

OPTIMIZATION OF PERFORMANCE IN UNDER-18 SOCCER PLAYERS THROUGH SELECTIVE ISOMETRIC TRAINING IN LOWER LIMBS: STATE-OF-THE-ART REVIEW

Optimización del rendimiento de futbolistas sub 18 mediante entrenamiento de isometría selectiva en miembros inferiores: evisión del estado del arte

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Manuscript information:

Recibido/Received: 06/05/25

Revisado/Reviewed: 11/09/25

Aceptado/Accepted: 23/09/25

ABSTRACT

Keywords:

Isometrics, selective strengthening, sports gesture, sports performance.

Soccer player training is constantly evolving, seeking strategies to optimize performance. This state-of-the-art review analyzes the evolution of isometric training, taking as a starting point a master's project from 2019. The objective is to determine how selective muscle training of the lower limbs influences the performance of young soccer players, comparing findings with current trends to identify significant advances.

A review of articles was conducted in the "Pubmed" database using keywords related to selective training, isometrics, and sports performance. Articles published from 2018 onwards were included, prioritizing randomized controlled trials, reviews, and comparative studies. Non-original articles and those published before 2018 were excluded.

The reviewed studies highlight the effectiveness of current selective isometric training to optimize muscle activation in the lower limbs, improving strength and endurance; benefits of isometrics by gender were observed, finding a correlation between isometrics and increased BMI. New applications of isometrics with physical means, useful in rehabilitation and improvement of sports gestures, were analyzed. For this study, the frequency of training and the population were analyzed. Although there was a limitation in the sample size in the studies, the results are promising, highlighting the usefulness of isometrics in selective strengthening, rehabilitation, and injury prevention.

RESUMEN

Palabras clave:

El entrenamiento de futbolistas se encuentra en constante evolución, buscando estrategias que optimicen el rendimiento, esta revisión del estado del arte analiza la evolución del entrenamiento isométrico, tomando como punto de partida un proyecto de maestría de 2019. El

isometría, fortalecimiento selectivo, gesto deportivo, rendimiento deportivo.

objetivo es determinar cómo el entrenamiento muscular selectivo de miembros inferiores influye en el rendimiento de futbolistas jóvenes, comparando hallazgos con tendencias actuales para identificar avances significativos.

Se realizó una revisión de artículos en la base de datos "Pubmed" utilizando palabras clave relacionadas con entrenamiento selectivo, isometría y rendimiento deportivo, se incluyeron artículos publicados desde 2018 en adelante, priorizando ensayos controlados aleatorizados, revisiones y estudios comparativos, se excluyeron artículos no originales y aquellos publicados antes de 2018.

Los estudios revisados destacan la eficacia del entrenamiento isométrico selectivo actual, para optimizar la activación muscular en el tren inferior, mejorando fuerza y resistencia; se observó beneficios de la isometría por género, encontrándose correlación entre isometría y aumento del IMC, se analizaron nuevas aplicaciones de la isometría con medios físicos, útiles en rehabilitación y mejora del gesto deportivo. Para este estudio se analizó, la frecuencia del entrenamiento y la población. Aunque existió limitación en el tamaño de muestra en los estudios, los resultados son prometedores, destacando la utilidad de la isometría en el fortalecimiento selectivo, rehabilitación y prevención de lesiones.

Introduction

Soccer training is a field in constant evolution, driven by the search for strategies that optimize performance, to achieve this, it is essential to carry out continuous research and develop new methodologies, in this context, this review of the state of the art aims to analyze the evolution of isometric training, taking as a starting point a master's project conducted in 2019. This project focused on determining how selective muscle training of the lower limbs influences the performance of soccer players in the training category of Ecuadorian soccer. By comparing the findings of this study with current trends, we seek to identify significant advances in the application and effectiveness of isometric training.

Selective muscle training is defined as a method that prioritizes the development and strengthening of specific muscle groups, its main objective is to optimize the functional capacity of the individual, allowing them to execute movements with greater efficiency and power, this translates into an improvement in the ability to perform actions that require strength, such as jumping, holding or reaching objects, which is applicable in various physical activities (Jacob et al., 2018).

Within this context, selective isometrics emerges as a complementary technique that focuses on performing static muscle contractions, targeting specific muscle groups or joints. This activation procedure is particularly valuable for strengthening stabilizing muscles, those that provide support and control during movement.

The application of selective isometrics can vary widely, from static contractions held in specific positions, to dynamic exercises incorporating external resistances, such as elastic bands or weights, this versatility allows training to be tailored to the individual needs and specific goals of each person (Wagner. et al, 2022).

A crucial aspect of selective training is its ability to contribute to injury prevention by strengthening the muscles that support and stabilize the joints, reducing joint tension and therefore the risk of injury. To ensure the effectiveness and safety of this type of training, it is essential that it is designed and supervised by professionals based on an initial assessment.

In this sense, an interdisciplinary approach combining physiotherapy and training is fundamental to obtain optimal results, collaboration between professionals from both areas, allowing to identify areas of individual weakness and design customized training programs (Azeem and Zemková, 2022).

Selective muscle training along with selective isometrics are valuable tools to improve functional capacity and prevent injuries, their application requires an individualized approach and the supervision of qualified professionals to ensure safe and effective results.

Over time, significant advances have been made in the understanding of this model of intervention, specifically in isometric exercise, this type of training is carried out from the planning in season, using the own body weight in a series of combinations with extra resistance. The results of this type of training have been shown to have a direct influence on the improvement of important factors for the field of soccer, such as vertical and horizontal movements and speed (Kun and Yue, 2022).

Although the use of resistances in physiotherapy is considered a traditional approach in physiotherapy, their integration in selective muscle training acquires a particular relevance; this is due to their direct influence on the muscle sarcomere, as well as their capacity to improve the response to external stimuli during physical activity. In this sense, the strength resulting from this type of selective training significantly optimizes the response during play, which underlines the importance of applying these findings in practice.

One of the new protocols where isometry is employed is the FIFA11+ warm-up program, due to the fact that it not only focuses on performance optimization, but also addresses the specificity needed to identify the weaknesses assessed in the first instance, in addition, the influence of the training plan on player performance has been observed (Zhou. et al, 2022).

This warm-up program consists of a series of exercises that are performed before the start of training or a match. These exercises focus on improving the player's technique, agility, coordination and endurance, while reducing the risk of injury. Making this type of intervention an essential tool for soccer coaches and physical trainers, it has been widely adopted by teams around the world and has proven to be effective in improving the physical condition of players and reducing the risk of injury. In addition, within the study by Zhou et al. (2022), observed that players who regularly perform the FIFA11+ warm-up program have a significant improvement in their performance on the field.

Isometrics as an intervention technique linked to the warm-up method mentioned above can also help improve the technique and performance of players, isometric exercises specific to soccer, another of the studies analyzed is the use of the "plank" or "wall position", for the influence on the stability and coordination of the player especially in the upper body tran, which translates into better ball control and greater accuracy in passing and shooting (Zhou. et al. 2022).

This approach, targets specific player weaknesses, for example, if a player has a weakness in the thigh muscles, a specific isometric exercise can be used to strengthen those muscles and reduce the risk of injury, it can even be used to improve endurance in the muscles or correct patterns of muscle imbalances, resulting in an increased ability to maintain pace throughout the match (Wagner. et al, 2022).

Now, although we have analyzed the approach of the studies presented and their importance on the optimization of sports performance, it becomes crucial to compare more classical measures such as the isotonic approach versus a new approach in training and warm-up such as isometrics, the importance within soccer training is crucial to maximize the sports performance of the players, constantly seeking to evolve the techniques and methods used.

In this sense, isotonic and isometric training are two approaches that have been shown to have a direct relationship with the increase of muscle strength and, therefore, with the sports performance of soccer players. The first focuses on the performance of muscle contractions with movement, which allows working on strength, speed and muscular endurance in different ranges of motion and in a more functional way. This type of training is commonly used in sports such as soccer, where the physical demand is high and the ability to generate strength in different positions and movements is fundamental.

Although in the past isotonic training has been considered more suitable for soccer than the latter, as isometric training would target a contraction in the absence of the sport-specific gesture, it has now been shown that both approaches are equally effective in increasing muscle strength, in fact, several studies have found that the combination of both approaches can be beneficial to the athletic performance of soccer players (Azeem and Zemková, 2022).

It is important to note that the isometric method is not widely used in soccer, a situation that may be due to a lack of knowledge and information about the benefits that this training approach can offer, many physical trainers may consider that isotonic training is sufficient to meet the needs of soccer players; however, this may be limiting the potential for improvement in the athletic performance of players.

Both isometric and isotonic training are effective approaches to increase muscle strength and improve athletic performance in soccer, it is necessary to have a

comprehensive approach in the training and care of athletes, in addition, it is important to inform and educate physical trainers and coaches about the benefits of isometric training so that they can incorporate it effectively in the training planning of soccer players.

An interesting study on this subject is that of da Costa et al. (2019), who conducted a comparative analysis between isometrics and plyometrics, training models that differ in their application and results. The authors concluded that isometric training yielded positive results superior to plyometric training, which allows us to reflect on whether we are focusing on the requirements necessary for the predominant objectives in soccer or whether it is necessary to focus more on the musculature of the lower limbs, expanding the range of possible options to be taken into consideration, always keeping in mind immovable gestures of the game such as jumps and explosive changes of direction in the training objective.

An important aspect to consider is that physiological differences between men and women can affect the response to training; women generally have lower muscle mass and lower strength compared to men, which can influence training results, however, this does not mean that isometric training is not equally effective for women, da Acosta et al, (2019) suggests that isometric training can be effective in improving athletic performance in both genders.

It is important to keep in mind that isometric and plyometric training can complement each other in a comprehensive training program. The author suggests that although plyometrics can improve jumping ability and explosiveness, isometrics can improve muscular strength and stability in playing positions, allowing to generate a balanced approach to training resulting in significant improvements in athletic performance, this type of understanding about the reality of athletes, about the way in which the objectives should be achieved, obviating classic facts of training that continue to yield the same results and does not lead to take on new challenges about research on these small findings on the principles of variability in training.

So far we have raised several investigations that have been executed around isometric training in the last 4 years and its significant contribution in increasing the performance of soccer players, we have even analyzed the relationship that exists on the gender factor and if this type of training, responds to these needs and although it seems to have reached the ideas there are still new strategies that are implemented and have yielded positive results.

The term "superisometric", coined by Wu (2022), refers to a modality of advanced isometric training that is performed in the aquatic environment, unlike traditional isometric training, which is performed on land, aquatic superisometric training takes advantage of the unique properties of water to increase the specificity and intensity of the muscle stimulus, the hydrodynamic resistance of water provides a constant and multidirectional load, which allows the activation of a greater number of muscle fibers and improved joint stability. In addition, the buoyancy of the water reduces the impact on the joints, allowing for high-intensity exercise with less risk of injury.

The application of aquatic superisometric training presents significant advantages for the development of muscular strength, neuromuscular coordination and the ability to jump, acceleration and running speed. These ideal characteristics can be taken especially to sports such as soccer, the ability to control the resistance and speed of movement in the water allows a more specific training adapted to the needs of each athlete, thus optimizing the results and minimizing the risk of injury.

Isometric based training within this study, proved to be an effective technique to improve muscle strength, joint stability and proprioceptive ability, this approach can be

applied to other sports that seek the same objective at the lower body level, with the aim of improving the performance of athletes, providing a number of advantages compared to traditional isometric training performed in dry.

The interdisciplinary approach, proposed by Wu (2022), integrates knowledge from sports science and physiotherapy, further enhances the benefits of isometric training in water, helping players recover from injuries or muscle pain by optimizing their muscle synergy and global biomechanics, this isometric training modality in water can be a great tool to maintain the performance of soccer players in the absence of mobility.

Method

A review was conducted by searching for articles in the database "Pubmed" using keywords such as selective, isometric, specific training, stability, sports performance, the search was conducted between the months of December 2023 and October 2024 the deadline, March 15, 2025, using the Boolean operators "and" and "or", and discarding all articles prior to 2018, the inclusion criteria were articles on selective training, isometrics and its impact on sports performance and that were published from 2017 onwards. Randomized control trials, reviews and comparative studies were selected. Exclusion criteria were articles that were not original and had been published before 2018.

Results

Figure 1

Flowchart describing the process of study identification and selection.

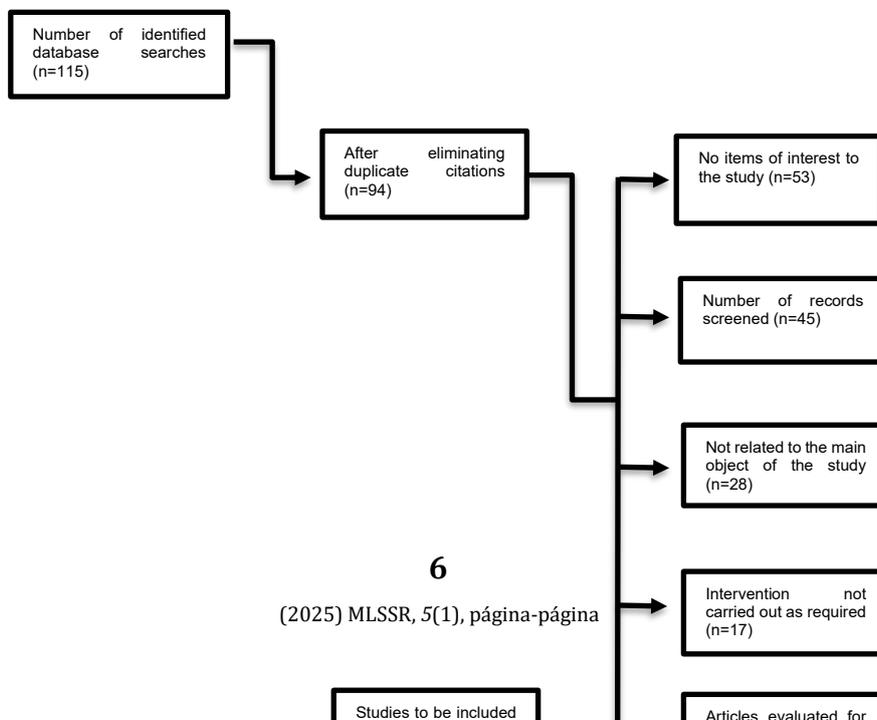


Table 1
Description of intervention studies

Author and year	Population and sample	Intervention	Frequency and method	Results
Kun and Yue (2022)	n=20	Training using the body weight of the participants, with a selective focus on soccer-specific musculature.	4 times a week	Strength increase in flexor and extensor muscles 8.78 and 9.90 (P<0.05)
Zhou et al (2022)	n=20 Men=20	FIFA 11+ warm-up program.	5 times a week 120 minutes	Increase in knee flexor muscle strength comparing pre-intervention versus post-intervention. (p < 0.05). Increase in knee extensor muscle strength comparing pre-intervention versus post-intervention (p < 0.05). Increase in sprint speed by 30 m comparing pre-intervention vs. post-intervention (p < 0.05). Shuttle run performance (lateral displacements) significantly improved in post-test scores for players (p<0.05).
Azeem and Zemková (2022)	n=100 men=50 (isometric group). men=50 (group 2 isotonic)	Experimental: analysis of isotonic versus isometric training.	2 times a week 45 minutes	Increase in BMI by 1.96% Increase in squat strength 7.80% Increase in squat tolerance 6.92% Increase over Resistance 6.99%. The increase in strength was similar to isotonic training.
da Acosta et al (2019)	n=10 Women=10	Experimental: influence of isometric training.	3 times a week 45 minutes	Increased lower limb strength in multiple gestures p = 0.33.
Wu (2022)	n=24 men=12 women=12	Superisometric training model.	3 times a week 120 minutes	Increase in gestural strength (P>0.05)
Wagner et al (2022)	n=16 male=16	Experimental: influence of isometric training, using continuous evaluations on their response.	5 times a week	Establishes an increase in strength by employing isometric training over isotonic training.
Jacob et al (2018)	n= 26 Men=16	Four-deep squats.	2 times a week	Increase in peak force ≤0.023 Increase in lower limb strength (p , 0.001, R2 = 0.98).

Women=10

3-2 hours

In reviewing the studies presented in Table 1, we found a remarkable consensus: selective isometric training stands out as an effective tool for optimizing muscle activation in the lower body. Virtually all articles (100%) support its ability to improve strength and endurance; going deeper into the data, 85.7% of the studies specifically highlight these improvements.

An interesting finding is that 42.85% of the studies found no significant differences in the effects of isometrics according to gender, suggesting that its benefits could extend to the general sports population. In addition, 28.5% of the studies observed a correlation between isometric training and an increase in Body Mass Index (BMI), which could indicate an increase in lower body muscle hypertrophy.

Finally, it is important to note that the research also explores new ways of applying isometrics, incorporating physical means that enhance its effects on the sporting gesture 14.28%. These innovations are not only relevant to soccer, but could also be applied in other sports involving the lower limbs, and could even be useful in rehabilitation programs, helping athletes to maintain their performance and avoid setbacks during injury recovery.

Discussion and Conclusions

The analysis of the papers mentioned in this paper provides a concise but revealing insight into the effects of selective isometric training on lower body performance in athletes. The studies by Kun and Yue (2022) and Zhou et al. (2022) provide strong evidence that this type of training can induce significant improvements in strength, speed and agility, in particular, the study by Kun and Yue (2022) highlights increased strength in the flexor and extensor musculature, which is critical for the execution of explosive and efficient movements in sports that require rapid changes of direction and jumping, such as soccer.

The study by Zhou et al. (2022) further delves into the benefits of isometric training, demonstrating improvements not only in knee musculature strength, but also in sprint speed and shuttle run performance, these results suggest that selective isometric training can have a positive impact on multiple aspects of athletic performance, which is crucial for athletes who need a combination of strength, speed and agility to excel in their respective disciplines.

The improvement in the shuttle run, specifically, highlights the relevance of this type of training in sports that demand fast and precise changes of direction, such as soccer, basketball and tennis, it is important to note that both studies used training protocols that emphasize muscle selectivity, meaning that they focused on strengthening specific muscle groups that are crucial for lower body performance, this selectivity allows for greater specificity in training, which can result in more significant improvements in athletic performance compared to training programs that address the lower body more generally. In addition, the inclusion of FIFA 11+ warming in the study by Zhou et al. (2022) suggest that combining specific warm-up exercises with isometric training can further enhance performance benefits.

Training frequency also appears to be an important factor in the observed results, both studies used a training frequency of 4 to 5 times per week, suggesting that consistency and regularity are crucial to obtain significant improvements in performance, this training variable allows for optimal adaptation of the muscles and nervous system, which translates into improvements in strength, speed and agility.

In addition, it is relevant to consider the population studied in both studies, since the focus was oriented towards young athletes, which suggests that selective isometric training may be particularly effective in this population, due to the developmental factor on adaptation and muscle plasticity that are increased obtaining greater benefits from isometric training compared to older athletes.

"Zhou et al. (2022) reported an increase in knee flexor muscle strength comparing pre intervention versus post intervention ($p < 0.05$), they also reported an increase in knee extensor muscle strength comparing pre intervention versus post intervention ($p < 0.05$). Although, the sample size is relatively small ($n = 20$), which may limit the generalizability of the results to larger populations, both studies focused on male athletes, which means that these results may not be applicable to female athletes.

Despite these limitations, the results of these studies are promising and suggest that selective isometric training may be a valuable tool for improving lower body performance in athletes, coaches and trainers may consider including this type of training in their training programs to optimize the performance of their athletes.

In the context of sports physiotherapy, selective isometric training is presented as a valuable tool for rehabilitation and injury prevention in athletes, its ability to strengthen specific muscles without generating excessive stress on the joints makes it ideal for post-injury recovery, allowing athletes to maintain strength and stability during the healing process, in addition, its focus on joint stability makes it an essential component of injury prevention programs, helping athletes to develop a solid foundation for optimal and safe performance.

The study by Azeem and Zemková (2022) is particularly interesting because it directly compares isometric training with isotonic training in a large sample of men, the results show that both types of training are equally effective in increasing muscular strength, however, isotonic training appears to have an advantage in terms of increasing BMI and improving tolerance and endurance, their research suggests that isotonic training may be more effective for developing muscle mass and cardiovascular endurance, while isometric training may be more effective for improving maximal strength, but ideally both strategies should be combined to achieve the athlete's full potential.

The study by da Acosta et al. (2019) focuses on the effects of isometric training in women, the results show that isometric training can increase strength in multiple gestures, although the difference is not statistically significant ($p = 0.33$), "Azeem and Zemková (2022) reported an increase in BMI by 1.96 %, increase in squat strength 7.80 %, increase in squat tolerance 6.92 %, increase over endurance 6.99 %, the increase in strength was similar to isotonic training."

Wu's study (2022) introduces the concept of "superisometric" training, which combines isometric exercises with isotonic exercises, the results show that this type of training can increase gestural strength, although the difference is not statistically significant ($P > 0.05$). This suggests that superisometric training may be an effective way to improve strength, but more research is needed to confirm these findings.

The study by Wagner et al. (2022) also compares isometric training with isotonic training, but uses continuous assessments to monitor participants' response to training, the results show that isometric training is more effective than isotonic training for increasing strength, this suggests that isometric training may be more effective for improving maximal strength, especially when an individualized training protocol is used.

The study by Jacob et al. (2018) focuses on the effects of isometric training on maximal strength and lower limb strength, the results show that isometric training can increase maximal strength and lower limb strength, especially when using squats at

different depths. This suggests that isometric training may be an effective way to improve strength in specific exercises.

Overall, it is inferred that the studies presented in the table suggest that isometric training may be as effective as isotonic training in improving muscle strength, however, isotonic training may have an advantage in terms of increasing BMI and improving tolerance and endurance. However, as mentioned, isometric training appears to be more effective in improving maximal strength, especially when an individualized training protocol is used.

It is important to keep in mind that the studies presented in the table have some limitations, for example, some studies have small samples, which may limit the generalizability of the results. In addition, some studies do not include a control group, which makes it difficult to determine the effectiveness of isometric training.

Despite these limitations, the studies presented in Table 1 provide solid evidence that isometric training can be an effective way to improve muscle strength, coaches and physical trainers may consider including isometric exercises in their training programs to improve the strength of their players.

Finally, the studies presented in the table suggest that isometric training can be a valuable tool for improving muscle strength in a variety of populations, coaches, physical trainers and physical therapists can consider including isometric exercises in their training programs to optimize the strength of their athletes and patients, ongoing research in this field is essential to optimize training protocols, identify the most effective exercises and determine the athlete populations that may benefit most from this type of training. Interdisciplinary collaboration is essential to translate research into practice to ensure that athletes receive the best possible care.

Thus, the studies presented in the table provide solid evidence that selective isometric training can be an effective tool to improve the performance of the lower body in athletes, the inclusion of this type of training in their programs can optimize the performance of soccer players, this strengthening modality is presented as a promising training tool to improve the performance of the lower body in athletes along with its potential for rehabilitation and injury prevention, making it a valuable element for sports physiotherapists.

As research in this field continues to advance, it is likely that new applications and benefits of selective isometric training will be discovered, allowing athletes to reach their maximum performance potential.

Conclusions

The studies analyzed converge in pointing to isometric training as an effective modality for the development of muscular strength, comparable in many cases to isotonic training. Nevertheless, a possible advantage of isotonic training in the promotion of hypertrophy and cardiovascular endurance is evident; the specificity of isometric training, particularly when adapted to individual needs and used in specific exercises such as the squat, highlights its potential for the improvement of maximal strength.

The variability in the training protocols and populations studied, however, underscores the need for further research to consolidate these findings and delineate the optimal applications of each training modality, the feasibility for future research in this field appears broad and promising, it is imperative to conduct studies with larger and more diverse samples, including equal representation of both genders, along with a wider age range, to increase the generalizability of the results.

In addition, the exploration of superisometric training protocols and the direct comparison of different isometric and isotonic training protocols, using continuous and objective evaluations, could shed light on the variables that optimize strength and endurance gains, likewise, research on the application of isometric training in injury rehabilitation and injury prevention, considering the individuality of each athlete and the specific sport context, is presented as an area of great relevance and potential impact.

Acknowledgments

The authors wish to express their gratitude to the Universidad Técnica Particular de Loja for its valuable support, both to the faculty and students, facilitating their participation and making this review possible.

Conflict of Interest

The authors declare that they have no conflicts of interest.

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