators, offer a more affordable entry point for individuals looking to incorporate BFRT into their training. As the technology becomes more widespread, it is likely that BFRT will become a standard tool in both commercial gyms and physical therapy clinics.

VII. FUTURE DIRECTIONS OF BFRT IN EXERCISE PHYSIOLOGY

Research on BFRT is expanding rapidly, with new studies exploring its application in a wide range of settings. Recent research is investigating the long-term safety of BFRT, particularly in populations with chronic diseases such as diabetes, cardiovascular disease, and metabolic syndrome. Additionally, researchers are looking into how BFRT can be used to enhance endurance and aerobic performance, as well as its potential to improve cognitive function and neurological health in aging populations.

As BFRT research continues to evolve, new applications are emerging in areas such as neurological rehabilitation, space travel, and metabolic conditioning. For example, BFRT is being investigated as a tool to prevent muscle atrophy in astronauts during extended space missions, where the lack of gravitational resistance leads to rapid muscle loss. There is also growing interest in using BFRT to improve glucose metabolism and insulin sensitivity in individuals with type 2 diabetes, as the low-intensity nature of the exercise makes it accessible to populations that struggle with traditional resistance training.

While the benefits of BFRT are well-established, there are still many areas that require further study. For example, more research is needed to determine the optimal occlusion pressure for different populations, including children, women, and older adults. Additionally, long-term studies are necessary to fully understand the effects of prolonged BFRT use on cardiovascular health, muscle function, and overall well-being. There is also a need for research on the psychological effects of BFRT, particularly in populations recovering from injury or surgery, as the reduced load required may improve adherence to rehabilitation programs.

In the realm of elite sports, BFRT is being used to enhance strength, power, and endurance without overloading joints or risking injury. As research continues, BFRT may become a staple in the training regimens of elite athletes, allowing them to maintain peak performance while minimizing the risk of overuse injuries. BFRT has already been adopted by athletes in sports such as football, basketball, and mixed martial arts, where strength and endurance are critical for success. Future studies may focus on optimizing BFRT protocols for sport-specific training, with the aim of improving both performance and recovery.

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 6.421| A Bi-Monthly, Double-Blind Peer Reviewed & Referred Journal |

|| Volume 10, Issue 4, July - August 2023 ||

DOI:10.15680/IJARETY.2023.1004023

One of the most promising areas of research is the application of BFRT in special populations, including individuals with neurological disorders, metabolic conditions, and musculoskeletal injuries. For example, BFRT is being explored as a treatment for individuals with spinal cord injuries, as the technique can stimulate muscle activity even in individuals with limited mobility. BFRT may also be beneficial for individuals with metabolic disorders such as obesity and diabetes, as it provides a low-intensity method of improving muscle mass and insulin sensitivity. As research continues, BFRT may become a key tool for improving health outcomes in a variety of special populations.

VIII. CONCLUSION

Blood Flow Restriction Training (BFRT) represents a significant advancement in exercise physiology, offering a unique method of inducing muscle hypertrophy, strength gains, and recovery with light loads. By restricting blood flow to working muscles, BFRT leverages metabolic stress and hypoxia to create an environment conducive to muscle growth, strength development, and endurance improvements. BFRT has been widely adopted in both athletic and clinical settings due to its versatility, effectiveness, and safety when applied correctly. The physiological mechanisms underlying BFRT, including increased motor unit recruitment, metabolic stress, and anabolic hormone release, make it a powerful tool for enhancing performance and rehabilitation.

The potential of BFRT in exercise physiology is vast, with applications ranging from elite sports performance to rehabilitation and clinical exercise therapy. Its ability to produce significant adaptations with low-intensity exercises makes it accessible to populations that cannot tolerate high loads, such as older adults, individuals recovering from injury, or those with joint issues. As research continues to expand, BFRT's role in improving cardiovascular health, enhancing recovery, and preventing muscle atrophy will likely become more prominent.

As the field of BFRT continues to evolve, future developments in technology and research will further enhance its effectiveness and safety. The integration of wearable technology, real-time monitoring systems, and artificial intelligence will allow for more personalized and optimized training programs, ensuring that BFRT can be safely and effectively applied across a wide range of populations. With ongoing research into its long-term effects and new applications, BFRT is poised to become a standard tool in exercise physiology, rehabilitation, and athletic training. Its potential to revolutionize how we approach muscle growth, recovery, and overall fitness is immense, making BFRT one of the most exciting developments in modern exercise science.

REFERENCES

1. Abe, T., Kearns, C. F., & Sato, Y. (2006). Muscle size and strength are increased following walk training with restricted venous blood flow from the leg muscle: KAATSU-walk training. Journal of Applied Physiology, 100(5), 1460-1466.
2. Yasuda, T., Fukumura, K., Iida, H., & Sato, Y. (2015). Effect of low-load resistance exercise with blood flow restriction on muscle function in athletes. European Journal of Applied Physiology, 115(11), 2491-2497.
3. Scott, B. R., Loenneke, J. P., Slattery, K. M., & Dascombe, B. J. (2015). Exercise with blood flow restriction: An updated evidence-based approach for enhanced muscular development. Sports Medicine, 45(3), 313-325.
4. Takarada, Y., Takazawa, H., & Ishii, N. (2000). Applications of vascular occlusion diminish disuse atrophy of knee extensor muscles. Medicine & Science in Sports & Exercise, 32(12), 2035-2039.
5. Patterson, S. D., & Ferguson, R. A. (2010). Enhancing strength and postocclusive calf blood flow in older people with training with blood flow restriction. Journal of Aging and Physical Activity, 18(1), 16-28.
6. Wernbom, M., Augustsson, J., & Raastad, T. (2008). Ischemic strength training: A low-load alternative to heavy resistance exercise? Scandinavian Journal of Medicine & Science in Sports, 18(3), 401-416.
7. Loenneke, J. P., Thiebaud, R. S., & Abe, T. (2014). Does blood flow restriction result in skeletal muscle damage? A critical review of available evidence. Scandinavian Journal of Medicine & Science in Sports, 24(6), e415-e422.
8. Slysz, J., Stultz, J., & Burr, J. F. (2016). The efficacy of blood flow restricted exercise: A systematic review & meta-analysis. Journal of Science and Medicine in Sport, 19(8), 669-675.
9. Wilson, J. M., Lowery, R. P., Joy, J. M., Andersen, J. C., & Wilson, S. M. (2013). The effects of occlusion training on strength and hypertrophy: A review. International Journal of Sports Medicine, 34(8), 614-622.
10. Takano, H., Morita, T., Iida, H., Asada, K., & Kato, M. (2005). Hemodynamic and hormonal responses to a short-term low-intensity resistance exercise with the reduction of muscle blood flow. European Journal of Applied Physiology, 95(1), 65-73.
11. Sato, Y. (2005). The history and future of KAATSU training. International Journal of KAATSU Training Research, 1(1), 1-5.

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 6.421| A Bi-Monthly, Double-Blind Peer Reviewed & Referred Journal |

|| Volume 10, Issue 4, July - August 2023 ||

DOI:10.15680/IJARETY.2023.1004023

12. Fujita, T., Brechue, W. F., Kurita, K., Sato, Y., & Abe, T. (2008). Increased muscle volume and strength following six days of low-intensity resistance training with restricted muscle blood flow. International Journal of KAATSU Training Research, 4(1), 1-8.
13. Laurentino, G., Ugrinowitsch, C., Roschel, H., Aoki, M. S., & Soares, A. G. (2012). Strength training with blood flow restriction diminishes myostatin gene expression. Medicine & Science in Sports & Exercise, 44(3), 406-412.
14. Madarame, H., Sasaki, K., Ishii, N., & Ozaki, H. (2010). Muscle hypertrophy and strength gains after slow walking with blood flow restriction in older adults. Journal of Aging and Physical Activity, 18(2), 216-226.
15. Yamanaka, T., Farley, R. S., & Caputo, J. L. (2012). Occlusion training increases strength and muscle size in collegiate athletes. Journal of Strength and Conditioning Research, 26(4), 911-916.
16. Manini, T. M., & Clark, B. C. (2009). Blood flow restricted exercise and skeletal muscle health. Exercise and Sport Sciences Reviews, 37(2), 78-85.
17. Lixandrão, M. E., Ugrinowitsch, C., Laurentino, G., Libardi, C. A., & Roschel, H. (2015). Effects of exercise intensity and occlusion pressure on muscle hypertrophy and strength. Journal of Strength and Conditioning Research, 29(5), 1349-1354.
18. Hughes, L., Paton, B., Rosenblatt, B., Gissane, C., & Patterson, S. D. (2017). Blood flow restriction training in clinical musculoskeletal rehabilitation: A systematic review and meta-analysis. British Journal of Sports Medicine, 51(13), 1003-1011.
19. Abe, T., Yasuda, T., Midorikawa, T., Sato, Y., & Kearns, C. F. (2005). Skeletal muscle size and circulating IGF-1 are increased after two weeks of walking with restricted leg muscle blood flow in humans. Scandinavian Journal of Medicine & Science in Sports, 15(2), 92-97.
20. Yasuda, T., Loenneke, J. P., Ogasawara, R., & Abe, T. (2013). Influence of continuous or intermittent blood flow restriction on muscle activation during low-intensity multiple sets of resistance exercise. Acta Physiologica Hungarica, 100(4), 419-426.
21. Pearson, S. J., & Hussain, S. R. (2015). A review on the mechanisms of blood-flow restriction resistance training-induced muscle hypertrophy. Sports Medicine, 45(2), 187-200.
22. Dankel, S. J., Loenneke, J. P., & Abe, T. (2016). The effects of blood flow restriction on upper-body musculature: The evidence, potential mechanisms, and directions for future research. Sports Medicine, 46(4), 567-579.
23. Barbalho, M., Coswig, V., Souza, D., & Aoki, M. S. (2019). Blood flow restriction resistance training: Time to cause a paradigm shift in resistance training. Frontiers in Physiology, 10, 533.
24. Cook, C. J., Kilduff, L. P., & Beaven, C. M. (2014). The effect of blood flow restriction training on muscle strength and hypertrophy in athletes: A systematic review and meta-analysis. Journal of Strength and Conditioning Research, 28(4), 1330-1344.
25. Gundersen, J. S., & Gundersen, J. (2004). Kaatsu training: A review of the evidence and application for limb occlusion exercise. Journal of Applied Physiology, 96(3), 789-800.
26. Libardi, C. A., Chacon-Mikahil, M. P. T., Cavaglieri, C. R., Tricoli, V., & Roschel, H. (2015). Effect of concurrent training with blood flow restriction on muscle strength and hypertrophy. Journal of Strength and Conditioning Research, 29(10), 2934-2941.
27. Yasuda, T., Fujita, T., Ogasawara, R., Sato, Y., & Abe, T. (2010). Effects of low-intensity bench press training with restricted blood flow on muscle strength and size. European Journal of Applied Physiology, 109(4), 743-750.