

Training for Martial Arts Athletes: Efforts to Increase Leg Muscle Strength: A Literature Review



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ABSTRACT: Sport is a systematic physical activity that aims to achieve physical performance and fitness. Physical fitness is claimed to be one of the factors to support athlete performance during training and competition. Exercise is one of the most important efforts to improve the physical abilities of athletes. Martial arts performance sports involve one-on-one combat between competitors based on certain rules. In the success of a martial arts athlete cannot be separated from the physiological aspect, the ability of cardiorespiratory endurance, muscle endurance, strength, speed, power, flexibility and agility. In martial arts sports, leg muscle strength and endurance play an important role in an athlete's performance. Methods using the literature review method. Literature to investigate improving leg muscle strength in martial arts athletes. Research emphasizes that specifically designed training programs can significantly improve leg muscle strength, endurance, and performance in martial arts athletes. A literature review focusing on the effectiveness of different training methods to improve leg strength in martial arts athletes is essential to optimize training programs and improve performance. In addition to conventional strength training, research has also highlighted the benefits of proprioceptive training. This training was shown to improve forefoot dorsiflexor strength, as well as dorsiflexor/plantarflexor and eversion/inversion ratios at three and six months. Conventional, plyometric and proprioceptive strength training, as well as a combination of training methods, can provide significant benefits. However, it is important to consider the specific needs of each martial art, training parameters (volume, intensity, periodization), training execution techniques, and other factors such as recovery. Proper evaluation and measurement is also crucial to monitor the effectiveness of the training program and ensure optimal performance is achieved.

KEYWORDS: training, strength, leg muscles, martial arts.

I. INTRODUCTION

The development of sports at this time is not only carried out by certain circles, but it is known that sports today have penetrated into a broad life and make a positive contribution in shaping physically and mentally healthy humans. Bácsné-Bába *et al.*, (2021) The term sport is a systematic physical activity that aims to achieve achievement and health, so that sports if pursued will have a positive impact on the body. Exercise is a physical activity related to improving fitness and maintaining health (Franklin *et al.*, 2022). Exercise is a very important activity to maintain one's physical fitness (Ali & Kamraju, 2020). Physical fitness is a set of attributes related to a person's ability to perform physical activities or sports (Roth *et al.*, 2020). Physical fitness is claimed to be one of the factors to support athlete performance during training and competition. Exercise is one of the most important efforts to improve athletes' physical abilities (Suchomel *et al.*, 2018). Sports activities are not only aimed at physical fitness, achievement is a tangible proof of the process of someone exercising, one of which is martial arts. Martial arts sports are currently in great demand by the world community (Bowman & Judkins, 2020).

Martial arts sports usually involve one-on-one combat between competitors based on certain rules (Barley & Harms, 2021). Martial arts is a combat sport that is based on technique. (Krabben *et al.*, 2019). Martial arts sports can usually be classified as karate, taekwondo, boxing, fencing, wrestling, judo. Other martial arts sports, such as Brazilian jiu-jitsu and mixed martial arts, are popular and growing (Blomqvist Mickelsson, 2020). According Song (2022) martial arts sports to achieve set goals is closely related to the widely understood control of the sports training process. Evaluation of training effects at individual stages requires regular supervision and control of training, including control of specific fitness parameters, taking into account aspects of possible correlation with the athlete's training experience (Kasprzyk-Kucewicz *et al.*, 2020). Martial arts athletes need a complete physical

Training for Martial Arts Athletes: Efforts to Increase Leg Muscle Strength: A Literature Review

condition in order to obtain higher achievements in addition to mastery of techniques, strategies, and mentality (Özsari et al., 2023). Targeted training is essential to increase the competitive level of martial arts athletes and improve their sporting performance.

In the success of a martial arts athlete is inseparable from the physiological aspect, the ability of cardiorespiratory endurance, muscle endurance, strength, speed, power, flexibility and agility (Lee et al., 2018). Martial arts athletes need a complete physical condition in order to obtain higher achievements in addition to mastery of techniques, strategies, and mentality. (Taylor et al., 2017; Mujika et al., 2018) Physical fitness level is an important requirement needed by an athlete in performing various individual and combined movements. Physical fitness is an important subject in physical education. The physical quality of martial arts athletes has its own characteristics. The level of athlete achievement is mainly influenced by the athlete's physical fitness, especially muscle strength (Suchomel et al., 2016; Albaladejo-Saura et al., 2021). In martial arts sports, leg muscle strength and endurance play an important role in an athlete's performance (Ojeda-Aravena et al., 2023; Stamenković et al., 2022). The feet are the foundation for many martial arts techniques and movements, such as kicks, jumps, and shifts in position. Therefore, optimal leg muscle development is a crucial element in the training of martial arts athletes.

Physical abilities such as strength, endurance, and leg muscle power are important components in martial arts sports. (Wąsacz et al., 2023). The feet are used as the base of movement to perform various attack and defense techniques, such as kicks, jumps, and positional shifts. Therefore, optimal leg muscle development can give martial arts athletes a competitive advantage. Various types of training have been recommended to improve leg muscle performance in martial arts athletes (Do Nascimento et al., 2023), such as squat, lunge, leg press and plyometric exercises. The effectiveness and application of each training method still needs to be studied in depth. In addition, other factors that can influence leg muscle development in martial arts athletes, such as training technique, volume, intensity, and periodization, also need to be considered (Øvretveit, 2020). A more comprehensive understanding of optimal training approaches can help martial arts coaches and athletes design effective training programs to improve leg muscle performance (Zhang et al., 2022).

Research has shown that specifically designed training programs can improve leg muscle strength, endurance, and performance in martial arts athletes (Hadi & Yudhistira, 2023; Kabadayı et al., 2022). Common types of exercises include squats, lunges, leg presses, and plyometric exercises. However, there has not been a comprehensive review of the effectiveness of these training programs in the context of improving leg muscles in martial arts athletes. While a general fitness program can be beneficial, martial arts requires specific movements and techniques that demand specialized training. For example, a kickboxer needs to develop explosive power in their legs for powerful kicks, while a judoka needs to build strength and stability for throws and grappling. Therefore, a literature review focusing specifically on the effectiveness of different training methods to improve leg strength in martial arts athletes is essential to optimize training programs and improve performance.

This literature review aims to analyze various training programs and their training parameters in an effort to improve leg muscles in martial arts athletes. The results of this study are expected to provide practical recommendations for martial arts coaches and athletes to optimize the development of physical abilities, especially leg muscle strength and endurance. Therefore, this study aims to conduct a systematic review of the existing literature related to leg muscle enhancement efforts in martial arts athletes. This review will analyze the types of exercises, training parameters, and their impact on leg muscle development. The results of this study are expected to provide practical guidance for martial arts coaches and athletes in designing effective training programs to improve leg muscle performance.

II. RESEARCH METHOD

This research uses the literature review method. (Martín-moya & González-fernández, 2022) literature to investigate the improvement of leg muscle strength in martial arts athletes. The literature for this study was sourced from reputable journal databases, including Mendeley, Google Scholar, PubMed, and ScienceDirect. The search process used relevant keywords such as “exercise”, “leg muscle strength”, and “martial arts athletes”. Articles selected for inclusion in this review should be aligned with the topic, emphasizing the improvement of leg muscle strength in martial arts athletes.

III. RESULTS AND DISCUSSION

The author used 10 publications as the main reference sources in completing the research tasks shown in Table 1. The articles in the table below provide the research database. The table below needs to include some elements from the 10 articles: 1) Author and Year; 2) Title and publisher of the study; 3) Methods; and 4) Research findings. A description of the articles reviewed is given below:

Training for Martial Arts Athletes: Efforts to Increase Leg Muscle Strength: A Literature Review

No	Author	Title, Publisher	Study Design	Research Objectives	Result
1	(Gabriela et al., 2021)	Effects of proprioceptive training on ankle muscle strength in fencers: A clinical trial	Clinical trials	to verify the effect of a twelve-week proprioceptive exercise program on ankle muscle strength and muscle balance in fencers.	Proprioceptive training improved forefoot dorsiflexor strength at three- and six-month follow-ups when compared to the previous intervention. Training also improved forefoot dorsiflexor/ plantarflexor conventional ratio at three and six-month follow-up when compared to the previous intervention; eversion/inversion conventional ratio at three-month follow-up when compared to the previous intervention; and eversion/ inversion functional ratio at follow-up.
2	(Arora et al., 2021)	Effects of combined whole-body vibration and endurance training on lower quadrant electromyographic activity, strength and power in athletes	Experiment	to compare the effects of a combination of WBV and resistance training (RVE) with strength training alone (RE) on changes in activity and strength of the gastrocnemius lateralis and broadus medialis obliquus muscles, and power performance in athletes.	VMO muscle activity (group effect) was significantly increased in the RVE group ($p < 0.05$). However, both groups showed statistically significant group $\times$ time and time $\times$ time interaction effects for VMO muscle activity, isometric strength (VMO and GL), and CMJ ($p < 0.05$).
3	(Kostikiadis et al., 2018)	Effect of Short-Term Sport-Specific Strength and Conditioning Training on Physical Fitness of Well-Trained Mixed Martial Arts Athletes	A two-group training study	The purpose of this study was to investigate the effect of a short-term, high-intensity, low-volume Mixed Martial Arts (MMA)-specific strength and conditioning training program on the performance of national-level MMA athletes.	that high-intensity, low-volume strength and conditioning training interventions designed according to the demands of MMA competition can produce significant performance improvements for trained fighters
4	(Wąsacz et al., 2023)	Searching for muscle fitness and its relationship with training experience and sports performance in modern combat sports athletes such as mixed	Observation Data	to determine the level of motor fitness development of combat sports athletes and examine their relationship with training experience, and high sports performance.	The results of this study enable early diagnosis and interpretation of motor fitness competencies and their main manifestation profiles in MMA and BJJ, promoting the optimization of training quality control.

Training for Martial Arts Athletes: Efforts to Increase Leg Muscle Strength: A Literature Review

		martial arts (MMA) and Brazilian jiu-jitsu (BJJ)			
5	(Purnamasari et al., 2022)	Functional Training: Effects on Arm Muscle Endurance, Limb Muscle Endurance, Aerobic Capacity and Body Mass Index in Judoka in the Train-to-Train Stage	Experimental	to determine the effect of Functional Exercise on arm muscle endurance, leg muscle endurance, aerobic capacity, and body mass index.	Functional training exercises have an effect on increasing arm muscle strength, there is no significant increase in leg muscle strength and aerobic capacity, and increasing Body Mass Index using functional training methods can support judoka performance from the training stage to the competition stage.
6	(Yoo et al., 2018)	Comparison of Proprioceptive Training and Muscle Strength Training to Improve the Balance Ability of Taekwondo Poomsae Athletes: A Randomized Controlled Trial	Experimental	The purpose of this study was to determine the effect of proprioceptive training and lower limb muscle strength training on the balance of Taekwondo Poomsae athletes for 6 weeks.	that proprioception training and lower limb muscle strength training result in improved athletic performance. It is also desirable to move the CoP position through conscious effort forward in P2 to maintain the crane position without swaying.
7	(Branco et al., 2022)	Effect of Supplemental Strength Program on Generic and Specific Physical Fitness in Judo Cadet Athletes	Experimental	This study aims to determine the effect of an additional strength program on general and specific physical fitness in judo athletes under 18 years old.	8 weeks of strength training had a positive effect on general and specific performance. Finally, this strength program can help trainers to develop strength without changes in body mass.
8	(Nysether et al., 2023)	Monitoring Changes in Lower Limb Strength and Power in Elite Athletes with the Countermovement-Jump and Keizer Leg-Press Tests	Experimental	To determine the usefulness of the countermovement-jump and Keizer leg-press tests for tracking change in elite athletes from different sports	Averaged over sports, Keizer's peak power and relative peak power had the highest proportion of decisional change in the first sense (60% and 55%) and the second sense (25% and 28%). The velocity intersection of the force-velocity relationship has the lowest proportion in the first and second sense (29% and 11%), while the jump height, Keizer average power, relative average power, cutting force, and slope of the force-velocity relationship have similar proportions (40%-53% and 15%-21%).
9	(Redondo et al., 2014)	Effects of a 12-Week Strength	Experimental	The purpose of this study was to determine	that a 12-week strength training program can improve maximal

Training for Martial Arts Athletes: Efforts to Increase Leg Muscle Strength: A Literature Review

		Training Program on Movement Time of Experienced Fencers		the effects of a 12-week strength training program on movement time (MT) in national-level fencers.	and explosive strength, and these improvements can be transferred to MT performance. However, fencers need time to transfer the gains.
10	(Özbay & Ulupinar, 2022)	Strength-Power Tests Are More Effective When Performed After Grueling Training in Distinguishing Between Elite and Non-Elite Wrestlers	Experimental	to analyze power-strength in elite and non-elite wrestlers, identify which variables allow discrimination between them, and to investigate whether the results change when the test is performed after exhaustive training.	that top-level elite wrestlers produced higher lower- and upper-body outputs in Wingate average (relative) strength than other elite wrestlers when testing was conducted after full rest. However, when the tests were conducted after grueling training activities, the elite top-level wrestlers still showed (relatively) superior results in almost all tests, except in the vertical and horizontal jump tests.

Modern sport is no longer just a recreational activity, but has become an integral part of a healthy lifestyle and a means of achievement. Sport, as a systematic physical activity, aims to improve health and achieve. Physical fitness, which is a set of attributes related to the ability to perform physical activities, plays an important role in supporting athlete performance, both in training and competition. Targeted training is the key to improving athletes' physical abilities, and achievement is the measure of the success of the process.

In this context, martial arts stand out as an increasingly popular discipline around the world. Martial arts, which generally involve one-on-one combat based on certain rules and techniques, demand excellent physical condition. The various branches of martial arts, such as karate, taekwondo, boxing, fencing, wrestling, judo, Brazilian jiu-jitsu, and mixed martial arts, each have specific characteristics and physical demands. Control of the training process, including evaluation of fitness parameters and their correlation with training experience, is essential to achieve the set goals. In addition to mastery of technique, strategy, and mentality, a complete physical condition is an absolute prerequisite for martial arts athletes to achieve higher achievements. The success of a martial arts athlete is greatly influenced by various components of physical fitness, including cardiorespiratory endurance, muscle endurance, strength, speed, power, flexibility, and agility (Lee et al., 2018). An optimal level of physical fitness allows athletes to perform a variety of movements, both individual and combined, efficiently and effectively. The physical qualities of martial arts athletes are unique, with muscular strength being the main determinant of performance.

Among the various components of physical fitness, leg muscle strength and endurance play a crucial role in martial arts. The feet serve as the main foundation in various techniques and movements, such as kicks, jumps, and positional shifts. Optimal leg muscle development provides a significant competitive advantage. Various exercises, such as squats, lunges, leg presses and plyometrics, are recommended to improve leg muscle performance (Suchomel et al., 2016; Albaladejo-Saura et al., 2021). However, the effectiveness and applicability of each training method needs to be studied in depth, taking into account factors such as implementation techniques, volume, intensity, and periodization of training. The selection of training methods that suit the specific needs of the sport and the individual characteristics of the athlete is a crucial factor in achieving optimal results. For example, athletes with a predominance of explosive movements, such as in MMA, may require more high-intensity training, while Judo or fencing athletes may benefit more from proprioceptive or functional training that focuses on stability and balance.

Research emphasizes that specifically designed training programs can significantly improve leg muscle strength, endurance, and performance in martial arts athletes (Zhang et al., 2022). Exercises such as squats, lunges, leg presses, and plyometrics are often applied. However, it is important to understand that the needs of each martial art are different. A kickboxer, for example, needs explosive strength to produce powerful kicks, while a judoka needs more strength and stability to perform throws and grappling. Therefore, a literature review focusing on the effectiveness of different training methods to improve leg strength in martial arts athletes is essential to optimize training programs and improve performance. In addition to conventional strength training, research has also highlighted the benefits of proprioceptive training. This training was shown to improve forefoot dorsiflexor strength, as well as dorsiflexor/plantarflexor and eversion/inversion ratios at three and six months. This suggests that

Training for Martial Arts Athletes: Efforts to Increase Leg Muscle Strength: A Literature Review

proprioceptive training is not only important for injury prevention, but also contributes to improved performance by enhancing ankle stability and control.

Other research reinforces the idea of exercise specificity. High-intensity, low-volume strength and conditioning training interventions designed around the demands of MMA competition have been shown to effectively improve the performance of trained fighters. Similarly, 8 weeks of strength training had a positive impact on general and specific performance in judo athletes, and helped develop strength without significant changes in body mass. In fencers, a 12-week strength training program can increase maximal and explosive strength, potentially improving movement time (MT) performance, although the transfer of these gains requires time and specific training. Studies of elite wrestlers also provide important insights. Top-level wrestlers showed higher output on the lower and upper body in Wingate's average (relative) strength, especially after rest. This emphasizes the importance of optimal recovery in maximizing performance.

IV. CONCLUSIONS

Leg muscle development in martial arts requires a comprehensive and specific approach. Conventional, plyometric, and proprioceptive strength training, as well as a combination of training methods, can provide significant benefits. However, it is important to consider the specific needs of each martial art, training parameters (volume, intensity, periodization), training execution techniques, and other factors such as recovery. Proper evaluation and measurement is also crucial to monitor the effectiveness of the training program and ensure optimal performance is achieved. With a deep understanding of these principles, martial arts coaches and athletes can design effective training programs to maximize performance potential through optimal leg muscle development. By exploring various approaches in depth, it is hoped that coaches can design training programs that are not only effective but also sustainable to support the optimal development of martial arts athletes, both physically and mentally.

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Training for Martial Arts Athletes: Efforts to Increase Leg Muscle Strength: A Literature Review

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