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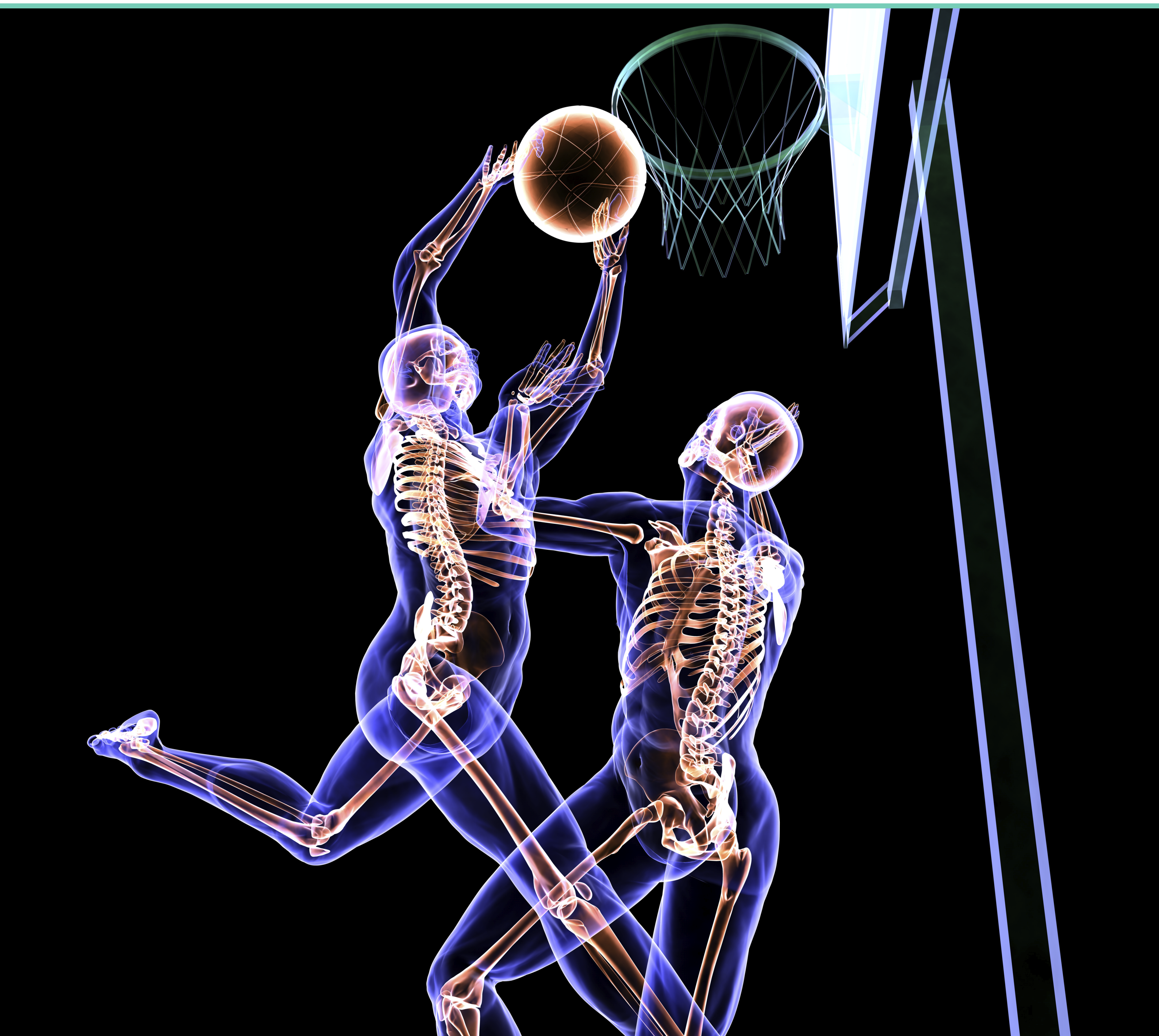

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SUMARIO / SUMMARY / RESUMO

Editorial

The studies published in this issue cover different areas within physical activity and sport. MLS Sport Research aims to publish original research and review articles in basic, applied and methodological areas that contribute to progress in the field of Physical Activity and Sport Sciences.

The first article is entitled "Strategies for the improvement of symptomatology in Achilles tendinopathy in athletes". The aim of this study was to establish the optimal strategies for the recovery of Achilles tendinopathy in the field of physical activity and sport. In this study, articles extracted from the PubMed database were reviewed, selecting all those articles written in English, carried out on injured subjects with Achilles tendinopathy and who were in the rehabilitation period. All the strategies analyzed proved to be beneficial for the recovery of Achilles tendinopathy, reducing symptomatology, pain and dysfunction in an injured person. However, heavy slow resistance seemed to be the one that provided the best results on the study population, over eccentric and isometric training.

The second study is entitled "Effect of proprioceptive training to prevent fall risk in older adults". The objective of this research was to determine the effectiveness of proprioceptive training in preventing the risk of falls in older adults aged 65 years. The conclusions derived from the study were that proprioceptive training is effective in improving static/dynamic balance, gait speed and lower extremity strength in older adults aged 65 years residing in a nursing home.

The next of the studies deals with "Fatigue monitoring: a case study in women's professional boxing". The objective of this research was to present a model for monitoring fatigue that could be used in Boxing, so that coaches have a tool to control their athletes during the training and tuning process.

The fourth study is entitled "Application of the continuous variable method in the planning of dance therapy classes for the improvement of the participants' endurance". The general objective of this project was to design a proposal for the application of the continuous variable method in dance therapy classes to improve endurance.

The issue of the journal is completed with a systematic review with the title "Systematic review on speed improvement in U-19 soccer players". The objective of this study was to compare and analyze the effectiveness of different training methodologies for speed improvement in U-19 soccer players. Using the PRISMA statement, a literature search was performed using the PubMed database. We included articles that were intervention studies written in Spanish or English, conducted in players aged 10 to 19 years, that had at least one plyometric, strength or sprint training method for speed improvement and that had an evaluation of sprinting. The results of the interventions showed benefits in the improvement of speed through the plyometric method in 20 m test, explosive strength in 5 m test and sprint in 20 m test. It can be concluded that the explosive strength method obtains greater benefits in short distances (5-10 m) when low intensities are used and in 17-year-old players, the ideal training volume is 2 sessions per week. The sprint method over longer distances (20-30 m) at ages 14-15, with a training volume of one or two sessions per week. Plyometrics achieves the same benefits over short and long distances (5-30 m) for ages 15-16 years and without notable differences in training volume.

Dr. Álvaro Velarde Sotres
Editor-in-Chief

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SYSTEMATIC REVIEW: STRATEGIES FOR THE IMPROVEMENT OF SYMPTOMATOLOGY IN ACHILLES TENDINOPATHY IN ATHLETES

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Summary. Achilles tendinopathy (AT) is one of the most common injuries among athletes, causing pain and impairment of tendon capabilities, as well as inflammation of the tendon body. This has a very high cumulative incidence, especially in elite athletes, and its main injury mechanism is the excessive load on the tendon accompanied by a short recovery period between loads. The risk factors that most influence this pathology are external, with internal factors also having relevance. Thus, the main objective of this review was to determine the optimal strategies for the recovery of Achilles tendinopathy in the field of physical activity and sport. In this work, articles extracted from the PubMed database were reviewed, selecting all those written in English, carried out on subjects injured with AT and who were in the readaptation period. All articles prior to 2010 were excluded. All the interventions performed in the different studies pointed to physical exercise as a very positive tool in the treatment of AT, with the most significant improvements being the reduction of tendon pain, improvement in functional capacities and an increase in the level of post-intervention satisfaction. In view of the results, eccentric and isometric training has proven to be beneficial for AT recovery, reducing symptomatology, pain and dysfunction in an injured person. However, heavy slow resistance (HSR) was the strategy that provided the best results on the study population.

Key words: Protocol, rehabilitation, pain, treatment, sport, health, tendon.

REVISIÓN SISTEMÁTICA: ESTRATEGIAS PARA LA MEJORA DE LA SINTOMATOLOGÍA EN TENDINOPATÍA AQUÍLEA EN ATLETAS

Resumen. La tendinopatía aquílea (TA) es una de las lesiones más comunes entre los atletas, produciendo dolor y deterioro de las capacidades del tendón, así como inflamación del cuerpo tendinoso. Esta presenta una incidencia acumulada muy alta, sobre todo en atletas de élite, y tiene como principal mecanismo lesional el exceso de carga sobre el tendón acompañado de un escaso periodo de recuperación entre cargas. Los factores de riesgo que más influencia tienen en esta patología son los externos, teniendo también relevancia los factores internos. Así, el principal objetivo de esta revisión fue determinar las estrategias óptimas para la recuperación de una tendinopatía aquílea desde el ámbito de la actividad física y el deporte. En este trabajo, se revisaron artículos extraídos de la base de datos PubMed, seleccionando todos aquellos redactados en inglés, llevados a cabo sobre sujetos lesionados con TA y que se encontrasen en periodo de readaptación. Se excluyeron todos los artículos previos a 2010. Todas las intervenciones realizadas en los diferentes estudios señalaron el ejercicio físico como una herramienta muy positiva en el tratamiento de la TA, siendo las mejoras más significativas la reducción del dolor del tendón, la mejora en las capacidades funcionales y un aumento del nivel de satisfacción post intervención. A la vista de los resultados, el entrenamiento excéntrico e isométrico ha resultado ser beneficioso para la recuperación de una TA, reduciendo la sintomatología, el dolor y la disfunción en una persona lesionada. Sin embargo, la resistencia lenta pesada (HSR) fue la estrategia que mejores resultados proporcionó sobre la población de estudio.

Palabras clave: Protocolo, readaptación, dolor, tratamiento, deporte, salud, tendón.

Introduction

Athletics is a sport that brings together running, jumping and throwing disciplines, among others, and whose difficulty lies in overcoming the opponent in speed and endurance.

Tendinopathy is one of the most common injuries in athletes (Pavone et al., 2019)especially in those who practice middle-distance events. Some of the most common tendinopathies are patellar tendinopathy, tensor fascia latae tendinopathy and goosefoot tendinopathy. Above all of them, Achilles tendinopathy stands out as the injury with the highest incidence in these athletes (Soidán and Giráldez, 2003).

In elite runners the cumulative incidence of Achilles tendinopathy is about 52%, these athletes also have a ratio of 6.1 injuries per 1,000 hours of racing (Lagas et al., 2020).

The Achilles tendon is the largest and strongest tendon in the human body. This is in charge of connecting both soleus and gastrocnemius (internal and external) to the calcaneus bone, located in the rear part of our foot. This set of structures is the so-called triceps suralis (Doral et al., 2010). The Achilles tendon does not end here, but continues through the plantar aponeurosis (Tenforde et al., 2016) and fundamentally carries out plantar flexion of both the foot and ankle.

Achilles tendinopathy is characterized by pain and impairment of the tendon's capabilities, as well as inflammation of the tendon body (Maffulli et al., 2020; Shakked and Raikin, 2017).

The fundamental injury mechanism in this pathology is the excess load on the tendon (Murtaugh and Ihm, 2013) and a short recovery period between loads. Excessive load on the tendon produces a reactive tendinopathy, which with increasing load leads to tendinosis, in which there is already tissue degeneration. Finally, reactive tendinosis occurs when the tissue is already severely affected (Rudavsky & Cook, 2014).

In relation to risk factors, it has not been determined that genetic aspects may have special relevance in the appearance of this pathology. Genetic contributors to collagen formation and tendon homeostasis might have some relationship but the results are ambiguous (van der Vlist et al., 2019).

Extrinsic risk factors are commonly known as those that have the highest incidence in an athlete's Achilles tendinopathy (volume of kilometers, number of sessions, running terrain, etc.). However, the most common is the combination of both extrinsic and intrinsic factors in the appearance of this pathology. Some of the most common intrinsic factors include: muscle strength, flexibility, previous injuries, age, body weight, and tendon temperature among others (Magnan et al., 2014).

Athletics is a cyclic sport in which the lower extremities are predominantly involved, especially the foot and all its joints (subtalar, metatarsophalangeal and ankle, among others). This type of athlete tends to have a limited range of passive dorsiflexion of the ankle joint, as well as reduced mobility in the subtalar joint. All this is a predisposing factor for injuries such as Achilles tendinopathy (Kvist, 1994) (Kvist, 1994).

The principle of progressive overload is the progressive increase of strain on the body during physical training (Haugen et al., 2021). This principle improves physical condition and reduces the risk of injury.

Therefore, the aim of the present review is to determine the optimal strategies for the rehabilitation of Achilles tendinopathy.

Method

For this review, a document search was conducted between February and the deadline of May 6, 2022. The Pubmed database was searched for articles using keywords such as tendinopathy, Achilles, eccentric work, runners, mobility, proprioception and isometric.

The Boolean operators used for the search were "and" and "or" and the search was conducted in English, discarding all articles prior to 2010.

Inclusion criteria were selected from studies carried out on injured subjects with Achilles tendinopathy who were in the process of readaptation. These articles had to be published from 2010 onwards choosing randomized control trials, clinical studies and clinical trials.

As exclusion criteria, all articles that were not original and were published before 2010 were excluded.

Results

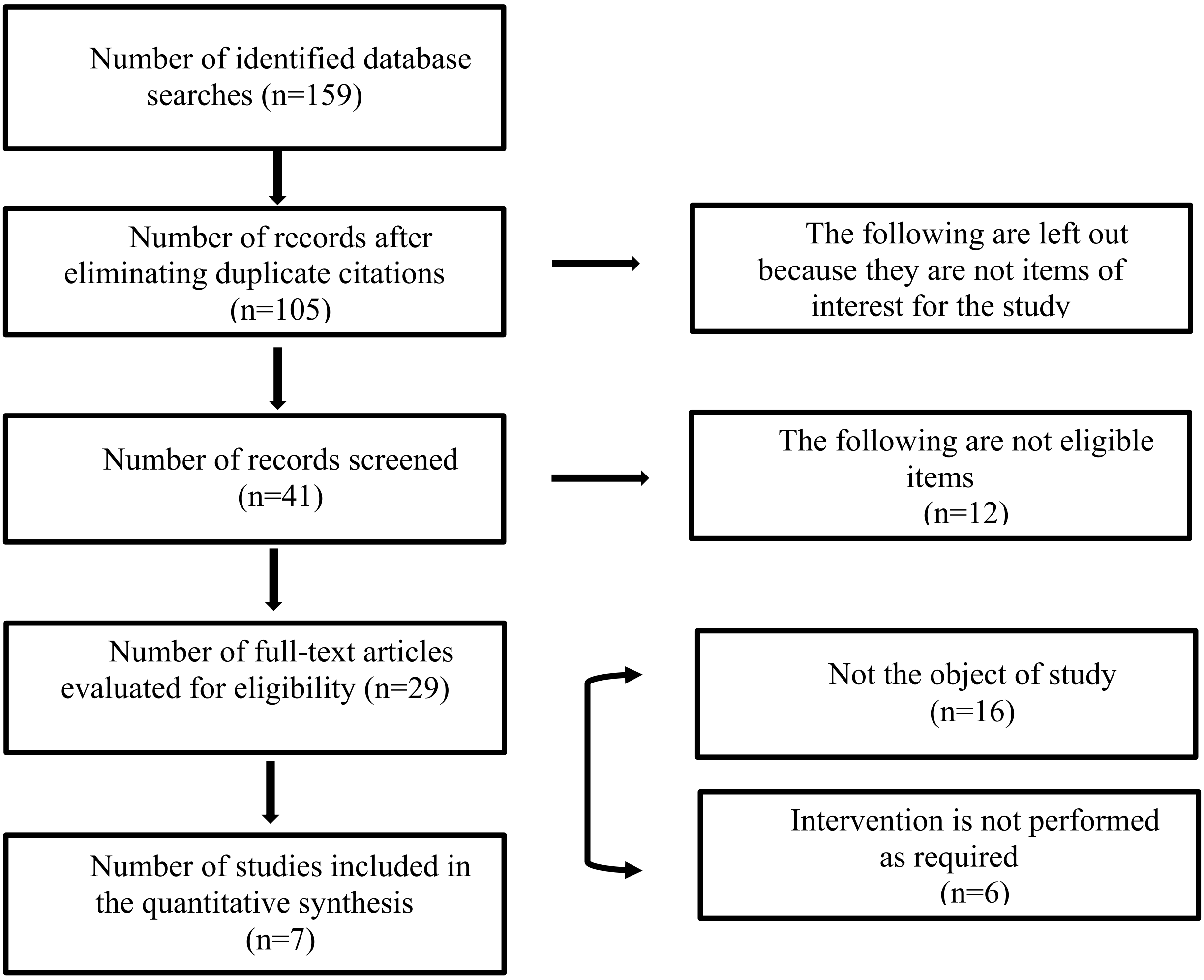

Figure 1. Flowchart

Table 1

Description of intervention studies

AUTHOR AND YEAR	POPULATION AND SAMPLE	INTERVENTION	TOOLS	RESULTS
Stasinopoulos and Manias (2012)	N=41 Stanish Group n=21 Alfredson Group n=20 All of them are recreational athletes between 35 and 55 years of age	12 weeks **Stanish Group**: 3x10reps eccentric 1x10reps 1x/day 6 weeks. 3x10reps eccentric 3 times a week for 6 more weeks with 2 min rest between sets in both. **Alfredson Group:** 3x15reps at slow speed, 2min rest between sets, 2 times a day 7 days a week. Heel descent with knee extended and flexed. Use uninjured leg for initial position.	VISA-A Questionnaire	Increase in VISA-A score in both groups compared to baseline (P<0.05). There were significant differences in the VISA-A score between groups at the end of treatment and at 6-month follow-up. Alfredson's exercise program group produced the greatest benefit (P<0.0005)
Stevens, Tan (2013)	N=28 Alfredson Group n=15 Group "les volume" n=13	6 weeks **Alfredson Group**: 3x15reps 2 times a day with knee extended and flexed, 180reps total. (heel falls) **Group "less volume"**: Heel drops were performed 2 times a day trying to reach a volume similar to the first group. They could choose the volume of repetitions that was tolerable.	VISA-A Questionnaire Visual Analog Scale VAS Treatment satisfaction	VISA-A: There is a significant improvement in both groups. Two statistical tests were carried out, with significant differences at 3 weeks, with the Alfredson group being worse (P=0.004/P=0.007), but no significant differences were found at 6 weeks. VAS: There is a significant improvement in the two groups, but no significant difference between groups. Treatment satisfaction: There is no significant difference between groups.
Yu, Park, Lee (2013)	N=32 Eccentric strengthening group n=16 Concentric strengthening group n=16	8 weeks **Eccentric group**: 3x15reps, 30sec rest between sets, with 10sec of ex. time (exercises) **Concentric group**: 3x15reps, 30sec rest between sets. (different exercises)	Visual Analog Scale VAS Biodex system Muscular strength and endurance (Amato el al and Thelen et al) Biodex balance system	Pain: Pain decreased significantly in both groups (P<0.5) with the decrease in pain being significantly higher in the eccentric group. Muscular strength and endurance: muscular strength in knee extension and plantar and dorsal flexion of the ankle improved significantly in the eccentric group (P<0.05).

	All of them were men in their 20s and 30s.		Side-step test	Plantar flexion strength improved significantly in the eccentric group and dorsal flexion strength improved in both groups, being significantly higher in the eccentric group.
Beyer et al. (2015)	N=44 ECC group n=24 HSR group n=20 All of them were amateur athletes between 18 and 60 years of age.	12 weeks **ECC Group**: 3x15reps 2 times a day 7 days a week, 3sec reps, 2min rest between sets 5min between ex. Unilateral eccentric on injured leg on step with knee extended and flexed. **HSR Group**: 3 times per week. Same rest protocol as in ECC. - Machine heel raise (seated position and bent knee) - Press heel raise (knee extended) - Multipower heel raise (knee extended) From week 1 to week 12 the MRs go from 15 to 6. All ej were performed at maximum ankle ROM.	VISA-A Questionnaire Visual Analog Scale (VASh) and (VASr) Ultrasound	Both groups showed significant improvements in VISA-A (P<0.0001) and VAS from 0 to 12 weeks and were maintained until revision at week 52. There is no significant difference between groups, with both presenting similar improvements. There was a reduction in tendon thickness in both groups, with no significant difference between the two groups. Patient satisfaction with clinical outcome at 12 weeks was ECC (80%) and HSR (100%); at 52 weeks follow-up, ECC (76%) and HSR (96%)
Van der vlist et al (2020)	N=91 Group1 n=24, isometrics with ankle in plantar flexion Group2 n=18, isometrics with the ankle in dorsiflexion Group3 n=24, isotonic exercises Group4 n=25, rest.	Group 1 Group 2 Group 3 Group 4 Hip 90º 90º 90º 90º Sitting Knee 90º 90º 90º 90º 90º 90º Ankle 20º 10º 0-20º 2x45" 2x45" 2x45" 2x15reps Rest Hip 0º 0º 0º 0º Standing Knee 0º 0º 0º 0º 0 Ankle 20º 10º 0-20º 3x45" 3x45" 3x15reps Recovery times between exercises were 2min.	Visual Analog Scale (VAS) 10 unilateral jumps before and after the tests analyzed with VAS RPE	There was no significant reduction in pain in the 10-jump test after performing any of the 4 interventions. There were also no differences between the groups after the interventions.

Gatz et al. (2020)	N=30 Group EE n=15 EE+ISO Group n=15	12 weeks **EE Group** 3x15 2 times a day (on tiptoe on injured leg lowering heel below step, except for patients with insertion AT). Use uninjured leg to return to initial position. **EE+ISO Group**: EE protocol equal to group 1 and ISO protocol 5x45sec once a day, in 3 levels (passing from level to level in the absence of pain).	Ultrasound Numerical scales: VISA-A AOFAS Linkert Roles and Mandsley	Both groups improved significantly, but there were no significant interindividual differences (VISA-A; P=0.362) between the EE group and the EE+ISO group.
Bradford el al. (2021)	N=11 Group (first extension) n=6 Group (bending first) n=5 Nine men and two women participated.	12 weeks **First extension group**: 5 isometric plantar flexion contractions of 45sec duration at 70% of your MVIC with 2 min rest between sets. **Flexion group first**: performed the same protocol as group 1. Exercises: - Isometric plantar flexion of ankle (10º of dorsiflexion) with knee extended - Isometric plantar flexion of the ankle with the knee flexed to 80º - Position: seated, hip at 60º, lateral malleolus aligned with dynamometer lever arm. Isokinetic dynamometry to measure contractions.	Numerical Pain Rating Scale (NPRS)	GEE showed that there was no significant effect of knee position or exercise order on the percentage change in pain at the completion of isometric plantar flexion. However, although not significant (P=0.110) isometric plantar flexion in knee extension appeared to provide a 20% greater pain reduction compared to isometric plantar flexion in knee flexion.

Discussion and conclusions

The treatment of Achilles tendinopathy from a non-medical perspective is currently of great relevance. As noted by Silbernagel et al. (2020) in the treatment of this injury, from a conservative point of view, the process with the highest level of evidence is undoubtedly exercises. These provide mechanical load to the tendon and stimulate its remodeling, reduce pain and improve the strength and function of the calf muscles.

As we can see in the previous section, none of the exercise protocols described for the treatment of Achilles tendinopathy exerts adverse effects on the Achilles tendinopathy (Aicale et al., 2020) (Aicale et al., 2020). On the contrary, the populations on which the study is carried out always report an improvement in post-intervention pain as we can see in the VISA-A tests of Beyer et al. (2015) among others.

The physiological characteristics that both eccentric and isometric work produce in the muscle-tendon structure are mainly the ability to increase tendon compliance, less displacement of the myotendinous junction or reduce the elongation of the muscle fascicles.

As for the adaptations at the neural level, there is a change in the recruitment of motor units, increased excitability of motor neurons and an increase in inhibitory feedback, also increasing inflammatory sensitivity. Finally, remodeling also occurs in the extracellular matrix, stimulating the production of type 1 and 2 collagen, as well as the alignment of collagen fibers (Hyldahl et al., 2017).

There are no optimal loading factors for the tendon (Silbernagel et al., 2020)which seems to respond quite similarly, both to high loads (6RM) with a lower number of repetitions throughout the week, and to lower loads and more prolonged in time, as we see in the study of Beyer et al. (2015) in relation to pain. However, the level of patient satisfaction is higher in the case of heavy slow resistance (HSR). However, in this study by Beyer et al. (2015) long-term follow-up beyond 52 weeks is not included, so additional studies that include it are needed.

On the other hand Yu et al. (2013) maintains that, for pain reduction and improved function in patients with Achilles tendinopathy, eccentric load strengthening is more effective than concentric load strengthening. In this study by Yu et al. (2013), the eccentric protocol underwent a progressive increase in loads over the weeks, while the concentric program did not undergo this progressive increase, a factor that may be a determining factor for this improvement.

Another factor that has been studied to aid in the recovery of Achilles tendinopathy is isometric work (Silbernagel et al., 2020). However, throughout the development of this review it is observed that it does not improve when combined with eccentric exercise (Gatz et al., 2020) (Gatz et al., 2020). Additional studies comparing eccentric vs. isometric work in isolation are needed to see the benefits of each. However, van der Vlist et al. (2020) which develops a study of isometric and isotonic exercises does not show a significant reduction in post-intervention pain, nor a significant reduction in pain between groups. Although in this study there is a correct progression of the loads, when the RPE is less than 7, the weight of the exercises is increased.

Continuing with isometric exercise, Bradford et al. (2021) proposes that isometric exercise in isolation does provide improvements in Achilles tendinopathy and above all by performing exercises in knee extension, above all exercises carried out with knee flexion.

According to Jayaseelan et al. (2019) eccentric exercise provides great improvements in people suffering from Achilles tendinopathy. In the study conducted by Stasinopoulos & Manias (2013) we see how an eccentric work protocol based on a high volume of repetitions such as Alfredson's which is carried out morning and evening and with a higher volume of repetitions, produces greater improvements than Stanish's protocol which is only carried out once a day for 6 weeks and 3 times a week for a further 6 weeks.

Also Beyer et al. (2015) uses Alfredson's protocol in his work, but in this case he compares it with the HSR (heavy slow resistance) protocol, obtaining superior improvements in the level of satisfaction of his patients

For their part, Stevens & Tan (2014) compared Alfredson's protocol, mentioned above, with a similar one in which the difference lies in the fact that patients do not have to perform the full volume of repetitions involved in Alfredson's protocol, but that patients can choose the volume of repetitions that is tolerable. A significant difference was observed at week 3 in favor of the "less volume" group. At week 6 there are no differences between groups and both groups improve.

Finally, the main limitation encountered when carrying out the review was not being able to carry out the study on a specific population, for example, middle-distance athletes.

As future lines of research, it is interesting to know how the symptomatology of the lesion is altered at the moment when the protocol ends and the different patients stop performing the exercises, beyond the 1-year follow-ups that we can see in the studies.

Finally, it is concluded that eccentric and isometric training has positive effects on Achilles tendinopathy, reducing pain, improving the functional capacities of the different patients, as well as influencing their level of satisfaction. In view of the results, the slow heavy resistance seems to be the one that has provided the best results in the study population. In short, all the exercises mentioned are appropriate strategies when dealing with a patient with Achilles tendinopathy in the process of readaptation to physical sports activity.

that all the methods of readaptation seen throughout the review have positive effects on Achilles tendinopathy, reducing pain, improving the functional capacities of the different patients, as well as influencing their level of satisfaction. In view of the results, heavy slow resistance seems to be the one that has provided the best results on the study population, above eccentric or isometric work. In short, all the exercises mentioned above are appropriate strategies when dealing with a patient with Achilles tendinopathy in his or her process of readaptation to physical sports activity.

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EFFECT OF PROPRIOCEPTIVE TRAINING TO PREVENT FALL RISK IN OLDER ADULTS

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Summary. Introduction: Falls are considered one of the most important geriatric syndromes due to their high incidence in adults over 65 years of age. Falls can generate diverse and important physical and/or psychological consequences, functional deterioration, dependence and even death. Objective: To determine the effectiveness of proprioceptive training to prevent the risk of falls in older adults aged 65 years old living in a nursing home at km 1 via Dapa, Valle del Cauca. Methodology: A quasi-experimental cross-sectional research was conducted, with a non-probabilistic sample consisting of 12 women and 3 men over 65 years of age residing in a nursing home, voluntarily participating in a 6-week proprioceptive training, twice a week during the months of March and April 2021. The feasibility of the proprioceptive exercises proposal was validated using the nominal group research technique. The results included the Short Physical Performance Battery (SPPB) and Timed up and go (TUG) tests evaluated pre- and post-intervention. Results: There were significant differences in the level of functionality pre post intervention, ($p<0.05$), the two variables (level of fall risk and level of functionality) correlate inversely ($p<0.05$). Conclusions: Proprioceptive training is effective in improving static/dynamic balance, gait speed, and lower extremity strength in nursing home-dwelling adults 65 years of age and older.

Key words: Prevention; Prevention; Fall; Proprioception; Older adults; Rehabilitation.

EFECTO DE UN ENTRENAMIENTO PROPIOCEPTIVO PARA PREVENIR EL RIESGO DE CAÍDA EN ADULTOS MAYORES

Resumen. Introducción: Las caídas se consideran como uno de los síndromes geriátricos más importantes por su alta incidencia en los adultos mayores de 65 años. Las caídas pueden generar diversas e importantes consecuencias físicas y/o psicológicas, deterioro funcional, dependencia e incluso la muerte. Objetivo: Determinar la efectividad del entrenamiento propioceptivo para prevenir el riesgo de caídas en el adulto mayor de 65 años residente en un hogar de reposo en el km 1 vía a Dapa, Valle del Cauca. Metodología: Se realizó una investigación cuasiexperimental de corte transversal, con muestra no probabilística constituida por 12 mujeres y 3 hombres adultos mayores de 65 años residentes en un hogar de reposo, participando de manera voluntaria en un entrenamiento propioceptivo de 6 semanas, dos veces a la semana durante los meses de marzo y abril de 2021. La factibilidad de la propuesta de ejercicios propioceptivos se validó a partir de la técnica de investigación grupo nominal. Los resultados incluyeron las pruebas Short Physical Performance Battery (SPPB) y Timed up and go (TUG) evaluadas pre y post intervención. Resultados: Hubo diferencias significativas en el nivel de funcionalidad pre- post intervención, ($p<0,05$), las dos variables (nivel de riesgo de caída y nivel de funcionalidad) se correlacionan en sentido inverso ($p<0,05$). Conclusiones: El entrenamiento propioceptivo es efectivo para mejorar el equilibrio estático/dinámico, la velocidad de la marcha y fuerza de extremidades inferiores en los adultos mayores de 65 años que residen en un hogar de reposo.

Palabras clave: Prevención; Caída; Propiocepción; Adultos mayores; Rehabilitación.

Introduction

Aging is a universal, irreversible and individual process that causes physiological changes in the different systems of the human being, among them: the musculoskeletal system, central nervous system and sensory systems; in addition, it has been demonstrated that as we age the risk of presenting various types of pathologies and medical alterations increases, all this causes a greater risk of presenting falls, being a public health problem, and one of the great geriatric syndromes, due to the high costs in the health system and functional complications that they represent in the elderly; unfortunately all these aspects constitute one of the main causes of morbidity and disability in this population.

This chapter aims to put into context this problem in this group of people, starting from the identification of the situation at the national level, the research that evidences the complications due to the aging process, the strategies to prevent and/or avoid further complications and the importance of the implementation of proprioceptive exercises as a strategy to promote the prevention of the risk of falling in older adults.

In Colombia, according to figures from the Ministry of Health and Social Protection (Cubillos, Matamoros, & Perea, 2020), eight out of ten older adults suffer more than one disease; example of this, diseases in the nervous and musculoskeletal system that can cause alterations in gait and, predispose a fall, according to data from research conducted by (Jaramillo-Losada, Gómez-Ramírez, & Calvo-Soto, 2020), the total prevalence of falls of the elderly during the last year was 31.9%; among adults who had already had falls in the last year, approximately, according to them, half were recurrent, increased in women and with age, In addition to this, locomotion capacity tends to decrease progressively and the alteration of gait and balance capacity in older adults is a predictor not only of functional impairment but also of frailty and restrictions in social participation.

It has been proven that aging leads to a natural biological degeneration in terms of strength, muscle mass and neurological functions. Likewise, it is evidenced that the fear of presenting a fall can change the gait parameters compared to people who do not fear falling, as exposed (Romano- Durán, Rodríguez -Camarero, & Martínez-Esparza, 2017) as well as it is also evidenced that those adults older than 65 years who perform some type of activity combined with all types of exercise (aerobic, muscle strengthening, balance training) have proven to be effective in preventing falls. (Bull, Al-Ansari, & al., 2020).

The changes brought about by the aging process have negative effects in terms of mobility, strength and autonomy in the older adult. As mentioned by (Garatachea & Torres, 2021), complications in the musculoskeletal system are generated due to various factors such as: central nervous system, muscle tissue, hormonal levels and lifestyle, this last aspect can be modifiable if 150-300 minutes of aerobic physical activity of moderate or vigorous intensity per week are performed, as mentioned by (Bull, Al-Ansari, & al., 2020), guidelines that can be added to activities aimed at strengthening balance, coordination and muscle strengthening; in that same research, these authors ensure that there is "high evidence showing that functional and balance exercises reduce the rate of falls"; research that resembles those conducted by (Cando-Macas & Fiallos-Holguín, 2019); (Anzatuña- Romero & Figueroa- Figueroa, 2016); (Huerta- Villar, 2018) and (Cabrera -Rivadeneyra & Rios, 2021), who conclude that there is a statistically significant difference between the risk of falling before and after performing proprioceptive training so older adults improve their independence in performing activities of daily living, proprioceptive exercises stimulate the muscle spindle, helping the perception and execution of body movements, contributing to improve balance and therefore, favor the prevention of falls in this group of people.

Prevention is the most efficient and least costly measure to prevent any event affecting a person's health status. Balance as a modifiable factor through a proprioceptive exercise program is a key aspect in the prevention of this adverse event.

Although the factors associated with falls in the elderly are multifactorial in nature (some may be more preventable than others), there is a need to apply practical interventions that are approached from a preventive context and, if necessary, minimize the risk of adverse events that lead to loss of functionality and reduce the quality of life of the elderly.

Therefore, the aim of this study was to investigate the effects of proprioceptive training on the level of fall risk and level of functionality assessed with the TUG and SPPB tests (respectively) pre- and post-intervention in 15 older adults aged 65 years and older residing in a nursing home.

Method

As mentioned above, this study was categorized as a quantitative methodology research, quasi-experimental subcategory and cross-sectional. The research was conducted during the months of March and April 2021.

Design

The nominal group technique was developed, in charge of 10 professionals, to determine the relevance of the exercises to be included in the proprioceptive training, taking into account that the exercises would not be performed with any type of external implement (hoops, cones, balls, among others), this in order to generate greater ease of learning the exercises in older adults and to be included in a regular physical exercise session. After each member presented the exercises, a socialization was carried out with their respective qualification, being 1 a low complexity qualification and 5 as very high complexity, to obtain the authorization and execute the intervention proposal. Older adults were invited to participate in such training after discussion and approval of the exercises; each participant was shown a visual support material of the tests and provided with written informed consent to participate voluntarily. Each participant was assigned a number according to the order of arrival at the time of evaluation.

After the analysis at the end of the study, the older adults received an individualized report in plain language detailing the results of each test (TUG /SPPB), their level of functionality and possible fall risks based on those results. Thus, a proprioceptive exercise intervention was carried out for 6 weeks to older adults aged 65 years who would reside in a nursing home at Km1 via Dapa (Valle del Cauca-Colombia). Data collection was performed at two points in time: before and after proprioceptive training, in order to compare and evaluate the changes recorded pre/post intervention.

Participants

Men and women over 65 years of age residing in a nursing home were recruited, followed by an analysis and observation of possible participants, with the staff of the institution, taking into account the inclusion and exclusion criteria, so this study was considered as a non-probabilistic sample.

Inclusion criteria were: (1) Men and women over 65 years of age, (2) older adults oriented in their three mental spheres (space, place, time) and the exclusion criteria were: (1) adults with any type of recent pathology (last 6 months) that contraindicates exercise and (2) older adults with any type of disability (hearing, visual and/or physical). The final research sample size was 15 older adults, 12 women and 3 men; all of them agreed to participate voluntarily by signing the corresponding informed consent form.

Intervention

The 6-week proprioceptive training protocol was designed to prevent fall risk in the older adult. Participants assigned to the intervention were asked to complete two sessions per week. In weeks 1 and 2, with a difficulty level of 1 and 2 according to the nominal technique, the following exercises were performed:

- Bipodal support (legs at shoulder height), upper limb support and eyes open.
- Bipodal support (legs in semi-tandem position) upper limb support and eyes open.
- Bipodal support (feet together) upper limb support and eyes open.
- Bipodal support (legs at shoulder height), upper limb support and eyes closed.
- Bipodal support (legs in semi-tandem position) upper limb support and eyes closed.
- Bipodal support (feet together) upper limb support and eyes closed.
- Bipodal support, left upper limb support, flexion and extension movement of the right upper limb and eyes closed.
- Bipodal support, right upper limb support, flexion and extension movement of the left upper limb and eyes closed.

- Bipodal support, left upper limb support, right upper limb abduction movement and eyes closed.
- Bipodal support, left upper limb support, right upper limb abduction movement and eyes closed.

Training volume: 1 set and 8 repetitions of each exercise; frequency: 2 days a week. march 2,4,9 and 11. Intensity: Modified Borg scale. Execution time of the exercises: 20 minutes *Methodological orientations: Guidance was given on the importance of unloading the weight of the body on both lower extremities. The older adult was advised that until he/she felt confident in the exercise position, he/she should not perform the upper extremity movement.

In week 3, with a difficulty level of 3, according to the nominal technique, the following exercises were performed:

- Full support of the left foot, support only with the forefoot (toes) of the contralateral limb, support of the right upper limb and eyes open.
- Full support of the right foot, support only with the forefoot (toes) of the contralateral limb, support of the left upper limb and eyes open.
- Full support of the left foot, support only with rearfoot (heel) of the contralateral limb, support of the right upper limb and eyes open.
- Full support of the right foot, support only with rearfoot (heel) of the contralateral limb, support of the left upper limb and eyes open.
- Full support of the left foot, support only with the forefoot (toes) of the contralateral limb, support of the right upper limb and eyes closed.
- Full support of the right foot, support only with the forefoot (toes) of the contralateral limb, support of the left upper limb and eyes closed.
- Full support of the left foot, support only with the rearfoot (heel) of the contralateral limb, support of the right upper limb and eyes closed.
- Full support of the right foot, support only with the rearfoot (heel) of the contralateral limb, support of the left upper limb and eyes closed.

Training volume: 1 set of each lower/upper limb, 10 repetitions of each exercise. Frequency: 2 days a week: march 16 and 18. Intensity: Modified Borg scale, Time of execution of the exercises: 18 minutes *Methodological guidelines: Guidance was given on the importance of unloading the weight of the body on both extremities, and then closing the eyes.

In week 4, with a difficulty level of 4, according to the nominal technique, the following exercises were performed:

- Left lower limb support, right knee flexed, eyes open and right upper limb support.
- Right lower limb support, left knee flexed, eyes open and left upper limb support.
- Left lower limb support, right hip flexed, eyes open and right upper limb support.
- Right lower limb support, left hip flexed, eyes open and left upper limb support.
- Left lower limb support, right knee flexed, eyes closed and right upper limb support.
- Right lower limb support, left knee flexed, eyes closed and left upper limb support.
- Left lower limb support, right hip extended without touching the floor, eyes closed and right upper limb support.
- Right lower limb support, left hip extended without touching the floor, eyes closed and left upper limb support.

Training volume: 2 sets, 10 repetitions of each exercise. Frequency: 2 days a week: march 23,25. Intensity: Modified Borg scale. *Execution time of the exercises: 20 minutes *Methodological orientations: The importance of fully supporting the foot (toe-heel) of the lower extremity that is fixed was emphasized. It was ensured that older adults (at the time of performing hip extension) the knee was in full extension.

In week 5, with a difficulty level of 5, according to the nominal technique, the following exercises were performed:

- Left lower limb support, right knee flexion/extension movement, upper limb support and eyes closed.
- Left lower limb support, left knee flexion/extension movement, upper limb support and eyes closed.
- Right lower limb support, left hip flexion/extension movement, upper limb support and eyes open.
- Left lower limb support, right hip flexion/extension movement, upper limb support and eyes closed.
- Left lower limb support, right knee and hip flexion movement, upper limb support and eyes closed.
- Left lower limb support, left knee and hip flexion movement, upper limb support and eyes closed.
- Left lower limb support, right hip abduction movement, upper limb support and eyes closed.
- Left lower limb support, left hip abduction movement, upper limb support and eyes closed.
- Left lower limb support, right hip external rotation movement, upper limb support and eyes closed.
- Left lower limb support, left hip external rotation movement, upper limb support and eyes closed.

Training volume: 2 sets and 10 repetitions of each exercise. Frequency: 2 days a week: april 30 and 1. Intensity: Modified Borg scale. Execution time of the exercises: 20 minutes *Methodological guidelines: Guidance was given on the importance of fully supporting the foot (toes-heel) before performing any movement. They were reminded of the importance of feeling secure in position to perform the exercise.

In the last week, with all levels of difficulty (from 1 to 5), according to the nominal technique, the following exercises were performed:

- Bipodal support, right upper limb support, flexion and extension movement of the left upper limb and eyes closed.
- Bipodal support, left upper limb support, right upper limb abduction movement and eyes closed.
- Full support of the left foot, support only with the rearfoot (heel) of the contralateral limb, support of the right upper limb and eyes closed.
- Full support of the right foot, support only with the rearfoot (heel) of the contralateral limb, support of the left upper limb and eyes closed.
- Left lower limb support, right hip extended without touching the floor, eyes closed and right upper limb support.
- Right lower limb support, left hip extended without touching the floor, eyes closed and left upper limb support.

- Left lower limb support, right hip external rotation movement, upper limb support and eyes closed.
- Left lower limb support, left hip external rotation movement, upper limb support and eyes closed.

Training volume: 2 sets, 12 repetitions of each exercise. Frequency: 2 days a week: april 6 and 8. Intensity: Modified Borg scale. Execution time of the exercises: 18 minutes.

Methodological guidelines: They were reminded about the importance of fully supporting the limb(s) before performing any movement. - Guidance was given on the importance of keeping the foot fixed and without ipsilateral knee flexion. They were reminded of the importance of feeling secure in position to perform the exercise.

In all 12 sessions of proprioceptive training, participants were supervised. Exercise progressions were only implemented when a given exercise was no longer challenging enough and/or when all older adults had learned the exercise and were performing it without methodological guidance. The duration of each session depended on the physical condition of the older adults and was modified according to individual considerations (physical condition, age, external assistance for walking).

Instruments

Prior to the start of each test, participants received written and verbal instructions and were allowed a practice run of each subtest. The instruments used were as follows:

Timed up and go test: used to assess the level of fall risk in older adults. Each participant was asked to get up from a chair, walk three meters, pass around a cone and return to the chair as quickly as possible. The indicators to determine if the older adult was at a low risk of falling were if the test execution time was less than 10 seconds, a time between 10 seconds and 20 seconds was categorized as a moderate risk of falling, and if the participant took more than 20 seconds to execute the test, he/she was categorized as a high risk of falling.

Guralnik Test/Physical Performance Battery: it was used to assess the level of functionality; the results of this instrument allowed the detection of frailty and the risk of disability in which the older adults were found. This battery made it possible to assess the older adults from three points of view: balance, gait speed and lower limb resistance. The balance test was evaluated in three positions: side by side (feet together), semi-tandem (toe of one foot at half the height of the other) and tandem (one foot in front of the other, touching the heel of one foot with the toe of the other). To assess balance, each participant was asked to perform (according to his or her condition) the three positions described above; to assess lower extremity endurance, each participant was asked to stand up and sit down from a chair (for 5 times) as quickly as possible ; if the older adult scored between 0 and 3 points he or she was categorized as having major limitations, with 4 to 6 points he or she was categorized as having a moderate limitation (frailty), 7 to 9 points as having a mild limitation (pre-frailty) and with a total score of 10-12 points the older adult was categorized as having no limitations.

Data analysis

Data collection was done through direct observation, and data were collected as the adults performed the tests; all analyses were coded using SPSS v.g. statistical software. A bivariate analysis was performed by applying means and standard deviations, categories and groups were described by frequency and percentages. The SPPB results were coded in the virtual calculator of the (Sociedad Española de Endocrinología y Nutrición., 2018) and subsequently the information was appended to the SPSS program for its respective analysis;

Since there were only 15 data, the Shapiro Wilk test was performed to determine whether the distribution of the data for the variables of the level of risk of falling and the level of functionality presented a normal distribution.

To compare the results of the evaluations before and after applying the proprioceptive training, a statistical analysis was performed with non-parametric tests, in this case, a Wilcoxon signed-rank test. Finally, Spearman's correlation coefficient was used to analyze the correlation between the variables proprioceptive training and the total score of the variables of level of risk of falling and level of functionality. An alpha level of 0.05 was adopted for all statistical tests.

Results

In total, 50 older adults reside in the nursing home, of whom 30 were chosen (according to the inclusion and exclusion criteria) to participate in the study. Finally, 15 adults over 65 years of age voluntarily agreed to participate in the study and performed 12 sessions of proprioceptive training, twice a week, during the months of March and April 2021. No serious adverse events occurred during the 6-week intervention period. Regarding the results of the Timed up and go test, the time of ambulation was not statistically significant, the before/after measure was not different ($P>0.05$); only 1 older adult modified the level of fall risk, going from high fall risk to moderate fall risk, so it was concluded that the total score of the level of fall risk of older adults over 65 years old after proprioceptive training is equal to the initial one.

Table 1 shows the results of the participants' fall risk level before and after the proprioceptive exercise intervention.

Table 1
Level of fall risk. TUG

Pre-intervention	Frequency	Percentage	Post-intervention	Frequency	Percentage
Fall risk level			Fall risk level		
>10-20 seconds: moderate fall risk	3	20,0%	>10-20 seconds: moderate fall risk	26,7%	4
> 20 seconds: High risk of falling	12	80,0%	> 20 seconds: High risk of falling	73,3%	11
Total	15	100,0%		100,0%	15

Note: Taken from pre- and post-intervention test results (2021)

With respect to the results of the Guralnik test (SPPB), the results show, specifically, the scores of the three subassessments that are part of the test. For the balance test, in the case of the side by side position, it was evident that at the beginning of the test 11 older adults found it difficult to perform more positions, after the proprioceptive exercises the participants were able to move from the first position, being 9 adults in total; likewise, only 2 of 15 participants performed the tandem position, after performing the proprioceptive exercises 6 of 15 adults performed this position.

Table 2 shows the score of the balance test, in its three positions, before and after the proprioceptive exercise intervention.

Table 2

Scoring of the balance test. SPPB

Pre-intervention	Frequency	Percentage	Post-intervention	Frequency	Percentage
Side by side	11	73,3%	Side by side	*	*
Semi tandem	2	13,3%	Semi tandem	9	60,0%
Tandem	2	13,3%	Tandem	6	40,0%
Total	15	100,0%	Total	15	100,0%

Note: Taken from pre- and post-intervention test results (2021)

For the ambulation subtest, at the time of the initial evaluation, only 1 of 15 adults took between 10-15 seconds to ambulate the distance, after the proprioceptive training 4 of 15 adults performed the test in that time; 3 of 15 adults performed the test between 15-20 seconds and after the exercises only 1 participant performed the test in that time. In the case of performing the test with more than 30 seconds, 6 out of 15 older adults obtained this result in the initial evaluation and, in the final evaluation, 4 out of 15 were located in that period.

Table 3 shows the ambulation test score before and after the proprioceptive exercise intervention.

Table 3

Scoring of the walking speed test. SPPB

Pre-intervention	Frequency	Percentage	Post-intervention	Frequency	Percentage
>10-15 seconds	1	6,7%	>10-15 seconds	4	26,7%
>15-20 seconds	3	20,0%	>15-20 seconds	1	6,7%
>20-30 seconds	5	33,3%	>20-30 seconds	6	40,0%
>30 seconds	6	40,0%	>30 seconds	4	26,7%
Total	15	100,0%	Total	15	100,0%

Note: Taken from pre- and post-intervention test results (2021)

The results of the subtest to get up and sit down from a chair, to evaluate the resistance of the lower extremities, showed that in the initial evaluation no participant was able to perform the test in less than 15 seconds, however, after performing the proprioceptive training, the results show that in the final evaluation 4 out of 15 adults were able to perform the test in less than that time; Similarly, it was shown that in the initial evaluation, 6 out of 15 participants were able to perform the test within 25 to 35 seconds, at the time of the final evaluation, 3 out of 15 of them performed the test in that time.

Table 4 shows the score of the standing and sitting up from a chair test before and after the proprioceptive exercise intervention.

Table 4

Lower extremity endurance test score. SPPB

Pre-intervention	Frequency	Percentage	Post-intervention	Frequency	Percentage
0-15 seconds	*	*	0-15 seconds	4	26,7%
>15-25 seconds	7	46,7%	>15-25 seconds	7	46,7%
>25-35 seconds	6	40,0%	>25-35 seconds	3	20,0%
>35 seconds	2	13,3%	>35 seconds	1	6,7%
Total	15	100,0%	Total	15	100,0%

Note: Taken from pre- and post-intervention test results (2021)

Table 5 shows, in a general way, the total score of the SPPB test before and after proprioceptive exercises. The results show that in the initial evaluation 9 out of 15 participants were at a level with major limitations and, in the final evaluation, 2 out of 15 participants were at this level. Likewise, it was shown that in the initial evaluation no older adult achieved a level of mild limitation, however, in the final evaluation, after performing the proprioceptive exercises, it was shown that 3 out of 15 older adults were located in a level of (pre-fragility) mild limitation.

Table 5
Total score of the level of functionality. SPPB

Pre-intervention	Frequency	Percentage	Post-intervention	Frequency	Percentage
0-3 points: major limitations	9	60,0%	0-3 points: major limitations	2	13,3%
4-6 points: moderate limitation (fragility)	6	40,0%	4-6 points: moderate limitation (fragility)	10	66,7%
7-9 points: mild limitation (pre-fragility)	*	*	7-9 points: mild limitation (pre-fragility)	3	20,0%
Total	15	100,0%	Total	15	100,0%

Note: Taken from pre- and post-intervention test results (2021)

Finally, Table 6 shows the comparison of the results between the two evaluations: TUG & SPPB before and after a 6-week proprioceptive training; in this table it can be observed that, in the level of fall risk, there were no significant changes in the sample, since only 1/15 adults managed to modify the level from high to moderate fall risk, a condition that could be due to intrinsic/extrinsic factors of the older adults and not for reasons inherent to the intervention; on the contrary, significant changes related to balance, walking speed and resistance in the lower extremities were generated, results that are reflected in the progress of the functionality of the older adults and, with it, a decrease in the rating of the frailty syndrome; a situation that favors the prevention of falls, dependence, disability and even death.

As for Figure 1, the correlation results showed a statistically significant value ($p<0.05$) and a relationship coefficient: -0.732, which indicates that the two variables are inversely correlated, therefore, it can be affirmed that as adults over 65 years of age (residing in a nursing home) progressively increase the level of functionality, the level of risk of falling will also decrease and vice versa.

Table 6
Comparison of results between the two evaluations: TUG & SPPB

Fall risk level		Level of functionality	
Pre-intervention	Post-Intervention	Pre-intervention	Post-intervention
20.0% of older adults were at moderate risk of falling.	Of the participants, 26.7% had a moderate fall risk rating.	Prior to initiating proprioceptive training, 60.0% of the total number of participants scored with major limitations	After 6 weeks of proprioceptive training the percentage was reduced to a total of 13.3% of participants with a rating of major limitations
80.0% of the participants were found to be at high risk of falling.	After a 6-week proprioceptive training intervention, 73.3% of the total participants obtained a moderate risk rating.	40.0% of the participants were found to have the frailty syndrome, generating a rating in adults with moderate limitation.	With proprioceptive training, 66.7% of the participants obtained a rating of moderate limitation.
		Before starting the proprioceptive training sessions, no older adult was able to obtain a mild limitation rating.	After the intervention of proprioceptive exercises, 20.0% of the total number of participants obtained a rating of mild limitation.

Note: Taken from pre- and post-intervention test results (2021)

			Puntuación total SPPB post - intervención	Puntuación total TUG post - intervención
Rho de Spearman	Puntuación total SPPB post- intervención	Coeficiente de correlación	1,000	-,732**
		Sig. (bilateral)	.	,002
		N	15	15
	Puntuación total TUG post- intervención	Coeficiente de correlación	-,732**	1,000
		Sig. (bilateral)	,002	.
		N	15	15

Figure 1. Correlation of the two post-intervention evaluations: TUG & SPPB
Note: This figure shows the results of the Spearman correlation between the two dependent variables. Taken from pre- and post-intervention test results (2021)

Discussion and conclusions

The aim of this study was to investigate the effectiveness of a six-week proprioceptive exercise intervention on the variables of fall risk level and level of functionality in nursing home residents to promote fall risk prevention in the elderly. The main findings of this analysis were that an intervention of 12 sessions of proprioceptive training, twice a week with a duration of 15-20 minutes each session, did not improve the level of fall risk in older adults, but it did generate significant changes in the level of functionality, in relation to the balance, ambulation and lower extremity resistance tests.

The finding that there was no effect of the proprioceptive exercise intervention on the level of fall risk is similar to the results of other research that found no significant changes when using this test, as in the studies of (Pérez- Ruíz, Ventura- Hernández, & Valverde- Grandal, 2015; Alfieri, Marcelo, & al, 2012), in the case of Pérez and Barry & al, these state that the results are due to inconsistencies with the characteristics of the test but not by the participants, the authors noted that this test does not allow to adequately cover the multiple intrinsic and extrinsic factors that depend falls, and also does not allow to detect small changes in this variable. In the case of Alferi, factors such as intervention time and comorbidities of the participants interfere directly and negatively in the results of the test but not because of the characteristics of the test. Although this study showed that the older adults improved their walking speed, this item was not enough to generate significant changes in the risk levels in which the test is classified and, therefore, only 1 of 15 participants modified the high level of fall risk to a moderate level.

Some of the reasons that may explain the lack of efficacy of the proprioceptive exercise intervention on the level of fall risk include the age of the participants (11 of 15 participants are over 80 years old) and lifestyle, factors that may increase the risk of having a fall, and with it, dependency in activities of daily living.

In the case of the level of functionality, the results of this research resemble those found by (Sierra-Silvestre & E, 2011; Mesquita, de Carvalho, & Freire, 2015; Almeida, Rodrigues, & Teixeira, 2017; Drummond, Cardoso, & Losada, 2018), the results of these studies showed that older adults increased walking speed and stride length after a balance exercise intervention. Likewise, in this study it was possible to obtain significant changes in the subtest of getting up and sitting down from a chair, an item that allowed improving the resistance of the limbs of older adults, which "allows the identification of both progressive and catastrophic onset of disability" in older adults according to (Tápanes, González, Cascudo, & al, 2016).

An unexpected observation of the present study was the trend toward improved confidence in performing the exercises. This could explain why more participants did not complete the ambulation test in less than 20 seconds. The 4 of 15 participants who used some type of ambulation aid performed the second evaluation without any type of technical aid, as they reported "feeling more confident" to perform basic activities of daily living after the 6 weeks of proprioceptive training. This finding is related to what was previously mentioned about the research of (Olmos & Pérez-Jara, 2010), these authors state that the same insecurity to move around produces a decrease to perform other activities and, thus, promote the appearance of other complications in this population.

The results of this study show that 9 of 15 participants obtained an initial rating of major limitations, while in the final evaluation 2 of 15 participants obtained the same rating after performing the proprioceptive training, these findings found in this research indicate that the functionality of people decreases as age advances, a situation that resembles what was stated by a research conducted in the Ministry of Health by (Gómez-Pavón, Martín, & al. 2007), ensuring that there is a linear and close relationship between fragility and functionality. As well as that mentioned by (Navalón-Alcañiz & Ignacio, 2020), who state that there is a positive association between the time of regular physical activity and a lower functional deterioration (p.580).

Finally, with the results obtained in this study, it is concluded that a proprioceptive exercise intervention is related to the level of functionality of older adults and, therefore, promote the prevention of fall risk, findings that are in line with the guidelines made by (Proske, 2012) assuring that "exercises that really challenge standing stability" are important to achieve a reduction in the incidence of falls in older adults; as mentioned by Bull & al (2020) who assert that there is "high evidence demonstrating that functional and balance exercises reduce the rate of falls" (p.1455).

Studies by (Bellew, Fenter, Chelette, & Moore, 2005;Sagastume, 2013), stating that proprioceptive exercises help to decrease the risk of falls which are of great benefit for older adults and what found by (Cando & Fiallos, 2019; Anzatuña & Figueroa, 2016; Huerta, 2018 and Mascaró, 2019) who conclude that there is a statistically significant difference between the risk of falling before and after performing proprioceptive training so older adults improve their independence in performing activities of daily living.

The strengths of this study include that proprioceptive training for 6 weeks is effective in improving static/dynamic balance, gait speed and lower extremity strength in older adults aged 65 years and, the unexpected finding, proprioceptive exercises promote confidence in the older adult to perform activities of daily living and, therefore, reduce the fear of a fall in older adults aged 65 years residing in a nursing home at Km1 via Dapa-Valle del Cauca.

The nominal group allowed to determine the relevance and feasibility of the proposal of a proprioceptive training in adults over 65 years of age residing in a nursing home at Km1 on the road to Dapa-Valle del Cauca. This proposed intervention is a viable option and can be included among the key strategies to promote fall risk prevention.

The limitations of the study, firstly, due to the health emergency caused by covid-19, the intervention time was too short to find more positive changes in the results and, perhaps, better results in the TUG test; secondly, the nursing home does not have professionals for an adequate prescription of exercise to promote physical activity in the elderly, since only 3 physiotherapists who were part of the nominal group were present.

Future research that seeks to promote the prevention of fall risk in adults over 65 years of age residing in a nursing home should ensure that the intervention is prescribed and supervised by professionals in the area, indicating the exact intervention program (time, frequency, training volume), a strategy that can facilitate adherence to physical training in older adults and, with this, include proprioceptive exercises in such sessions.

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FATIGUE MONITORING: A CASE STUDY IN WOMEN'S PROFESSIONAL BOXING

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Summary. The objective of this research was to present a model for monitoring fatigue that could be used in Boxing, so that coaches have a tool to control their athletes during the training and tuning process. The article provides a case study of a professional boxer, with whom fatigue monitoring was carried out prior to a world title fight in the lightweight category, using as indicators the height of jumps, speed of straight punches and a subjective perception questionnaire on sleep quality, stress level, fatigue and muscle pain. At the end of the monitoring process, improvements were obtained in the height reached for all jumps and in the isolated straight left jabs, as well as a reduction in the accumulation of fatigue indicators, reflecting the possibility of considering the use of similar models with the objective of controlling the training process and optimizing performance.

Key words: Fatigue, performance, recovery, boxing.

MONITOREO DE LA FATIGA: UN ESTUDIO DE CASO EN BOXEO PROFESIONAL FEMENINO

Resumen. El objetivo de esta investigación fue presentar un modelo para el monitoreo de la fatiga que pudiera ser utilizado en Boxeo, a fin de que los entrenadores dispongan de una herramienta para el control de sus deportistas durante el proceso de entrenamiento y puesta a punto. El artículo provee el estudio del caso de una boxeadora profesional, con la que se llevó a cabo el monitoreo de la fatiga previo a una disputa por los títulos mundiales de la categoría ligero, utilizando como indicadores la altura de saltos, velocidad de golpes rectos de puño y un cuestionario de percepción subjetiva sobre la calidad del sueño, nivel de estrés, fatiga y dolor muscular. Al finalizar el proceso de monitoreo se obtuvieron mejoras en la altura alcanzada para todos los saltos y en los golpes rectos aislados de izquierda, así como una reducción en la acumulación de los indicadores de fatiga, plasmando la posibilidad de considerar el uso de modelos similares con el objetivo de controlar el proceso de entrenamiento y optimizar el rendimiento.

Palabras clave: Fatiga, rendimiento, recuperación, boxeo.

Introduction

Fatigue monitoring is a strategy from which with the use of different tools, it is possible to know the responses of athletes to a given physical exercise load (Gabbett et al., 2017). In this way, it is possible to know if the adaptations to training are those sought during the different phases of the periodization (Halson, 2014)in order to avoid an accumulation of stress that could lead to overtraining or even a detriment to health (Drew & Finch, 2016; Hamlin et al., 2019).

While it has been postulated that fatigue is a requirement for activating the supercompensation and capacity enhancement mechanisms in athletes (Wada et al., 2020)it should be controlled in order to avoid a stagnation or reduction of performance due to a wrong dosage of training loads (Mukhopadhyay, 2021). An adequate regulation of fatigue is essential, especially during *tapering* periods, since in these cases athletes must be allowed to recover properly without loss of adaptations in order to arrive in optimal conditions to the competition (Le Meur et al., 2012).

In order to carry out fatigue monitoring, assessments on neuromuscular function, such as the height of different types of jump and the quality of execution of some specific gestures have been proposed (Coutts et al., 2007; Gathercole et al., 2015; Halson, 2014; Kennedy & Drake, 2017)as well as subjective perception questionnaires, using indicators such as level of fatigue, sleep quality, muscle aches and stress (Chen et al., 2022; Hooper et al., 1995; Ramírez-López et al., 2022; Thorpe et al., 2016),

Boxing is a sport in which muscle strength-power levels are an indicator of performance efficiency and one of the most important factors in the damage produced by the blows (Rezzonico, 2022)for this reason, its appropriate development would be one of the main objectives sought in training plans. In this context, punch force analysis can be used as a diagnostic tool for the design and control of exercise programs (Lenetsky et al., 2013). Considering that a relationship has been found between the speed reached by the hand and the force applied in the strokes (Mack et al., 2010)in cases where force cannot be directly evaluated, speed could be considered as a valid performance parameter.

In this activity, participants are classified according to different weight categories, so those who perform it competitively usually adjust their body composition by maximizing muscle content and limiting fat tissue (Chaabène et al., 2015). In order to reach the desired or agreed weight, caloric restrictions, decreased fluid intake and/or use of coats to increase body fluid loss are often carried out (Barley et al., 2019; Pallarés et al., 2016). There is a high risk of compromising performance when the dosage of loads exceeds the energy and hydric possibilities (Burke et al., 2021) (Burke et al., 2021)a situation that even leads to a greater likelihood of injury, due to a direct relationship between its incidence and increased fatigue (Drew & Finch, 2016).

According to the above, fatigue monitoring would be a good way to know the effects of training and control the process, being in the case of boxers a very useful option to regulate their preparation and thus optimize performance, considering the possibility of adverse nutritional conditions or an overload due to accumulation of work. Taking this into account, this article studies a case in which fatigue monitoring was carried out in a female professional boxer during the four weeks prior to a lightweight world title fight.

Characteristics of the athlete

The boxer who participated in the study began her professional career in 2013, having 9 years of experience and a total of 19 fights under her belt at the time of the intervention. Throughout his career he competed in the feather (55.3 - 57.1 kg) and super feather (57.1 - 58.9 kg) categories. His experience in Strength-Power training goes back to his beginnings in the professional field, carrying out 3 weekly stimuli of this type of work uninterruptedly (except for periods of vacation breaks and an interval of 3 months for pregnancy), which usually included: *core*exercises, plyometric, derived from Olympic weightlifting, ballistic, basic strength and accessories. In addition to the aforementioned work, the fighter kept a load of 6 weekly stimuli (Monday to Saturday) of boxing training of approximately 60-90' of duration, which were performed in a first shift during the morning hours (10 to 12hs approximately).

Since women's boxing still does not receive the same economic income as men's boxing, the athlete has always had to work as a teacher to earn extra money. This was considered at the time of scheduling her training sessions, since she did not have all the time outside of them for her breaks, but rather they were conditioned by her daily activities.

Regarding the nutritional area, the fighter received support on some occasions from specialists in the area who provided her with a program adjusted to her activity, but this was not sustained in the long term. In any case, she remained at approximately 5-10% of the categories in which she competed, and this percentage was not exceeded except during the period of her pregnancy.

Characteristics of the competition

The bout for which this work was carried out was agreed in the lightweight category (58.9 - 61.2 kg) and was a dispute for the titles of the World Boxing Council (WBC), World Boxing Association (WBA), International Boxing Federation (IBF) and World Boxing Organization (WBO).

The boxer carried out all the preparation in her country of residence, but had to travel a week before the fight to the country where the contest would take place. The evaluations were carried out up to one week before the combat, since due to travel and distance it was not possible to monitor the variables during this last period.

Strength-Power Training Program

Table 1

Strength-Power Training Program

TYPE OF EXERCISE	EXAMPLES	VOLUME	INTENSITY
CORE	Rotations with elastic band, Press pallof, Bicho Muerto, Anti-Throwing, Anti-Throwing, etc	3-4 series	Moderate
PLIOMETRY	Variations of jumps minimizing the contact time on the floor	3-4 series of 30-40 jumps	Maximum
POWER	*Hang Power Snatch/Clean, Jerk*	3-5 sets of 3-4 repetitions	70-85% 1RM
BALISTIC	Medicine ball throws	4-3 series of 10-12 pitches	5-10% PC
FORCE	Squats, Flat Bench Strength, Hip Thrusts	3-4 sets of 12-6 repetitions	30-60% 1RM

Note: lhe intensity is represented according to the percentage of Body Weight (BW) and the maximum repetition in the exercise (1RM).

Table 1 shows how the Strength-Power training program was conformed, which consisted of 3 weekly training sessions that took place at noon (13hs) on Mondays, Wednesdays and Fridays, with approximately one hour of rest interval with respect to their boxing work.

During the 4-week period in which it was developed and with the objective of reaching a peak performance at the time of combat, a gradual reduction in volume was carried out while maintaining the intensity thus respecting the principles of a precompetitive *tapering* (le Meur et al., 2012). An ATR (Accumulation, Transformation, Realization) periodization model was used, which has great application in the case of professional boxers (Rezzonico, 2022)the beginning of the last period (Realization) was made to coincide with the beginning of the fatigue monitoring process.

Method

The methodology used for this study was quantitative, since it was based on the treatment of numerical data which were extracted from the periodic evaluations carried out with the boxer. On the other hand, the work was longitudinal and intensive, since the study was carried out in depth on a single case during a period of four weeks. The research design was descriptive, with a detailed analysis of the results of the tests used.

Measuring Instruments and Techniques

Data collection for fatigue monitoring was carried out 3 times per week, on the same days that Strength-Power was trained. For this purpose, once the pre-activation consisting of *core* exercises had been completed, we began first with the evaluation of the jumps, then we collected the speed of the fist blows and, finally, we asked them to answer a series of questions (*wellness*questionnaire) about their physical condition. The evaluations began 5 weeks before the competition, and were carried out for a total of 4 weeks, thus completing 12 monitoring sessions. The last week prior to the competition, it was not possible to continue with the monitoring, because the fighter had left for the country where the fight took place. Prior to each training session, the weight of the boxer was recorded, because the *software* used to evaluate the height of the jumps needed it to perform the relevant calculations, and also to know the variability of the weight during the training process. For this purpose, a Dolz balance, model DPP Industria Argentina, was used.

Regarding the plyometric assessment, using a Win Laborat jumping mat and Win Laborat software version 5.4 ©Fernando Di Nezza, the athlete was asked to perform 3 maximum attempts of 3 different types of jumps: jump with 3-4" arrest at 90° (SJ), jump with counter movement without arrest (CMJ) and jump by dropping forward from a standing position with one foot forward (DJ without height). After the completion of all the attempts, the one in which the highest altitude was reached was recorded. The protocol was based on the Bosco test evaluation battery, which has been proposed as a reliable tool for the assessment of lower limb explosive strength (Villa & García-López, 2003).

Hykso Punch Trackers © Hykso punch sensors were used to determine the speed of the punches. First, the boxer was asked to throw a punch with the left and after a 2-3" pause to throw a punch with the right; this was done 3 times and the highest velocities were recorded for each arm. With respect to the 5" strokes, it was evaluated only once and the average peak velocity of all the left and right strokes thrown separately during that time was recorded. Due to the relationship between the velocity achieved by the fists and the force applied in the punch by the fighters (Mack et al., 2010)these values could be established as a reference of the neuromuscular performance in the specific gestures of the upper body.

Finally, the athlete was asked to rate on a scale of 1 to 7 (Table 2) the level of perception regarding sleep quality, stress level, fatigue and muscle pain (Hooper et al., 1995).

Table 2

Wellness questionnaire rating scale

	1	2	3	4	5	6	7
Dream	Excellent	Very Good	Good	Regular	Malo	Very bad	Lousy
Fatigue, Stress, DM	Very very low	Very low	Bass	Regular	Tall	Very High	Very very high

Note: DM - Muscle Pain.

On the other hand, it is important to highlight that a plyometric and stroke speed profile was established from the values obtained in the tests prior to starting the complete training cycle composed by the ATR periodization. In this way, the initial reference values were recorded, with which the fatigue monitoring results would later be compared.

Results

Plyometric Profile

Table 3 shows the height values achieved by the boxer for the Squat Jump (SJ), Counter Movement Jump (CMJ) and Drop Jump without height (DJ), evaluated before starting the training cycle.

Table 3

Height achieved in jumping tests

EXERCISE	HEIGHT (cm)
SJ	25.9
CMJ	27.2
DJ (no height)	28.4

Note: SJ - Squat Jump, CMJ - Counter Movement Jump, DJ - Drop Jump.

Stroke velocity profile

Table 4 consists of the peak velocity values reached by straight punches (jab and direct) thrown into the air individually and for 5" without stopping, prior to the start of the training cycle.

Table 4

Peak velocity achieved in straight fist strikes

EXERCISE	ARM	PEAK SPEED (m/s)
ISOLATED KNOCKS	Left	4.4
	Law	5.0
HITS IN 5"	Left	7.5
	Law	7.8

Note: in the strokes launched during 5" is expressed as the average of the peak velocity reached by all the strokes executed.

Fatigue monitoring

Jumpability

Table 5 and Figure 1 present the results of the jumping tests evaluated during the 4 weeks of monitoring. Only the values of the highest height reached among the three maximum SJ, CMJ and DJ attempts were recorded.

Table 5

Height of jumps during fatigue monitoring

	1	2	3	4	5	6	7	8	9	10	11	12
SJ	25.5	25.1	26.6	27.6	26.2	25.1	28.0	26.6	24.3	28.1	26.2	29.2
CMJ	25.4	25.4	26.2	28.1	26.5	26.5	27.6	27.8	26.9	29.0	26.6	28.4
DJ	27.2	25.7	28.1	29.0	25.9	27.1	28.5	27.1	27.0	30.0	28.4	29.1

Note: the height of the jumps is expressed in centimeters (cm). SJ - Squat Jump, CMJ - Counter Movement Jump, DJ - Drop Jump, DE - Standard Deviation

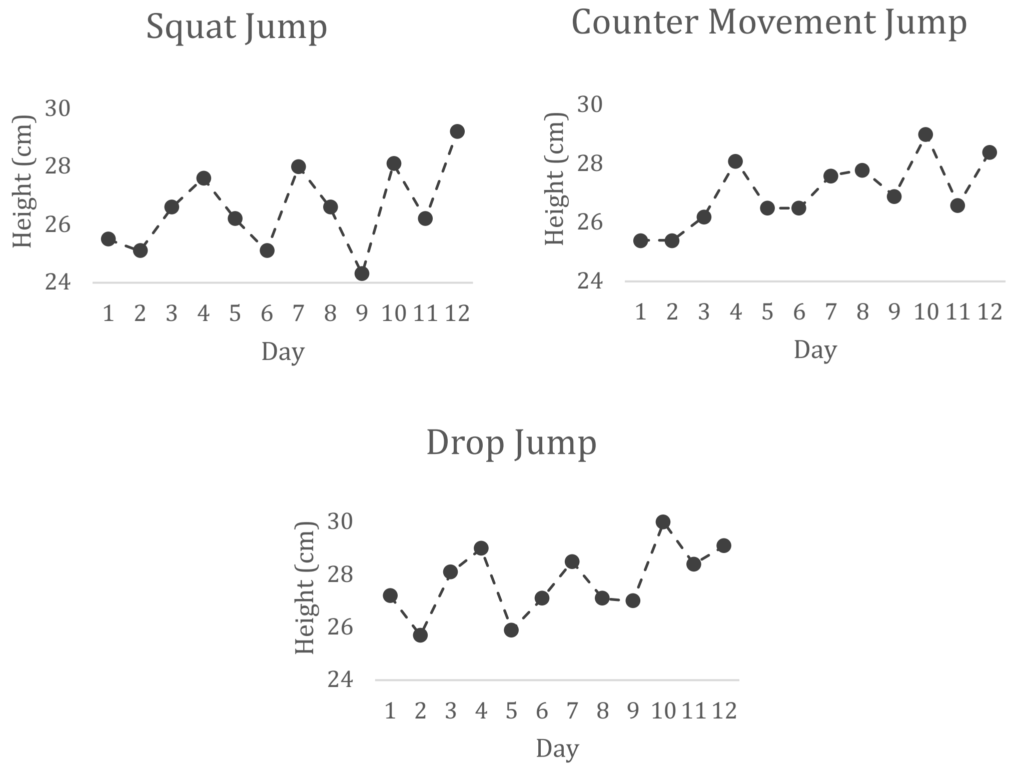

Figure 1. Height of the jumps.

Table 6 consists of the jump efficiency indices, percentage that was calculated based on the jump height obtained in the evaluations prior to the beginning of the fatigue monitoring period (Table 3).

Table 6

Jump efficiency index

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
SJ	98.5	96.9	102.7	106.6	101.2	96.9	108.1	102.7	93.8	108.5	101.2	112.7
CMJ	93.4	93.4	96.3	103.3	97.4	97.4	101.5	102.2	98.9	106.6	97.8	104.4
DJ	95.8	90.5	98.9	102.1	91.2	95.4	100.4	95.4	95.1	105.6	100.0	102.5

Note: the efficiency index is expressed as a percentage (%). SJ - Squat Jump, CMJ - Counter Movement Jump, DJ - Drop Jump.

Plyometric assessment during the monitoring process provided results below those initially obtained in the SJ on days 1, 2, 6, 9, in the CMJ on days 1, 2, 3, 5, 6, 9, 11, and in the DJ on days 1, 2, 3, 5, 6, 6, 8, 9. On days 4, 7, 10 and 12, efficiency rates higher than the initial ones were obtained for all jumps

Stroke speed

Table 7 and Figure 2 present the results of the stroke velocity tests obtained during the 4 weeks of fatigue monitoring. For the isolated strokes, the values of the highest velocity achieved among the three attempts made with each arm were recorded.

Table 7

Stroke rate during fatigue monitoring

		1	2	3	4	5	6	7	8	9	10	11	12
ISOLATED KNOCKS	Left	4.8	4.2	5.4	5.0	4.4	4.6	4.6	4.9	4.3	4.4	5.0	5.0
	Right	5.7	4.8	5.8	5.7	5.4	6.1	5.8	6.3	5.5	5.6	5.4	4.9
HITS IN 5"	Left	7.9	7.2	7.9	7.9	4.6	6.9	7.6	7.8	5.3	6.4	3.9	6.3
	Right	7.7	6.7	7.5	7.3	4.4	6.8	6.5	7.3	5	6	3.8	5.9

Note: the speed is expressed in meters per second (m/s). Left - Left, Right - Right.

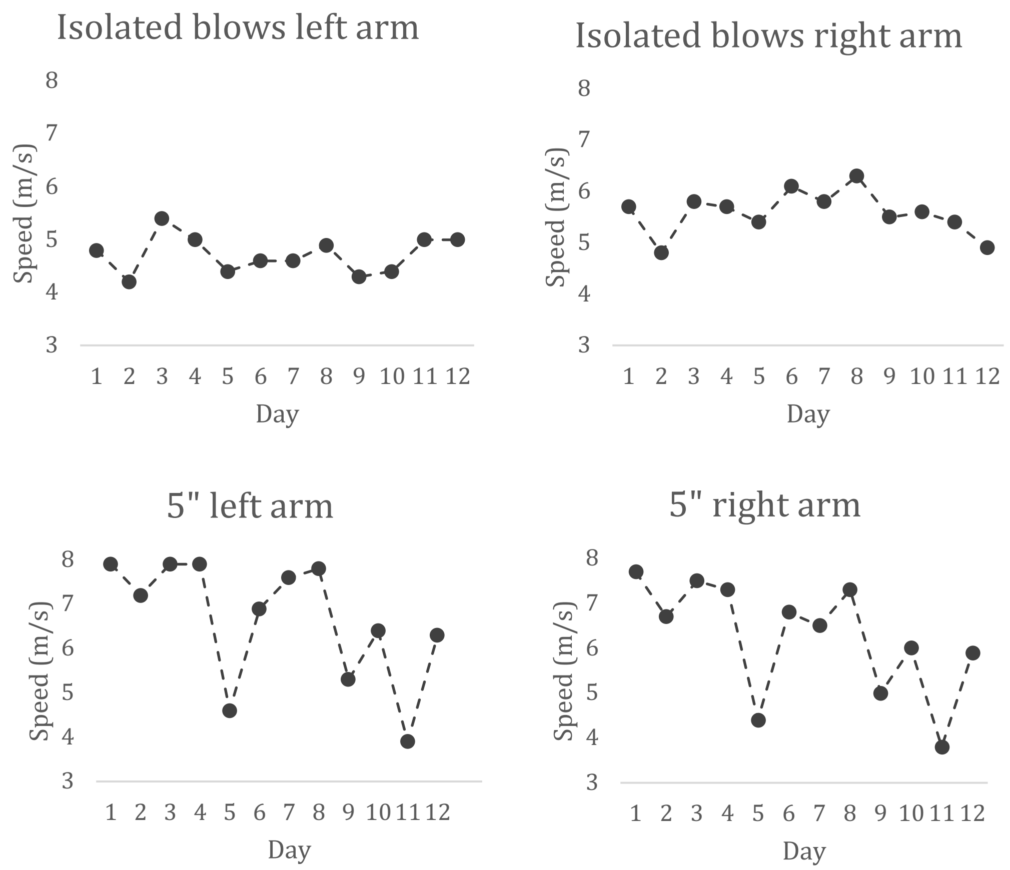

Figure 2. Speed of the blows.

Table 8 presents the efficiency indexes of the speed achieved in the different stroke protocols, with respect to the speed achieved in the initial evaluations (Table 4).

Table 8

Stroke efficiency index

		1	2	3	4	5	6	7	8	9	10	11	12
ISOLATED KNOCKS	Left	109.1	95.5	122.7	113.6	100.0	104.5	104.5	111.4	97.7	100.0	113.6	113.6
	Right	114.0	96.0	116.0	114.0	108.0	122.0	116.0	126.0	110.0	112.0	108.0	98.0
HITS IN 5"	Left	105.3	96.0	105.3	105.3	61.3	92.0	101.3	104.0	70.7	85.3	52.0	84.0
	Right	98.7	85.9	96.2	93.6	56.4	87.2	83.3	93.6	64.1	76.9	48.7	75.6

Note: the efficiency index is expressed as a percentage (%). Left - Left, Right - Right, DE - standard deviation.

The evaluation of straight punch speed showed an improvement in almost all sessions for isolated punch speed, except for days 2 and 9 for the left punch, 2 and 12 for the right punch.

The 5" strokes presented lower efficiency rates when compared to pre-monitoring values, in the left arm on days 2, 5, 6, 9, 9, 10, 11, 12, and in the right arm in all sessions.

Wellness Questionnaire

Table 9 and Figure 3 show the results of the *wellness* questionnaire questions (sleep, stress, fatigue and muscle pain) during the course of fatigue monitoring.

Table 9

Results of the Wellness questionnaire

	1	2	3	4	5	6	7	8	9	10	11	12
Dream	4	4	3	6	5	4	5	4	4	3	3	4
Stress	6	3	1	5	1	2	3	4	3	1	2	3
Fatigue	3	4	2	1	6	4	2	3	3	2	4	5
DM	1	6	2	1	4	7	2	1	7	4	7	4

Note: DM - Muscle pain.

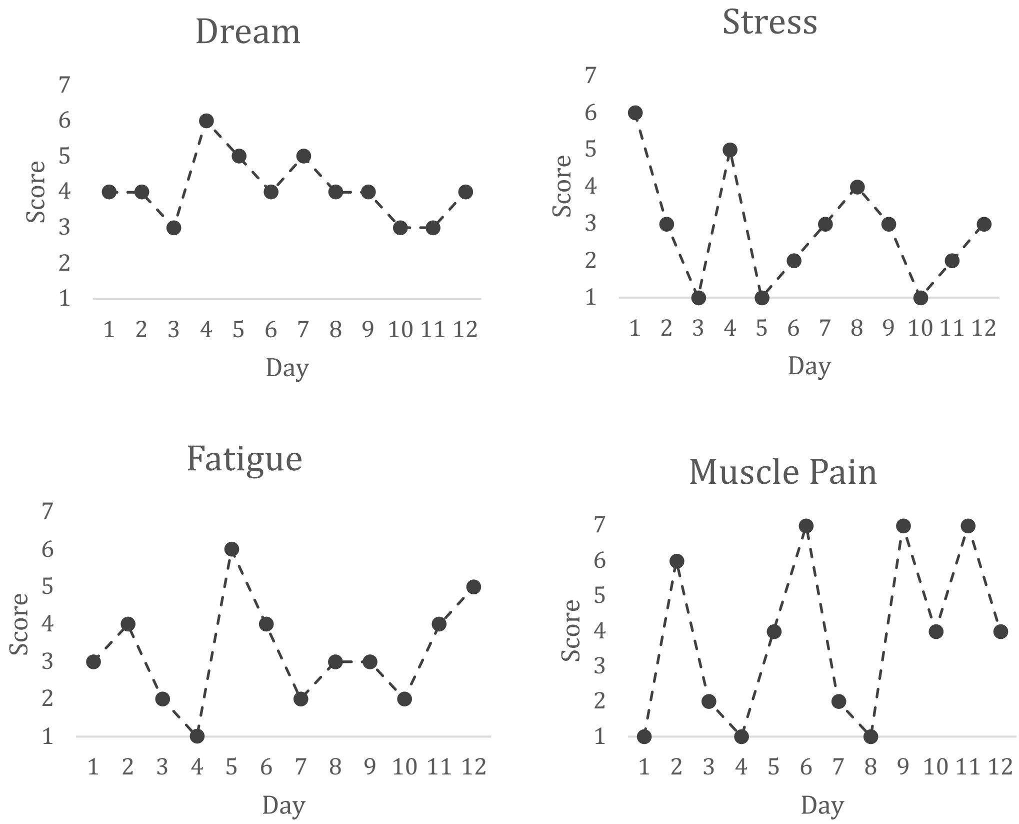

Figure 3. Scores of the different items of the *wellness*questionnaire.

Results between 4 (fair) and 7 (very poor-very high) were obtained for sleep quality on days 1, 2, 4, 5, 6, 7, 8, 9, and 12, stress level 1, 4 and 8, fatigue level 2, 5, 6, 11 and 12, muscle pain 2, 5, 6, 9, 10, 11 and 12.

Relationship between fatigue monitoring evaluations

Table 10 shows the relationship established between the results of the jumping and stroke speed evaluations, together with the scores of the *wellness*questionnaire. Fatigue was only considered in each indicator for all those cases in which the efficiency index was below 100% in terms of jumping and stroke speed, and when the questionnaire scores were between 4 and 7 (fair to very bad/very high).

Table 10

List of fatigue indicators

	1	2	3	4	5	6	7	8	9	10	11	12
SJ	*	*				*			*			
CMJ	*	*	*		*	*			*		*	
DJ	*	*	*		*	*		*	*			
Left A		*							*			
Right A		*										*
Left 5"		*			*	*			*	*	*	*
Right A	*	*	*	*	*	*	*	*	*	*	*	*
Dream	*	*		*	*	*	*	*	*			*
Stress	*			*				*				
Fatigue		*			*	*					*	*
DM		*			*	*			*	*	*	*
TOTAL	6	10	3	3	7	8	2	4	8	3	5	6

Note: SJ - Squat Jump, CMJ - Counter Movement Jump, DJ - Drop Jump, Left A - Isolated left arm strikes, Right A - Isolated right arm strikes, Left 5" - Left arm strikes for 5", Right 5" - Right arm strikes for 5", DM - Muscle soreness.

Figure 4 shows the daily variation of the totals of the ratio of fatigue indicators in Table 10, as well as the weekly variation calculated by the sum of the scores obtained in the 3 sessions of each one.

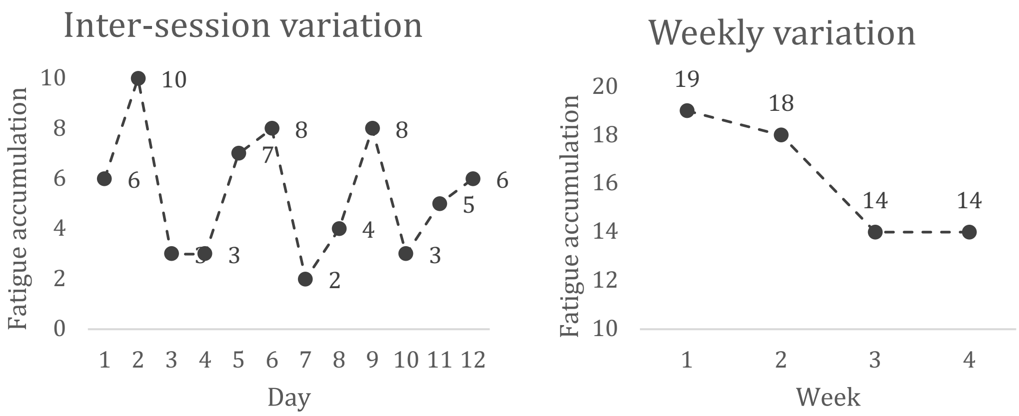

Figure 4. Daily and weekly variation of the totals of the comparative fatigue indicators.

Table 10 and Figure 4 show 3 peaks of fatigue accumulation with scores of 10 and 8 on days 2, 6 and 9, followed by another of the highest values with a score of 7 on day 5. The weekly variation represented in Figure 4, which expresses the sum of the scores achieved in the 3 sessions of each week, shows a gradual decrease in the accumulation of fatigue between weeks 1 and 3, with a maintenance between weeks 3 and 4.

Body weight

Table 11 and Figure 5 show the boxer's body weight records, evaluated prior to the beginning of each strength training session. The distance to the competition category in kilograms (kg) and percentage (%) is also presented.

Table 11

Body weight and relation to competition category

		1	2	3	4	5	6	7	8	9	10	11	12
Weight (Kg)		63	62.8	62.6	62.3	63.1	62.6	63.8	62.6	63.3	62.7	63.3	63.3
Distance to category	Kg	1.8	1.6	1.4	1.1	1.9	1.4	2.6	1.4	2.1	1.5	2.1	2.1
	%	2.9	2.6	2.3	1.8	3.1	2.3	4.2	2.3	3.4	2.5	3.4	3.4

Note: the distance to the light category was calculated based on the highest limit of the same(61.2 kg).

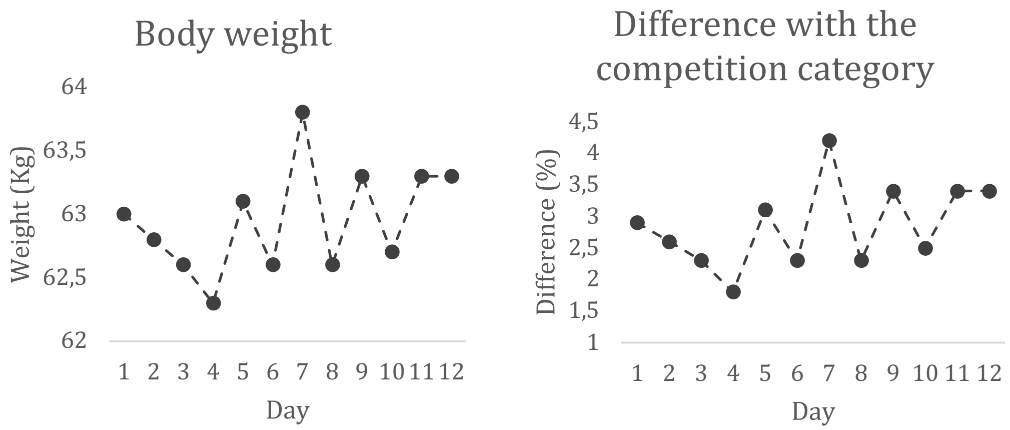

Figure 5. Body weight and percentage difference with the competition category.

Table 12 shows the inter-session weight difference, represented in kilograms and as a percentage in relation to the weight recorded on the previous evaluation day.

Table 12

Inter-session weight variation

	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12
Weight change (Kg)	-0.2	-0.2	-0.3	0.8	-0.5	1.2	-1.2	0.7	-0.6	0.6	0
Percentage of weight change (%)	-0.3	-0.3	-0.5	1.3	-0.8	1.9	-1.9	1.1	-1	1	0

Body weight records showed a maximum inter-session decrease of 1.9% between days 7-8 and a minimum of 0.3% between days 1-2 and 2-3. The lowest weight during the fatigue monitoring process was found on day 4 (62.3 kg), being 1.8% of the competition category. The highest weight was recorded on day 7 (63.8 kg), being 4.2% of the competition category. Between the first day on which the athlete was weighed and the last day, there was a 0.5% increase in body weight.

Discussion

The main objective of this work was to analyze the fatigue monitoring process of a professional female boxer, in the search to maximize the positive effects of training loads and minimize the negative ones (Gabbett et al., 2017).

During the fatigue monitoring process, body weight was not taken into account as a factor that would have impacted the athlete's fatigue, considering that <3% weight adjustment would not generate negative effects on performance (Barley et al., 2019; Burke et al., 2021) and that in the case presented the maximum weight loss was 1.9% of body weight.

With regard to jumping, while some studies have used as a control measure only CMJ (Gathercole et al., 2015; Kennedy & Drake, 2017), other types of jumps have also been recommended and used for the assessment of fatigue and/or neuromuscular performance (Coutts et al., 2007; Halson, 2014; Rezzonico, 2022). It is for this same reason that in the present study we chose to evaluate the SJ and DJ, in conjunction with the CMJ, in order to know the Strength-Power performance of the lower limbs during the monitoring process.

Specific gestures have also been used to investigate athlete performance (Chaabène et al., 2015; Coutts et al., 2007; Halson, 2014; Mack et al., 2010). Taking this into account, the velocity of straight fist strikes was used as a measure of specific performance of boxing gestures (Kimm & Thiel, 2015). Thus, we chose to evaluate the velocity of isolated straight blows, and also of continuous blows in 5" due to the contribution of a double peak of force when launching combinations of these (McGill et al., 2010).

Considering that several studies have made use of questions about athletes' perceptions of their performance levels (Hamlin et al., 2019; Ramirez-Lopez et al., 2022; Thorpe et al., 2017)the ones used in the work of Hooper et al. were selected. (1995) and thus formed the *wellness* questionnaire for the subjective assessment of fatigue.

During the boxer's Strength-Power training process, in those cases in which an accumulation ≥6 points was found in the ratio of fatigue indicators, it was chosen to schedule a 10% decrease in the volume of the training load for that day. In this way, the monitoring allowed a rearrangement of the workloads during the fine-tuning period, which promoted a decrease in the sum of the weekly fatigue indicators. This would be favorable to reach peak performance (le Meur et al., 2012) and prevent the occurrence of injury or any disease that could interfere with participation in competition (Drew & Finch, 2016).

Although the comparison between the initial values of the performance profiles and the last monitoring record (day 12) showed an increase in the height for all jumps and the speed of the isolated straight punches, but a decrease in the speed of the rest of the punches, it should be noted that during the last week the boxer reported pain in her right shoulder after a *sparring* session that took place between evaluations 10-11. For this reason, during sessions 11 and 12 a greater unloading of the upper body exercises was carried out, as well as the last *sparring*sessions were cancelled.

The lack of evidence on an efficient system for monitoring the fatigue of the fighters during their pre-competitive training, which allows reaching the objectives with the least possible compromise of performance, would make this work the starting point to investigate with a greater number of participants, men and women of different weight categories, and in different competitive scenarios, in order to establish a reliable method of control.

Although the fact of having analyzed a single case represents a limitation to conclude about the use of fatigue monitoring during the period of boxers' training, in the same way and considering this work, coaches could make use of some of the variables that were used for the control of their athletes.

Conclusions

Through this research, the results of the fatigue monitoring process have been investigated in a professional boxer with 9 years of experience in the rental field and in Strength-Power training, while she was preparing for a fight for the WBC, WBA, IBF and WBO world titles in the lightweight category.

The fatigue monitoring process consisted of 3 weekly evaluations on Monday, Wednesday and Friday prior to the start of their Strength-Power training, for 4 continuous weeks and carrying out the last evaluation 8 days before the fight. The performance indicators taken as reference were the height of the jumps (SJ, CMJ and DJ without height), speed of the straight punches (isolated and continuous in 5") and a *wellness* questionnaire consisting of 4 questions: quality of sleep, stress level, degree of fatigue and muscle pain. The variation of their body weight prior to each training session was also recorded, in order to know the distance with the competition category as the combat approached and if it was necessary to make an adjustment to it.

The results of the research demonstrated a variation in the boxer's fatigue levels throughout the process of tuning up for her bout. A comparison between the different indicators evaluated showed a gradual reduction in fatigue during the first 3 weeks, and a maintenance of fatigue between weeks 3-4. An improvement in height attained was evident for all jumps (SJ +12.7%, CMJ +4.4%, DJ +2.5%) and for isolated left straight strokes (+13.6%) when comparing the initial baseline values of the plyometric and stroke velocity profiles with the latter obtained during fatigue monitoring. On the contrary, a reduction was found in the velocity of isolated blows launched with the right arm (-2%) and of continuous blows in 5" for both arms (left -16% and right -24.4%).

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APPLICATION OF THE CONTINUOUS VARIABLE METHOD IN THE PLANNING OF THE DANCE THERAPY CLASSES FOR THE IMPROVEMENT OF THE RESISTANCE OF THE PARTICIPANTS OF THE PARISH GRL. PEDRO J. MONTERO OF YAGUACHI CANTON, ECUADOR

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Summary. The aim of this study was to find out how the application of the continuous variable method affects the improvement of the resistance of the participants in the dance therapy classes. The general objective of this project was to designa proposal for the application of the continuous variable method in dance therapy classes to achieve the improvement of resistance. A quantitative, experimental, cross-sectional and field study was carried out with a total of 20 adult women between the ages of 20 and 59 years old. To determine the initial state of resistance, a pre-intervention assessment was carried out, recording the results on observation sheets. Sstudent' s t-statistic for related samples was used to compare the means in relation to the research objectives, since the same group was evaluated in a pre- and post-evaluation. From the results obtained, it can be seen that there is a significant increase in the resistance observed in the pre-evaluation of partial fatigue with a mean of 12.95 minutes and the post evaluation of partial fatigue with a mean of 22.75 minutes; with a confidence level of 0.05, observing a value of p =.000. Likewise, it can be seen that there is an increase in the resistance observed in the pre-evaluation of total fatigue with a mean of 19.80 minutes and in the post-evaluation of total fatigue with 30.40 minutes, with a confidence level of 0.05, observing a value of p =.000.

Key words: Physical training methods, motor fatigue, physical capacities, health, dance.

APLICACIÓN DEL MÉTODO CONTINUO VARIABLE EN LA PLANIFICACIÓN DE LAS CLASES DE BAILOTERAPIA PARA EL MEJORAMIENTO DE LA RESISTENCIA DE LAS PARTICIPANTES DE LA PARROQUIA GRL. PEDRO J. MONTERO DEL CANTÓN YAGUACHI, ECUADOR

Resumen. Este estudio, pretendía conocer, cómo incide la aplicación del método continuo variable en la mejora de la resistencia de las participantes en las clases de bailoterapia. El objetivo general de este proyecto, fue diseñar una propuesta de aplicación del método continuo variable en las clases de bailoterapia para lograr el mejoramiento de la resistencia. Se realizó un estudio de tipo cuantitativo, experimental, de corte transversal y de campo, participaron un total de 20 mujeres adultas, con edades entre 20 y 59 años. Para saber el estado inicial de resistencia se llevó a cabo una evaluación pre intervención, registrando los resultados en fichas de observación. Se utilizó la estadística t de Student para muestras relacionadas por tratarse del mismo grupo evaluado en una pre y post evaluación, para comparar las medias con relación a los objetivos de la investigación. De los resultados obtenidos, se aprecia que existe un incremento significativo de la resistencia observada, en la pre evaluación de cansancio parcial con una media de 12,95 minutos y la post evaluación de cansancio parcial con una media de 22,75 minutos; con un nivel de confianza de 0,05, observando un valor de p =,000. Así mismo, se aprecia que existe un incremento de la resistencia observada en la pre evaluación de cansancio total con una media de 19,80 minutos y en la post evaluación de cansancio total con 30,40 minutos, con un nivel de confianza de 0,05, observando un valor de p =,000.

Palabras clave: Métodos de entrenamiento físico, cansancio motor, capacidades físicas, salud, baile.

Introduction

Dance therapy is considered a tool to help people improve their physical, psychological and social health, however, the approach that has been given to it focuses more on the contents (dances) and the methods to organize these contents, than on those methods that will improve the physical condition of those who practice it. In order to develop a good physical-health condition, it is necessary to improve the basic physical *endurance* capacity through aerobic training. According to Bermúdez et al. (2019),performing systematic physical exercise, preferably of the aerobic type, which allows the degradation of triglycerides stored in adipose tissue and the substantial reduction of body fat; is the most effective strategy to prevent or reduce obesity, reducing the risk of cardiovascular disease.

Dancing as a means to improve basic physical capacities, especially endurance, requires one or more methods to achieve this objective; however, there is no theoretical-practical material or studies on the subject to support and reinforce the knowledge of trainers, monitors or instructors of this type of training. Every day the demand for aerobic dance trainers and instructors is increasing and scientific support material is scarce. Rivera (2017), points out that since 2012 in the province of Chimborazo, as in the other provinces of the country, the National Government initiated the project, "Ecuador Ejercítate", whose main objective is to reduce the levels of sedentary lifestyle of its participants, through the implementation of an activation program for the population, with the practice of dance therapy and its implementation will be long-term with a considerable economic investment.

According to Salinas (2018), sport specialists have a great responsibility towards their clients, part of those responsibilities are: performing an initial assessment of the client's state of health and physical condition to structure training sessions correctly, in order to make a safe and effective exercise prescription, systematically teaching and communicating ideas and notions, maintaining an appropriate level of knowledge and experience to train people, proposing real objectives, select the activities preferred by the client to keep him/her motivated, make any necessary corrections to the training program, carry out periodic evaluations to elaborate a new prescription that generates physiological changes and health benefits, provide information to the practitioner about the benefits of physical exercise and the positive impact on quality of life.

The present research work will improve the endurance of people who regularly attend aerobic dance classes, in order to improve their physical condition. Resistance training is important to optimize cardio vascular and respiratory functioning, however, no importance is given to the application of a resistance training method that provides a solution to this problem. The aim is to know how the application of the continuous variable method affects the improvement of endurance when implemented in a controlled aerobic dance program.

This research will allow the identification of possible errors in the methods and instruments to meet the physical needs and how to help achieve the expected results in the improvement of resistance during dance therapy classes. Reality shows us that the complexity surrounding modern training is increasing every day. This makes it necessary to have a training plan with a scientific methodological support, where the objectives are specified, where a sequential process is followed and improvisation is avoided. This will replace the empirical work of the trainer, providing him/her with the knowledge, skills and abilities necessary to know, plan and conduct training.

Finally, it is worth mentioning that, in terms of social relevance, there is currently no scientifically based planning in dance therapy classes to measure the physical endurance of the practitioners of this activity. For this reason, it is convenient to carry out the research, it is considered that from the conclusions and recommendations a new model will emerge that will contribute to future projects. In terms of its practical relevance, it will allow trainers, instructors and instructors to recognize the implication and importance of planning aerobic dance training with the continuous variable method, and to take the pertinent actions to improve it. On a theoretical level, it will be favored by increasing the knowledge about the relationship between physical condition and the improvement of endurance through the continuous variable method. This type of research will allow decisions to be made to motivate teachers, trainers and monitors, and in turn will be reflected in the improvement of the health of the population that attends this type of classes.

For this reason, the general objective of this study was to design a proposal for the application of the continuous variable method in dance therapy classes to improve the participants' resistanceis to design a proposal for the application of the continuous variable method in dance therapy classes in order to improve the resistance of the participants.

Method

Design and methodology

This is a quantitative research, which is justified since pre and post intervention values are required to prove that the continuous variable method applied in the aerobic dance classes improves the resistance of the participants. The project was divided into three phases: planning and design prior to the field study, with a duration of one month; carrying out the field work with a duration of one month and a frequency of three weekly sessions applying the continuous variable method in the dance therapy classes. And finally, the preparation of the final report.

The study is a cross-sectional experimental design, with repeated measurements (resistance assessment) pre- and post-intervention, under special conditions created for this purpose. The persons investigated were fully aware that they were being evaluated and were part of a group previously formed by the parish authorities. The research lasted one month.

Participants

The population consisted of 20 adult women between 20 and 59 years of age from the parish of General Pedro J. Montero in Yaguachi. The research was carried out with 100% of the population. The criteria for participation were: signing the informed consent form, completing a survey and a verbal commitment to attend training sessions on time. All participants gave their consent to participate in the research, which was previously approved by the ethics committee of the Universidad Internacional Iberoamericana (UNINI).

Instrument

The techniques used for data collection in this research were: the survey with closed questions for the participants of the parish Gral. Pedro J. Montero of Yaguachi Canton and pre- and post-intervention observation sheets. The survey was conducted to find out if the members of the dance therapy group of the parish had previously received classes in this modality with a continuous method, without interruptions and with varying intensities, as well as to find out the degree of participation and relevance that this training modality had for the participants as a mechanism to improve their health.

For the observation sheets, we have based ourselves on the concept of resistance by Vrijens (2006) and Hohmann et al. (2005). The cards were divided into three sections: the first to record partial fatigue in minutes, i.e., the ability to keep dancing only with the lower body without the use of arms and with a decreased quality of movement. The second section belongs to total fatigue, which is the moment when the performer cannot continue dancing with the lower and upper body and needs to march on her own ground until she recovers and integrates back into the training or definitively withdraws. And a third section to record observations if necessary.

The participants were identified according to a number superimposed on the T-shirt and organized in ascending rows, in order to be able to enter the data and keep better control of individual performance during the evaluation. An external trainer was contacted, who was in charge of carrying out the observation during the pre- and post-evaluation and filling out the pre- and post-intervention forms. The observer was previously trained for this purpose. A stopwatch was used to enter data in minutes for each participant.

Variables

The independent variable *continuous method* , understood as the cause, was first studied to understand its characteristics, benefits and protocols applicable in the moments of greater effort and those of lesser effort during physical exercise. For the pre and post intervention evaluation and according to the needs of the group, a variation of the intensity was chosen in a range of 1 to 10 minutes for the moments of higher intensity alternated with moments of medium or low intensity for an incomplete recovery with a minimum time of 2 minutes or more than 3 minutes, depending on the level of effort made a range of 1 to 10 minutes for the moments of higher intensity alternated with moments of medium or low intensity for an incomplete recovery with a minimum time of 2 minutes or more than 3 minutes, depending on the level of effort made in the moments of higher intensity. During the research process, instead, we opted for a protocol that allows a gradual progression and adaptation to the effort for the 4 weeks, working within a range of 5 minutes for the moments of higher effort and those of lower intensity of less than 3 minutes. The continuous variable method was applied in the planning of the dance therapy classes, using the goals of the music (beat) as the indicator of the change of intensities, that is, the speed of the music and the songs were adapted to the concept, characteristics and effort protocols of the continuous variable method for which the Adobe Audition program was used. The music underwent as many cuts or extensions as necessary to achieve the changes in intensity proposed by the method and there were no interruptions between songs. It was necessary to study each mix in detail to have complete mastery and control of the dances and intensity changes, in order to verbally anticipate the participants and prepare them psychologically for the next effort.

With respect to the independent variable dance therapy, the methods for organizing the contents were applied, together with the *variable continuous*resistance training method, in order to improve the resistance levels of the research participants.

The dependent variable *resistance* , understood as the effect, was measured in minutes of dynamic work. Participants in the pre- and post-intervention assessments were required to dance for as long as possible, without interruptions and at varying intensities. Partial fatigue (dancing without using arm technique, only working with the lower body) and total fatigue (impossibility to continue dancing) were used as indicators to measure the initial and final level of resistance. During the two evaluations, the moment in which the participants manifested partial or total fatigue was recorded in minutes on observation cards, and at the end of the research, the results obtained were analyzed to determine the impact of the application of the continuous variable method on the improvement of the participants' endurance.

Procedure

Prior to conducting the pre-intervention assessment, all the documents necessary to initiate the research were organized. Subsequently, the facilities where the training sessions would be held and the audio equipment were evaluated, verifying that the surface of the room would allow the feet to slide properly to avoid injuries.

Participants were explained the conditions under which they had to attend in order to be evaluated: rest, food, hydration, footwear and clothing. The recommendation was not to perform strenuous exercise on the weekend; on the day of the evaluation not to eat heavy food 4 hours before, the recommendation was two hours before, a snack containing carbohydrates and protein, hydration before, during and after the evaluation, taking into account that on the coast dehydration is greater. Comfortable cotton clothing and shoes that allow normal foot sliding were requested (no non-slip shoes to facilitate pivoting in turns).

The track used was edited in Adobe Audition and consisted of three parts: warm-up, main part and cool-down. For the warm-up, Afro-Latin music was played at 120 beats per minute (bpm) for joint mobility, specific dissociation movements of the hips, trunk and arms, basic Afro-Latin movements with small displacements to raise the heart rate gradually, facilitate changes of direction and be able to engage with the first musical track of the main part, the duration was 7 min.

The main part of the evaluation was designed based on the concepts of Forteza et al. (2013, p.99) and Navarro (1998), cited by López and Fernández (2006). The musical edition was uninterrupted, lasting 43 minutes. The moments of higher intensity were in a range of 1 to 10 minutes alternated with moments of medium or low intensity for incomplete recovery, according to the recommendations of Navarro (1998, p. 106). Incomplete recovery time was a minimum of 2 minutes or more than 3 minutes, depending on the level of effort made at the moments of greatest intensity.

As recommended by Charola (1996, p.42)as recommended by Charola (1996), beats per minute were used to achieve the intensity changes, for which ranges between 128 bpm to 175 bpm were programmed for the entire session. The bpm between 136 and 175 fell within a 1 to 10 minute duration range for elevating the intensity of effort, alternating with beats per minute between 120 and 128, for incomplete recovery based on Navarro's (1998, p. 106) definitions.

The return to calm was edited with kizomba at 120 bpm using relaxation and breathing movements with a duration of 5 minutes. Participants were asked to perform the arm and hip technique with the best possible quality throughout the session.

The pre- and post-intervention evaluations were performed at the same time (7:00 pm), on the same day (Monday), so that they would have two days of recovery, under the same conditions of rest, food, hydration, footwear and clothing, and with the same musical mix.

Once the pre-intervention evaluation was completed and with a clearer diagnosis of the initial situation of the participants, the training sessions were planned, determining the technical levels of execution for each dance, the intensities and protocols that would be used, the volume of work, the musical editions necessary for the process, the duration and progression of the efforts.

It was detected during the initial evaluation that the participants had very little knowledge of the basic steps of each genre, so the planning had to include a teaching-learning section on the basic arm techniques and steps of salsa, bachata and samba.

Before starting each training session, the objective of the session, the contents and what was expected to be achieved at the end of the training session were explained to the participants; this brief explanation served to educate them about the program, keep them motivated, make them participants in the process and thus generate greater adherence, which would allow the research to be carried out successfully.

Data analysis

The program used in the research was the SPSS. The data obtained in the present investigation, from the observations of the continuous variable method and endurance, with the evaluations of partial and total fatigue, were compiled in an Excel sheet, both from the partial and total pre-evaluation and from the partial and total post-evaluation. The normality test was performed with the Shapiro Wilks test to determine the distribution of the data and to determine whether they are parametric or nonparametric data, in order to choose the appropriate statistic according to the objectives. Once it was determined that the data were parametric, Student'st test was used for analysis. These data were transferred to the IBM Statistics 23 program and the t Student statistic was used for related samples because they were the same group evaluated in a pre-evaluation and post-evaluation, to compare the means in relation to the research objectives.

Results

The continuous variable method was successfully adapted in the dance therapy classes according to the physical condition and technical knowledge of the participants, since it was found during the pre-intervention assessment that they belonged to a basic level of both training and dance. Taking this into account and through proper planning, they were able to progress in the technical learning of the dances and in resistance, which allowed them to progress without any inconvenience.

The musical genres that matched the culture and traditions of the participants were selected by means of a verbal survey, prior to the beginning of the research, which allowed us to know their preferences: salsa, bachata, samba, bomba del Chota, merengue, reguetón and soca. This allowed the participants to stay motivated and with greater adherence to the training.

Together with a trained and knowledgeable observer of the process, the participants' resistance was successfully measured prior to the start of the research and at the end of the research. The results of these measurements are presented in tables below. The survey results are expressed in totals and percentages.

Table 1
Closed Questions Survey

Questions	F (%)
do you attend dance therapy classes frequently?	
Yes	20 (100%)
No	0 (0%)
do you consider that you can improve your physical condition and health through dance therapy classes?	
Yes	20 (100%)
No	0 (0%)
do you know of any training methods applied to dance therapy classes that improve endurance?	
Yes	0 (0%)
No	20 (100%)
have you participated in dance therapy classes in which there are no breaks between dances and the intensity is variable throughout the session?	
Yes	4 (20%)
No	16 (80%)
would you like to have dance therapy classes that improve your stamina and health?	
Yes	20 (100%)
No	0 (0%)
would you like to receive more information about a training method applied to dance therapy and the benefits it brings to your health?	
Yes	20 (100%)
No	0 (0%)
do you believe that physical activity and exercise can prevent some diseases?	
Yes	20 (100%)
No	0 (0%)

Note: F, frequency, %, percentage.

Partial Fatigue

From the results obtained, it can be seen that there is a significant increase in the resistance observed in the partial fatigue pre-evaluation, with a mean of 12.95 minutes, and the partial fatigue post-evaluation, with a mean of 22.75 minutes, with a confidence level of 0.05, observing a value of p =.000.

Table 2

Paired Samples Statistics

	Variable	Media	N	Standard deviation	Mean standard error
Par 1	PreCanPartial	12,9500	20	7,47962	1,67249
	PostCanPartial	22,7500	20	7,09985	1,58758

Note: N, number, PreCanPartial, Pre partial fatigue, PostCanPartial, Post partial fatigue.

Table 3

Paired Samples Correlations

	Variable	N	Correlation	Sig.
Par 1	PreCanPartial & PostCanPartial	20	,953	,000

Note: N, number, Sig, significance, PreCanPartial, pre partial fatigue, PostCanPartial, Post partial fatigue.

Table 4

Paired Samples Test

		Matched differences					T	l	Sig. (bilateral)
					95% interval trusted of the difference				
Variable		Media	Standard deviation	Media from error standard	Inferior	Superior			
Par 1	PreCanPartial-PostCanPartial	-9,80000	2,26181	,50576	-10,85856	-8,74144	-19,377	19	,000

Note: t, t-statistic, SD, standard deviation, gl, degrees of freedom, Sig, significance, PreCanPartial, PrePartial fatigue, PostCanPartial, PostPartial fatigue.

Total Fatigue

From the results obtained, it can be seen that there is a significant increase in the resistance observed in the pre-evaluation of total fatigue, with a mean of 19.80 minutes, and in the post-evaluation of total fatigue, with 30.40 minutes, with a confidence level of 0.05, observing a value of p =.000.

Table 5

Paired Samples Statistics

	Variable	Media	N	Standard deviation	Mean standard error
Par 1	PreCan Total	19,8000	20	6,84874	1,53143
	PostCan Total	30,4000	20	8,37540	1,87280

Note: N, number, PreCanTotal, pre total fatigue, PostCanTotal, Post total fatigue.

Table 6
Correlation of Paired Samples

	Variable	N	Correlation	Sig.
Par 1	PreCanTolal & PostCanTotal	20	,948	,000

Note: N, number, Sig, significance, PreCanTotal, PreTotal fatigue, PostCanTotal, PostTotal fatigue.

Table 7
Paired Samples Test

		Matched differences					T	gl	Sig. (bilateral)
					95% interval trusted of the difference				
	Variable	Media	Standard deviation	Media from error standard	Inferior	Superior			
Par 1	PreCanTolal - PostCanTotal	-10,60000	2,87274	,64236	-11,94448	-9,25552	-16,502	19	,000

Note: t, t-statistic, gl, degrees of freedom, sig, significance, PreCanTotal, PreTotal fatigue, PostCanTotal, PostTotal fatigue.

Discussion and conclusions

So far, there is no information available regarding the benefits of the continuous variable method applied in aerobic dance classes for the improvement of endurance, this being the first to be carried out, but there are studies such as Labrador et al. (2021), in which they agree with other research on the application of an aerobic endurance training method with work phases above the anaerobic threshold and active recovery phases interspersed as the most effective for improving the functional capacity of patients with acute coronary syndrome, as opposed to the continuous harmonic method of constant intensity, also mentioning the safety that this method presents, since it does not have sudden passive rest interruptions that can produce possible arrhythmic events, thus demonstrating the benefits of the continuous variable method. Comparing it with the present study, it was possible to effectively demonstrate an improvement in the basic physical endurance capacity of the research participants and therefore an improvement in their physical condition.

Observation of the data shows that there is a significant increase in both the evaluation of partial fatigue and total fatigue. Based on these findings, the null hypothesis is rejected and the alternative hypothesis is accepted, which establishes that the application of the continuous variable method in the planning of the dance therapy classes improves the resistance of the participants. These results are in line with Rubio and Cano (2021), who concluded that the application of the variable continuous *fartlek* method in a group of mountain trail runners improves aerobic endurance, giving greater running capacity and improving both the maximum aerobic speed and the maximum aerobic power of each athlete.

In relation to the time of partial fatigue pre and post intervention, the results obtained were very important, with a notable improvement. The data confirm that the mean partial fatigue before the application of the continuous variable method was 12.95 minutes and at the end of the intervention it was 22.75 minutes. Another author who seconds this result obtained in the research is Conlago (2019), who expresses that by applying fartlek training in athletes preparing for the marathon using constant changes of rhythm and going from the aerobic to the anaerobic threshold, it was possible to improve the physical condition, therefore, the increase of Vo2 Max, evaluated through Fisher's test.

Another result obtained from the present investigation was a significant increase in the mean total fatigue. The data show that before the intervention, total fatigue averaged 19.80 minutes and after the intervention, it averaged 30.40 minutes. According to Vrijens (2006), endurance is "the ability to sustain dynamic or static work for as long as possible". These results confirm that there was an improvement in this capacity by increasing the dynamic work time before reaching total fatigue as a result of the application of the continuous variable method.

Ulloa(2020), carried out a study in which the improvement in the physical capacities of endurance is confirmed, in addition to allowing a playful work in senior soccer players when using this modality of continuous variable method (fartlek), which is comparable with the benefits obtained by the participants of the research, in terms of the improvement of endurance and the fun of training under the continuous variable method.

Dancing is currently considered a tool to improve health, in this study 100% of the participants consider that this activity can improve their physical condition and health. This result is supported by studies such as those of Rodríguez et al. (2021), who when evaluating the benefits of dance therapy combined with Tae Bo, obtained a decrease in BMI values, weight in kilograms, skin folds, and abdomen-waist diameter. In addition to this, a decrease in heart rate and in the results of the Ruffier-Dickson functional test, which evidences the improvement of the functions of the cardiovascular system. In this same study, it was determined that greater adherence to dance therapy is generated through the use of dance music with rhythms that are heard on the radio and national television and are danced to at parties and popular activities; this result was also observed in the present study in which the participants felt more motivated and in certain cases shouted or chanted during the session when listening to the songs of their preference.

In another research carried out by Avila and Murcia (2021), the positive effect generated by electronic music in a resistance training with first semester university students was determined, which ratifies the results obtained on the frequency with which the participants attend the dance therapy training (100% attend frequently), as music is one of the elements that dance needs to facilitate motivation and adherence.

In a study by Jiménez et al. (2015), to measure the benefits of dance therapy and its impact on vulnerability to stress, found the appreciation of the low levels of satisfaction of the sample under study by the activities they practiced due to their poor relationship with their tastes and preferences before the implementation of the program. This result is closely related to the results of the present investigation, in which 100% of the participants stated that they frequently attend dance therapy classes, thus confirming the high levels of motivation that the participants of the study have for this activity and the importance of offering programs that are in accordance with the tastes and preferences of the practitioners.

According to Salinas (2018), sport specialists have a great responsibility towards their clients, part of those responsibilities are: to systematically teach and communicate ideas and notions, to provide information to the practitioner about the benefits of physical exercise and the positive impact on quality of life. In relation to this explanation, the present study effectively detected that 100% of the research participants would like to receive more information about some training method applied to dance therapy and the benefits it brings to their health.

100% of the participants believe that physical activity and exercise can prevent some diseases, this result is supported with the study of Gonzalez and Rivas (2018), which indicates that there is strong scientific evidence, which supports the benefits of physical activity and exercise, on women's health in more than twenty-five medical conditions, including cardiovascular disease and premature mortality, producing beneficial effects on the immune, hemostatic, autonomic, metabolic and hormonal systems among others.

Villaquirán et al. (2020), in their research, conclude that the results found in their study were favored by performing a correct design and prescription of the exercise, which validates the present study that adapted the training method to the characteristics of the participants, taking into account that resistance training methods have been studied more in the field of competitive sport and high performance.

Unlike the studies mentioned in this section, the present research focuses on the benefits obtained in the improvement of endurance by applying the continuous variable method in dance classes. The results obtained from the research promote the main question of the study, about the incidence of the application of the continuous variable method in the planning of the dance therapy classes to improve the resistance of the participants.

Conclusions

The efficacy of the the proposal of application of the continuous variable method in the dance therapy classes to achieve the improvement of the participants' resistance is proved to be effective. As for determining the concepts, types of resistance and characteristics of the continuous variable method, it was verified that they facilitate their application at the time of planning the dance therapy classes in accordance with the objectives set out in them and in search of an improvement in the resistance and physical condition of those who participate in these classes, avoiding improvisation in this type of training.

Measuring the initial level of resistance of the participants of the dance therapy classes allows the correct application of the variable continuous training method and the correct monitoring of progress, which results in greater motivation on the part of the participants knowing that they are constantly being evaluated and in the achievement of the objectives in terms of reaching a better resistance at the end of a training period. Likewise, the correct selection of musical genres, adjusting them to the culture and traditions of the participants, allows for greater motivation, adherence to the program and therefore progress over time.

It was found that adapting the continuous variable method to the characteristics of the participants allows gradual progress in the loads, generating adherence to the training and avoiding possible injuries. On the other hand, the continuous variable method adapts favorably to dance classes, being a very good option if you want to improve the resistance of the people who participate in this type of sessions.

It is concluded that the continuous variable method produces beneficial effects for health and the improvement of endurance by increasing the capacity to maintain a dynamic work as long as possible to maintain dynamic work for as long as possible.

It is recommended, for future studies, to carry out a control through variables such as heart rate or maximum oxygen consumption, in order to enhance the results of the research. Likewise, it would be convenient, research on other resistance training methods that can be applied to aerobic dance classes to respond to the different objectives and needs of individuals. On the other hand, it is convenient to carry out evaluations at the end of each planning period, contrasting the results with the initial evaluation in order to make improvements, changes or continue with the medium and long term plan

Based on the objectives and the hypothesis proposed in relation to the participants from Pedro J. Montero Parish of Yaguachi Canton, it is suggested that through the National Police of Ecuador, the Community Police of Yaguachi Canton and the parish GAD, training for coaches, instructors and monitors should be carried out through talks or workshops on the application of the continuous variable method in the planning of dance therapy classes for the improvement of resistance. In the same way, and tbased on the results obtained, it is recommended to design a manual on the application of the continuous variable method in the planning of aerobic dance classes to improve the endurance of the participants.

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SYSTEMATIC REVIEW ON SPEED IMPROVEMENT IN U19 SOCCER PLAYERS

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Summary. The objective was to compare and analyze the effectiveness of different training methodologies for speed improvement in U-19 soccer players. A systematic review literature study was carried out. Using the PRISMA statement, a literature search was performed using the PubMed database. We included articles that were intervention studies written in Spanish or English, conducted in players aged 10 to 19 years, that had at least one plyometric, strength or sprint training method for speed improvement and that had an evaluation of sprinting. The results of the interventions showed benefits in the improvement of speed through the plyometric method (TE=0.66) in 20 m test, explosive strength (TE=0.64) in 5 m test and sprint (TE=0.33) in 20 m test. It can be concluded that the explosive strength method obtains greater benefits in short distances (5-10 m) when low intensities are used and in 17-year-old players, the ideal training volume is 2 sessions per week. The sprint method over longer distances (20-30 m) at ages 14-15, with a training volume of one or two sessions per week. Plyometrics achieves the same benefits over short and long distances (5-30 m) for ages 15-16 years and without notable differences in training volume.

Key words: Plyometric, explosive strength, sprint, training, method, test.

SYSTEMATIC REVIEW ON SPEED IMPROVEMENT IN U-19 SOCCER PLAYERS

Abstract. The objective was to compare and analyze the effectiveness of different training methodologies for speed improvement in U-19 soccer players. A systematic review literature study was carried out. Using the PRISMA statement, a bibliographic search was carried out through the PubMed database. Articles were included that were intervention studies written in Spanish or English, carried out in players aged 10 to 19 years that had at least one plyometric, strength, or sprint training method for speed improvement and that had an evaluation of sprinting. The results of the interventions showed benefits in speed improvement through the plyometric method

(TE=0.66) in 20 m test, explosive strength (TE=0.64) in 5 m test, and sprint (TE=0.33) in 20 m test. It can be concluded that the explosive strength method obtains greater benefits in short distances (5-10 m) when low intensities are used and in 17-year-old players; the ideal training volume is 2 sessions per week. The sprint method at longer distances (20-30 m) in 14-15-year-olds, with a training volume of one or two sessions per week. Plyometrics achieves the same benefits over short and long distances (5-30 m) for ages 15-16 years with no noticeable difference in training volume.

Keywords: Plyometric, explosive strength, sprint, training, method, test.

Introduction

Soccer is a sport that is in continuous expansion and more and more people have a federative license, both in the senior category and in grassroots soccer (Sedano Campo et al., 2007). According to the Royal Spanish Football Federation (RFEF), in the 09/10 season the number of federative licenses was 781,415 while, in the 15/16 season, the federation reached 923,805 federated members (RFEF, 2017). This has led to an increase in the creation of clubs and sports schools, where players start from pre-benjamin (7 years old) to youth (18 years old) (Sedano Campo et al., 2007).

In soccer, performance depends both on individual skills, as well as on the interaction of different players in the same team (Haugen et al., 2014). In addition, it is conditioned by speed, strength and power levels which, in turn, are reflected in sprints, jumps and changes of direction (Jiménez-Reyes et al., 2017). Therefore, in order to become a good soccer player, optimal development in basic skills must be achieved (Haugen et al., 2014).

The continuous evolution of soccer means that more and more schemes, numerous analyses, new ways of playing and new variables are emerging. The pace of the games is progressively higher and so is the intensity (Barraza Gómez et al., 2011). The movements must be performed at a higher speed, and this makes it a very important aspect nowadays, as it can be decisive in the outcome of a match (Beato et al., 2018). One of the main characteristics that soccer has is that its activity profile is intermittent, predominantly changes of direction (COD), accelerations and decelerations, jumps and small recovery periods (Beato et al., 2018). Speed will depend on two variables: i) the internal variable; in which factors such as morphological proportions, number of fast fibers, running technique of each player, speed at which the muscles contract, attention and technical-tactical knowledge are present; and, ii) external factors; such as weather conditions, the state of the terrain or the material used (Barraza Gómez et al., 2011).

Throughout a match, players perform a high number of sprints, however, the duration of these sprints is low (Sedano Campo et al., 2007). Each player executes between 17 and 81 sprints, with a duration of 2 to 4 seconds, over maximum distances of 20 meters (Marzouki et al., 2021). Per match, an average of 9 to 12 km is covered per player, between 8% and 12% of that distance occurs at high intensity (Haugen et al., 2014). Similarly, the maximum sprint speed in a match is around 32 km/h, occurring in most cases without a ball (Marzouki et al., 2021). A study conducted in the English Premier League from 2006 to 2013 determined that, over the 7 seasons, both sprint distance and number of sprints increased by 35% and high intensity actions increased by 50% (Loturco, Jeffreys, et al., 2020). Another study that was carried out in the German premier league analyzed through different videos, 360 goals from which they managed to extract that: in 45% of the goals, the player who scored a goal, previously performed linear sprints mostly without opponent and without ball (Haugen et al., 2014).

In the research literature, straight-line sprinting is classified as acceleration, maximal running speed and deceleration (Haugen et al., 2014). Numerous game analyses have verified that, more than 90% of the total number of sprints performed in a match are in less than 20 meters (Haugen et al., 2014). Fifty percent of sprints performed at maximum speed occur at distances less than 12 m, 20% range from 12 m to 20 m and 15% between 20 and 30 m (Hernandez et al., 2012). This makes the acceleration capacity very important, so it would be convenient to parameterize the speed in ranges of no more than 30 meters.

In soccer, having more speed, power and acceleration over the opponent means having a great advantage, therefore, numerous researches have focused on how sprinting and jumping performance is developed through different training methods such as; sprint training, sprinting against resistances, training through weights, training combining resistance and sprinting or plyometric training (Asadi et al., 2018).

Plyometric training is both popular and effective in producing improvements in sprint power and performance (Beato et al., 2018). Plyometric exercises are based on a specific methodology that enjoys strong support from the scientific literature (Beato et al., 2018). Such methodology focuses on jumping exercises in which the muscle action used is the shortening-stretching cycle (Beato et al., 2018). It is a type of training that is easy to implement as well as effective, therefore, it is attributed as the right approach to achieve performance improvements with respect to soccer, such improvements can be related to neuromuscular adaptations; although these may differ depending on the characteristics of the players and fundamentally maturation (Asadi et al., 2018).

Repeated sprint ability (RSA) is the ability to repeat sprints with short recovery intervals (Haugen et al., 2014). It is a method that, in team sports, has gained great importance in recent years (Haugen et al., 2014). On the other hand, speed is a capacity that depends largely on strength work (Sedano Campo et al., 2007). Usually in research works on strength training in soccer, the most studied aspect is related to the effects on speed (Hernandez et al., 2012).

It can be seen that there are numerous methods for speed improvement. Therefore, the aim of the present study is to compare and analyze the effectiveness of different training methodologies for speed improvement in U-19 soccer players.

Method

For the preparation of this systematic review, a thorough search for articles was carried out using the PubMed database. The keywords used were: "sprint", "soccer", "training" and "young". To make the item search more specific, Boolean operators (AND/AND, OR/OR and NOT/NOT) were used. For the selection of articles, the following inclusion criteria were marked; (1) interventions performed on soccer players aged between 10 and 19 years, (2) that included at least one plyometric, strength or sprint training method for speed improvement and (3) that included an evaluation of sprinting. The exclusion criteria used were; (1) articles written in a language other than Spanish or English, (2) involving women and (3) combined training methods.

Results

Figure 1 shows the flow diagram of the systematic review.

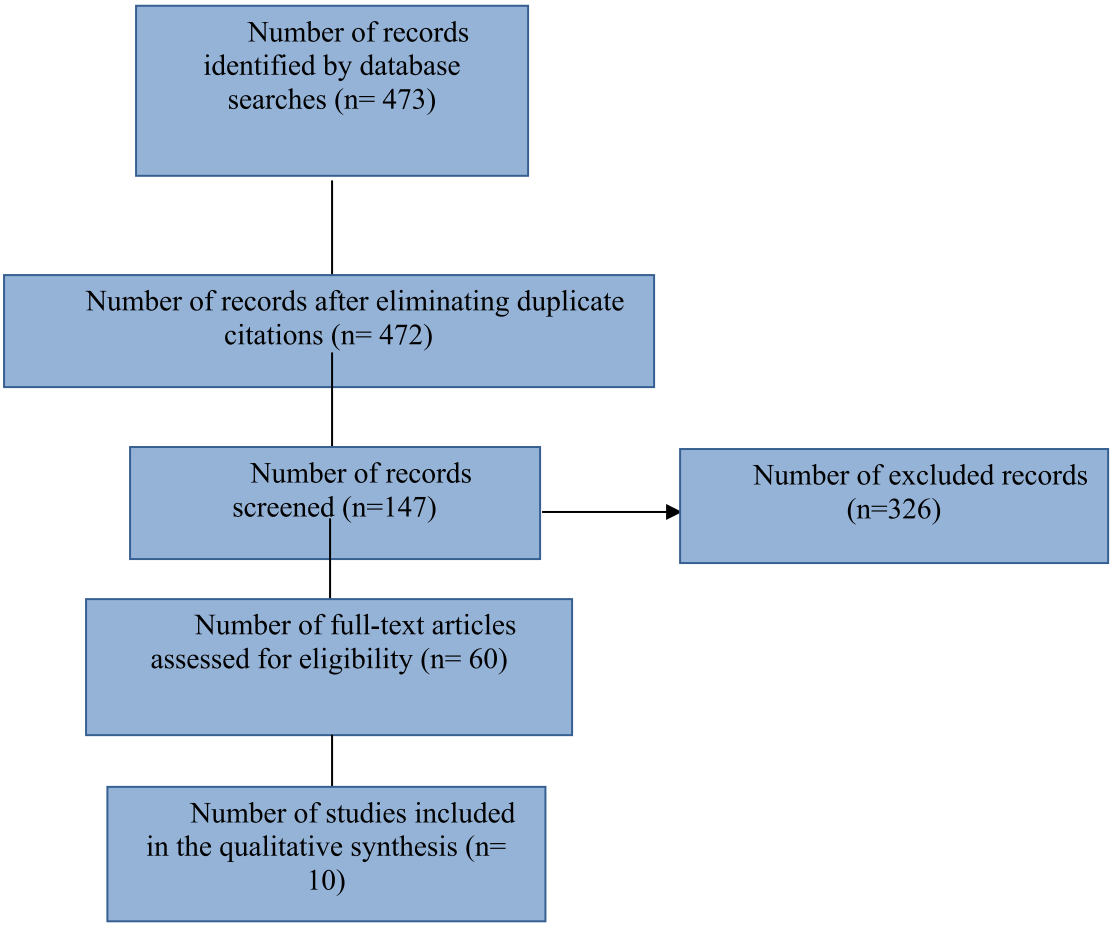

Figure 1. Flow chart.

Table 1

Description of intervention studies

AUTHORS	PARTICIPANTS	METHOD	INTERVENTION	RESULTS
Asadi et al., 2018	N= 60 -Age: 11-16 -They were divided into 3 groups depending on maturity: -10 players between 11 and 12 years old (GE1), 10 players between 11 and 12 years old (GC1). -10 players between 13 and 14 years old (GE2), 10 players between 13 and 14 years old (GC2). -10 players between 15 and 16 years old (GE3), 10 players between 15 and 16 years old (GC3).	Plyometric	6 weeks -GE: 3 days per week they performed soccer training and 2 days per week plyometric training. The plyometric exercises consisted of 2x10 jumps with drops from 20, 40 and 60 cm Intensity: 100% Rest period between repetitions and sets: 7 and 120 s -GC: 3 days a week they performed soccer training, without plyometric training.	Tests for data collection: -Test: 20 m sprint (pre and post intervention). -GE1: (4.48 ± 0.85 vs 4.3 ± 0.75) TE= -0.12 -GC1: (4.72 ± 0.77 vs. 4.7 ± 0.8) -GE2: (3.82 ± 0.48 vs 3.53 ± 0.45) TE= -0.58 -GC2: (3.76 ± 0.37 vs. 3.71 ± 0.33) -GE3: (3.83 ± 0.52 vs 2.8 ± 0.4) TE= -0.66 -GC3: (3.09 ± 0.68 vs. 3.07 ± 0.59)
Bianchi et al., 2018	N= 21 -Age: 17 ± 0,8 -10 players performed low volume plyometric training (LVP). -11 players performed high volume plyometric training (HVP).	High and low volume plyometric	8 weeks -PBV: Once a week, 4x5 drop jumps from 60cm, jump over two 15cm high hurdles, 4x6 horizontal jumps, 4x6 jumps over 15cm high hurdles. -PAV: Same training, but twice a week.	Tests for data collection: -Test: 10, 30 and 40 m sprint (pre and post intervention). -PBV: 10 m: (1.84 ± 0.08 vs. 1.79 ± 0.08) 30 m: (4.25 ± 0.15 vs. 4.19 ± 0.15) 40 m: (5.48 ± 0.24 vs. 5.27 ± 0.27) -PAV: 10 m: (1.85 ± 0.07 vs. 1.77 ± 0.08) 30 m: (4.36 ± 0.16 vs. 4.26 ± 0.15) 40 m: (5.52 ± 0.18 vs. 5.46 ± 0.17)
	N= 32 -Age: 17-18		8 weeks All players performed 2 sessions per week of their specific method. -F:	Tests for data collection: -Test: 10, 20 and 30 m sprint (pre and post intervention). -F:

De Hoyo et al., 2016	Three training groups were formed, each group performed one method. -11 players were part of the strength group (F). -12 players were part of the resisted sprint group (SRE). -9 players were part of the plyometric group (P).	Strength, resisted sprinting and plyometrics	Full squat: 2-3 sets x 4-8 repetitions. Intensity: 40-60% 1RM. Rest: 3 min between sets. -SRE: Resisted sprint: 6-10 sets of 20 m. It was performed with a sled equivalent to 12.6% of the player's body mass. Rest: 3 min between sets. -P: Plyometric: 1-3 sets x 2-3 repetitions. Intensity: 100%. Rest: 3 min between sets. Exercises: unilateral crosses jumps + 15 m sprint, unilateral alternate jumps + 15 m sprint, unilateral lateral jumps (40 cm).	10 m: (1.67 ± 0.05 vs 1.68 ± 0.08) TE= -0.31 20 m: (2.95 ± 0.09 vs. 2.94 ± 0.10) TE = 0.05 30 m: (4.11 ± 0.12 vs 4.07 ± 0.11) TE= 0.32 -SRE: 10 m: (1.72 ± 0.05 vs 1.71 ± 0.06) TE= 0.11 20 m: (3.00 ± 0.07 vs 2.99 ± 0.08) TE = 0.05 30 m: (4.22 ± 0.12 vs 4.19 ± 0.13) TE= 0.21 -P: 10 m: (1.72 ± 0.07 vs 1.72 ± 0.08) TE= 0.02 20 m: (2.99 ± 0.08 vs 2.98 ± 0.12) TE= 0.12 30 m: (4.17 ± 0.11 vs 4.13 ± 0.17) TE= 0.35
Loturco et al., 2019	N= 23 -Age: 18,3 ± 0,7 Two groups were formed depending on the maximum peak power achieved in the jump squat. -11 players trained with a load above 20% of peak power (GE1) -12 players trained with a load below 20% of peak power (GE2)	Explosive strength	4 weeks All players performed 3 power-oriented training sessions per week. The exercises that were carried out were as follows: -Squat with jump: 6x6 repetitions. The GE1 group with a load 20% higher than the peak power, the GE2 group 20% lower. This loading intensity was chosen because at ± 20% of maximum peak, players produce 90% of their maximum power output in the jump squat.	Tests for data collection: -Test: 5, 10 and 20 m sprint (pre and post intervention). -GE1: (expressed in meters per second) 5 m: (5.03 ± 0.34 vs 5.13 ± 0.22) TE= 0.26 10 m: (5.86 ± 0.27 vs 5.92 ± 0.23) TE= 0.23 20 m: (6.79 ± 0.25 vs. 6.83 ± 0.26) TE= 0.15 -GE2: (expressed in meters per second) 5 m: (5.12 ± 0.17 vs 5.24 ± 0.23) TE= 0.64 10 m: (5.91 ± 0.18 vs 5.98 ± 0.26) TE= 0.41 20 m: (6.84 ± 0.21 vs. 6.84 ± 0.26) TE= 0.03

Moran et al., 2017	N= 17 -Age: 13.6 ± 0.7 (GE), 14.5 ± 1.0 (GC). - 7 players were part of the experimental group (EG). -10 players were part of the control group (CG).	Sprint	1 weekly session -GE: During the session they performed 16 sprints over a distance of 20m. Rest: 90 s between each sprint -GC: They continued with their usual training program.	Tests for data collection: -Test: 10 and 20 m sprint (pre and post intervention). -GE: 10 m: (1.93 ± 0.10 vs 1.89 ± 0.07) TE= 0.51 20 m: (3,35 ± 0,14 vs 3,30 ± 0,15) TE= 0,33 -GC: 10 m: (1.92 ± 0.11 vs 1.89 ± 0.13) TE= 0.29 20 m: (3.33 ± 0.22 vs 3.28 ± 0.23) TE= 0.24
Black et al., 2018	N= 29 -Age: 13 ± 0,7 -13 players performed plyometric training with load (PCC) -16 players performed plyometric training without load (PSC)	Plyometric with and without load	8 weeks -PCC (all exercises with weighted vest, 8% of body mass) Once a week, bilateral ankle jumps forward (fence height: 20cm), jump against movement. Volume: 4-6 sets, 6-10 repetitions. Ground contacts: 50 the first session, gradually increasing to 120 in the last session. Rest: 90 s between sets. -PSC Same training, but without additional load.	Tests for data collection: -Test: 5, 10 and 20 m sprint (pre and post intervention). -PCC: 5 m: (1.3 ± 0.1 vs 1.2 ± 0.1) TE= 1.00 10 m: (2.2 ± 0.1 vs 2.0 ± 0.1) TE= 2.00 20 m: (3.8 ± 0.2 vs 3.6 ± 0.2) TE= 1.00 -PSC: 5 m: (1.2 ± 0.1 vs 1.1 ± 0.1) TE= 1.00 10 m: (2.1 ± 0.1 vs 2.0 ± 0.2) TE= 0.63 20 m: (3.7 ± 0.3 vs 3.6 ± 0.3) TE= 0.33
Nuñez et al., 2019	N= 20 -Age: 17 ± 1 -10 players performed the strength training and acceleration exercise with conical pulley (GE). -10 players performed only strength training (QA).	Force + conical pulley	9 weeks GE performed all 4 exercises, while GC performed 3 (excluding CP training). The following 4 exercises were performed: -Full squat: 3x4-6 repetitions. Intensity: 30-40% 1RM. -Sled training: 2-3 repetitions of 20 m. Sled weight: 15-20% of body mass. -CP training (conical pulley): 2-3x6 repetitions. Intensity: concentric average power. -Plyometric: 2-3x4 repetitions.	Tests for data collection: -Test: 10 and 20 m sprint (pre and post intervention). -GE: 10 m: (1.69 ± 0.06 vs 1.65 ± 0.04) TE= -0.78 20 m: (2.96 ± 0.08 vs 2.90 ± 0.07) TE= -0.66 -GC: 10 m: (1.64 ± 0.05 vs 1.63 ± 0.05) TE= -0.30 20 m: (2.85 ± 0.09 vs 2.82 ± 0.09) TE= -0.38

Otero-Esquina et al., 2017	N= 36 -Age: 17,0 ± 1,0 -12 players performed 1 session per week (GE1). -12 players performed 2 sessions per week (GE2) -12 players did not perform the strength training (GC)	Force	7 weeks 4 exercises carried out in the following order: -Full back squat: 3x4-6 repetitions. Intensity: 40-55% 1RM. Rest: 3 min between sets. -Yo Yo leg curl: 2x4, 3x4, 3x5 and 3x6 repetitions, every two weeks increase. Rest: 2 min between sets. -Plyometric: (box jumps, drop jumps feet together, hurdle jumps) 1x3-6 repetitions per session. Rest: 1 min between repetitions. -Resisted sprint: 3-5 repetitions of sprint 20 m.	Tests for data collection: -Test: 10 and 20 m sprint (pre and post intervention). -GE1: 10 m: (1.70 ± 0.06 vs 1.70 ± 0.05) TE= -0.3 20 m: (2.99 ± 0.07 vs. 2.98 ± 0.08) TE= 0.3 -GE2: 10 m: (1,71 ± 0,05 vs 1,69 ± 0,05) TE= 1,4 20 m: (2.98 ± 0.09 vs 2.93 ± 0.11) TE= 1.5 -GC: 10 m: (1.74 ± 0.04 vs 1.74 ± 0.05) TE= 0.5 20 m: (3.04 ± 0.05 vs 3.04 ± 0.06) TE= 0.1
Pavillon et al., 2020	N= 55 -Age: 14-18 -27 players were part of the sprint change of direction (SCD) group. -28 players were part of the linear sprint (SL) group.	Linear and change of direction sprint	30 weeks They carried out 2 sessions of specific training per week. The exercises performed were as follows: -SCD: 3 short and intense exercises, 4 sets x 10 repetitions. 20 m distance in 5 s intervals. Rest: 25 s between repetitions. Sprint totals: 1200 -SL: Back and forth sprints of 20 m (10 out and 10 back), 2 sets x 10 repetitions. Rest: 25 s between repetitions. Sprint totals: 1200	Tests for data collection: -Test: 5 and 10 m sprint (pre and post intervention). -SCD: U-15, 17 and 19 5 m: (1.19 ± 0.07 vs. 1.14 ± 0.02) sub-15 10 m: (2.03 ± 0.10 vs. 2.14 ± 0.06) sub-15 5 m: (1.17 ± 0.08 vs. 1.05 ± 0.03) U-17 10 m: (1.93 ± 0.10 vs. 1.79 ± 0.12) U-17 5 m: (1.20 ± 0.08 vs 1.08 ± 0.2) u-19 10 m: (1.94 ± 0.11 vs. 1.84 ± 0.03) U-19 -SL: U-15, 17 and 19 5 m: (1.21 ± 0.07 vs. 1.15 ± 0.02) sub-15 10 m: (2.06 ± 0.09 vs. 2.25 ± 0.23) sub-15 5 m: (1.14 ± 0.06 vs. 1.31 ± 0.03) U-17 10 m: (1.95 ± 0.09 vs 2.07 ± 0.13) U-17 5 m: (1.20 ± 0.09 vs 1.11 ± 0.21) U-19 10 m: (1.94 ± 0.09 vs 1.85 ± 0.03) u-19

Rey et al., 2019	N= 27 -Age: 14,5 ± 0,5 -14 players performed one session per week of repeated sprinting (SR1). -13 players performed two sessions per week of repeated sprinting (SR2).	Repeated sprint	6 weeks -SR Training: 2-6 sets of 4-6 x 15 to 30 m of maximal straight line sprints. Intensity: 100% Rest: 20 s of passive recovery between repetitions. 240 s between sets.	Tests for data collection: -Test: 5, 10 and 20 m sprint. Repeated sprint skill test (6 maximum sprints of 25 m). -SR1: 5 m: (1.05 ± 0.53 vs. 1.05 ± 0.91) 10 m: (1.87 ± 0.99 vs. 1.85 ± 0.11) 20 m: (3.31 ± 0.15 vs. 3.23 ± 0.21) TM: (4.20 ± 0.17 vs. 4.12 ± 0.20) TMR: (4.08 ± 0.16 vs. 4.02 ± 0.21) TT: (25.17 ± 1.03 vs. 24.71 ± 1.21) -SR2: 5 m: (1.04 ± 0.52 vs. 1.04 ± 0.54) 10 m: (1.84 ± 0.09 vs. 1.81 ± 0.11) 20 m: (3.28 ± 0.15 vs. 3.23 ± 0.22) TM: (4.20 ± 0.20 vs. 4.08 ± 0.19) TMR: (4.06 ± 0.19 vs. 3.97 ± 0.16) TT: (25.18 ± 1.23 vs. 24.46 ± 1.13)

Note: TE: Size effect, GE: Experimental group, GC: Control group, SR: Repeated sprint, TM: Average time, TMR: Faster time, TT: Total time, RM: Maximum repetition, CP: conical pulley, PBV: Plyometric low volume, PAV: Plyometric high volume, F: Strength, P: Plyometric, SRE: Resisted sprint, PCC: Plyometric with load, PSC: Plyometric without load, SCD: Sprint with change of direction, SL: Linear sprint.

Discussion and conclusions

The objective of this study is to compare and analyze the effectiveness of different training methodologies for the improvement of speed in U-19 soccer players. With a plyometric exercise program have been widely implemented as a training method for sports performance improvement (Bianchi et al., 2019). This training method is mainly performed with jumps, in which the aim is to generate maximum power levels (Sáez-Sáez et al., 2009) .In the review, 3 articles that implemented such method in their soccer players were included (Asadi et al., 2018; Bianchi et al., 2019; Negra et al., 2020). In all the articles, improvements were observed in the 10, 20, and 30 m sprint performance. The improvement obtained in the 20 m sprint may be due to the maturity effect, as there were greater changes in the GE3 group (15-16 years) than in the GE1 (11-12) and GE2 (13-14) groups, all 3 groups performed two plyometric trainings per week with the same exercises and intensity (Asadi et al., 2018). Stride speed and stride length condition running performance, both elements are influenced by anthropometric characteristics so, the results obtained in the more mature group are due to the anthropometric change between groups (Asadi et al., 2018). Higher training volume could not be shown to produce changes in sprint performance (Bianchi et al., 2019). The low and high volume groups showed improvements after applying the method, but showed no differences between them. This may be because two sessions instead of one session per week is not enough to obtain significant differences in young elite players, who are used to 4 sessions per week (Bianchi et al., 2019). Therefore, it is advisable to employ low-volume plyometric training that is equivalent to 80-100 jumps per week (Bianchi et al., 2019). In plyometric training with and without load, improvements were obtained in both groups, but greater in the group with load (PCC) (Negra et al., 2020). This may be due to the higher eccentric load attributed to the loaded group (Coratella et al., 2018). Increased eccentric overload during loaded training may have produced improvements in central nervous system efficiency, tendon muscle tissue stiffness and muscle activation (Negra et al., 2020).

Sprint acceleration is a fundamental aspect of physical performance in team sports (Morin et al., 2017). What will determine the sprint acceleration profile is the ability the player has to produce high levels of mechanical power (Morin & Samozino, 2016). Power production basically depends on ground reaction forces going in the postero anterior direction only if the movement is performed at high contraction velocities (Morin et al., 2017). Because of this, plyometric training can be an effective way to train power as it involves jumping exercises in which the stretch-shortening cycle is used, which can elicit improvements in the neural and muscle-tendon systems to produce the greatest possible force in the shortest amount of time (Beato et al., 2018).

A further 3 strength articles were added and included in the review (Loturco et al., 2020; Nuñez et al., 2019; Otero-Esquina et al., 2017). In explosive strength training with heavy and light load (± 20% maximum peak power), the light-loaded group obtained better scores than the heavy-loaded group in the 5 and 10 m tests (Loturco et al., 2020). Although the reason for this is unclear, it can be speculated to be related to the lower fatigue levels produced by light loads compared to heavy loads (Loturco et al., 2020). Strength training using conical pulley proved to be more beneficial at distances of 10 meters than at distances of 20 meters, even so, the expected benefits were not obtained (Nuñez et al., 2019). The improvements in the 10 meters may be due to the fact that the training routine was based on squat, sled and plyometric exercises, which makes it have an additional effect to improve the ability to accelerate in the first meters (Nuñez et al., 2019). Delivering this method once a week for 9 weeks does not seem to be sufficient to get the maximum benefit from the device (Nuñez et al., 2019). On the other hand, in terms of volume, the execution of two explosive strength training sessions per week elicited greater benefits than one session per week in linear sprint performance (Otero-Esquina et al., 2017). By applying two sessions per week increase lower body strength levels, players produced higher levels of reaction strength, greater momentum and higher rate of strength development after workouts, conducive to higher training performance and improvements in linear sprinting ability (Otero-Esquina et al., 2017).

An article analyzing the strength (full barbell squat), plyometric and resisted sprint method across different groups was included in the review (de Hoyo et al., 2016). In all 3 groups, substantial improvements were only found in the 30 m sprint (de Hoyo et al., 2016). This may be because the loads implemented have been low (40-60% 1RM in barbell squat and 12.6% body mass in repeated sprint), as numerous studies that have employed higher loads in strength training (80% 1RM) or repeated sprint (20% body mass) have provided improvements in the early phases of sprinting (de Hoyo et al., 2016).

Sprinting is an action that occurs continuously in soccer, so the inclusion of sprinting in a speed training program is a fundamental factor (Rumpf et al., 2011). We added 3 articles related to sprint training (Moran et al., 2018; Pavillon et al., 2021; Rey et al., 2019).

In the linear sprint, no differences were noted between the experimental and control groups (Moran et al., 2018). This is due to the phenomenon of adolescent clumsiness, whereby the motor coordination of young people is temporarily disrupted because of rapid growth of the limbs and trunk at 13-14 years of age (Moran et al., 2018). At these ages the body is in continuous change, it is recommended to decrease the volume of sprint training and increase the volume of endurance training to optimize a correct development, since biological maturation can derive in increases in sprint speed regardless of the training method employed (Moran et al., 2018). Linear and change of direction sprint training produced significant changes in sprinting in U-15, U-17 and U-19 soccer players, although the results were very similar in all age groups (Pavillon et al., 2021). These changes can be related to improvements in technique, greater stride, greater strength in the lower extremities, even improved body coordination (Pavillon et al., 2021). Improvements in change-of-direction sprinting are associated with an improvement in lower extremity strength produced by the large number of turns performed, high braking forces in deceleration and propulsive forces in acceleration make increased strength demands on the lower extremities (Pavillon et al., 2021). One or two sessions per week of repeated sprinting are equally effective in the development of the 20-m sprint, but are not effective in the development of the 5- and 10-m sprint (Rey et al., 2019). Improved 20 m performance is closely related to different metabolic adaptations, such as increases in muscle metabolites (phosphocreatine and glycogen) in addition to neuromuscular changes, changes in contractile properties, and increases in muscle fiber recruitment, activation frequency, and motor unit synchronization (Rey et al., 2019). More specific training strategies (plyometric, sprint with resistance) are necessary to obtain improvements in 5 and 10 m (Rey et al., 2019).

To conclude, this review aimed to compare and analyze the effectiveness of different training methodologies for speed improvement in U-19 soccer players. Each method produces more or less improvement in sprint performance depending on variables such as volume, age of maturation or the exercises that have been implemented in each method. It can be concluded that the explosive strength method obtains greater benefits in short distances (5-10 m), at low intensities and in 17-year-old players, the ideal training volume seems to be 2 sessions per week. On the other hand, the sprint method obtains better results at longer distances (20-30 m), at ages 14-15 and with a volume of one or two sessions per week. It seems that at 14-15 years of age repeated sprinting is more indicated while at 17-18 years of age it is linear sprinting. Likewise, the plyometric method achieves the same benefits over short and long distances, and is most effective in players aged 15-19 years. In volume there seems to be no noticeable difference, the most advisable is a low volume training equivalent to 80-100 jumps per week. From all this, it can be concluded that there is no perfect method that improves speed in all areas, i.e., each method must be applied according to the characteristics and needs of the players.

This review has some limitations that are explained below: the great variability in the ages of the players analyzed in the articles makes it difficult to establish an optimal age range on which to focus the review. In this line, the period of time in which the interventions are applied is short and different in most of the articles (6-9 weeks), which means that the results do not reflect the expected adaptations.

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