The impact of a Yoga training program on muscle contractile properties in elite football players

El impacto de un programa de entrenamiento de Yoga en las propiedades contráctiles musculares en jugadores de fútbol de élite

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Abstract

Introduction: Yoga challenges the body in many ways, can be an important complementary technique with a highly positive impact on football training.
Aims: Soccer players undergoing additional Yoga training improve the contractile properties of their lower limb muscles. Methodology: Twenty-one professional soccer players, 1st Portuguese Soccer League, seniors U-23 - B, participated voluntarily and were randomly divided: Experimental Group (EG), Control Group (CG), all evaluated by tensiomyography, in the right/left biceps femoris muscles (BFE/E), right/left rectus femoris (RFR/E), right/left vastus medialis (VMR/E), right/left vastus lateralis (VLR/E), before training and after 12 weeks of Yoga. EG practiced Yoga at the end of the training, 12 weeks, 2 sessions/week, 60 minutes/each, guided by a certified teacher with 40 years of experience. Yoga techniques were selected and ordered for the purposes of the study: pránáyáma (breathing), ásana (psychophysical), yoganidrá (relaxation), samyama (concentration, meditation, etc.).
Results: Comparing (%) EG and CG in terms of evolution from the 1st moment (baseline) to the 2nd moment (final), we verified statistically significant differences for the variables: left biceps femoris muscle (LBF): Time Contraction (-13.06 vs 0.29), Time Delay (-1.16 vs 1.54); Displacement (-2.17 vs 2.99), the evolution being significantly greater in EG, with improvements in some muscle groups after Yoga, compared to the CG. No effect was observed in other muscle groups.
Discussion/Conclusions: More studies are needed to clarify the impact of Yoga on the contractile properties of muscles in improving the performance of professional footballers.

Keywords

Injury; muscle contractile properties; soccer; tensiomyography; yoga.

Resumen

Introducción: El Yoga desafía al cuerpo de diversas maneras y puede ser una técnica complementaria importante con un impacto muy positivo en el entrenamiento de fútbol.
Objetivos: Los futbolistas que realizan entrenamiento adicional de Yoga mejoran las propiedades contráctiles de los músculos de las extremidades inferiores.
Metodología: Veintiún futbolistas profesionales de la 1.ª Liga Portuguesa de Fútbol, categoría sénior Sub-23 - B, participaron voluntariamente y se dividieron aleatoriamente en: Grupo Experimental (GE) y Grupo Control (GC). Todos fueron evaluados mediante tensiomiografía en los músculos bíceps femoral derecho/izquierdo (BFE/E), recto femoral derecho/izquierdo (RFR/E), vasto medial derecho/izquierdo (VMR/E) y vasto lateral derecho/izquierdo (VLR/E), antes del entrenamiento y después de 12 semanas de Yoga. El GE practicó Yoga al final del entrenamiento, durante 12 semanas, con 2 sesiones semanales de 60 minutos cada una, guiadas por un profesor certificado con 40 años de experiencia. Se seleccionaron y ordenaron las técnicas de Yoga para el estudio: pránáyáma (respiración), ásana (psicofísica), yoganidrá (relajación), samyama (concentración, meditación, etc.).
Resultados: Al comparar (%) la evolución del GE y el GC desde el primer momento (inicio) hasta el segundo (final), se verificaron diferencias estadísticamente significativas para las variables: músculo bíceps femoral izquierdo (LBF): Tiempo de contracción (-13,06 vs. 0,29), Retardo (-1,16 vs. 1,54); Desplazamiento (-2,17 vs. 2,99), siendo la evolución significativamente mayor en el GE, con mejoras en algunos grupos musculares después del Yoga, en comparación con el GC. No se observó ningún efecto en otros grupos musculares.
Discusión/Conclusiones: Se necesitan más estudios para aclarar el impacto del Yoga en las propiedades contráctiles de los músculos y mejorar el rendimiento de los futbolistas profesionales.

Palabras clave

Lesión; propiedades contráctiles musculares; fútbol; tensiomiografía; yoga.

Introduction

Yoga developed in India over five thousand years ago as a set of values, norms, and techniques (Feuerstein, 2006), a system that teaches how to train the body and mind in the expansion of consciousness, as a direct and broad path to human transcendence (Calazans, 2020). In other words, it is an essentially practical method that aims to lead to samádhi, a state of hyperawareness or self-knowledge (DeRose, 2024). Therefore, it is necessary to distinguish Yoga as a practice that emerges from the vastness of older Indian traditions, while Yoga as a doctrinal or philosophical system emerges later, based on this practice but rooted in interpretations related to closed groups and shared interests or beliefs. It presents itself as a philosophy rather than the oldest original practice (Mallinson & Singleton, 2022), consisting of a systematized set of techniques, which we use in this research. Thus, Yoga is presented as a method that challenges the body of athletes with a very positive impact on football practice and training by using alternative training methodology and important complementary techniques replacing traditional methods (Polsgrove, Eggleston, Lockyer, 2016). In this way, the application of Yoga as a complementary tool to usual training can be an interesting trainning methodology to present another vision regarding modifications in sports training related to injury prevention (Arbo, Brems, Tasker, 2020).

Football is a complex team sport, the complexity of which can be seen from a biomechanical perspective (e.g., movements around all axes and through all planes, different levels in the manifestation of strength and power), metabolic (e.g., multi-energy requiremnts to execute intermittent exercises in both high- and low-intensities, like sprints, jumps and multiple changes of direction at maximum effort), technical and tactical (Fernández-Baeza, Diaz-Urena, González-Millán, 2022). High-level footballers make between 1,000 and 1,400 changes of movement during a game, with several high-intensity actions and multiple sprints at almost maximum intensity (Redd et al., 2021), in which muscle contractile properties are important characteristics of football players (Fernández-Baeza, Diaz-Urena, González-Millán, 2022), allowing them to perform increasingly longer sprints during the game in order to create goal-scoring situations.

Therefore, it is a paradox that typical football preparation negatively affects players' neuromuscular development, due to the interference observed between endurance training, strength-power training and technical-tactical sessions. The coaching team constantly faced with an extra challenge to reconcile the appropriate volume of ball training - aerobic load - and to preserve the neuromuscular capacities that allow football players to physical dispute the demands of contemporaneous football game (Loturco et al., 2016; Fernández-Baeza, Diaz-Urena, González-Millán, 2022), avoiding impairments to neuromuscular performance that could increase the risk of injuries, especially in the hamstrings during faster runs, accelerations, and deceleration efforts. This means that significant muscular strength imbalances can increase muscle discomfort and lead to a high risk of hamstring strains, due to the performance of various repetitive movements, which can be injury-inducing factors in sports (Fernández-Baeza, Diaz-Urena, González-Millán, 2022; Cancino-Jiménez et al., 2025). High-speed running or acceleration efforts account for 60% of hamstring injury cases in football, representing a total of 12% of lower limb injuries in major European leagues, with 37% of all muscle injuries occurring during football practice, and in 80% of these cases involving the long head of the biceps femoris (Cancino-Jiménez et al., 2025).

The neuromuscular system of football players is extremely important for their competitive performance (Fernández-Baeza, Diaz-Urena, González-Millán, 2022), so muscle stiffness, strength, and elasticity are fundamental for better performance. In football, precision and dynamic control are required, which highlights the importance of maintaining stability and control during repetitive and high-speed actions, as these heavily depend on these muscular capabilities (Ismaeel et al., 2025). Meanwhile, it has been observed that weekly training demands can alter muscle stiffness, serving as an indicator of injury risk if elevated levels of stiffness are present before training (Rey et al., 2020). This is because muscle stiffness is extremely important for maintaining stability, reducing deformation under stress, and simultaneously being an efficient transmitter of force, as emphasized by studies on its importance for executing complex motor tasks performed in football. At the same time, muscle strength and elasticity are vital for force production and rapid recovery from deformation, contributing to improved athletic performance (Ismaeel et al., 2025).

Tensiomyography (TMG) emerged in the early 1990s and was developed by Professor Valencic, at the Faculty of Electrical Engineering at the University of Ljubljana (Slovenia), with the main aim of assessing muscle tone in patients with neuromuscular diseases (Garcia et al., 2016). Subsequently, this technology began to be used in sport due to the work carried out at the Biomedical Visualisation and Muscle Biomechanics Laboratory and at the Computational Electromagnetics Laboratory at the University of Ljubljana. The expansion of TMG to sport was the result of the growth of studies at the universities and following the work carried out with the Slovenian Olympic team during their preparation for the Sydney Olympic Games in 2000 and the 2002 Winter Olympic Games held in Salt Lake City. Thus, the university developed a simple method for measuring skeletal muscle response with implications for athletic performance (Garcia et al., 2016).

Additionaly, TMG is recognised as a competent tool that analyses the contractile properties of muscles, assessing post-exercise stiffness and neuromuscular status without generating extra fatigue or relying on extra encouragement. It is a harmless, non-aggressive, non-invasive, highly reliable method for identifying the state of the muscles and has been developed to assess the mechanical and contractile properties of skeletal muscle in response to electrical stimuli without any physical effort, fatigue or changes to the athlete's training routine. A portable device is used to measure the properties of individual superficial muscles, recording isometric muscle contraction induced externally by electro-stimulation, thus responding to the specific demands of the sport or the needs of the athlete, who is only subjected to moderate- or low-intensity electrical stimulation (from 1 to 110 mA). In this way, TMG provides information on muscle stiffness or tone, contraction speed, predominant skeletal muscle fibre type, muscle fatigue, body asymmetry, training on the mechanical and contractile properties of all superficial skeletal muscles, allowing an individual assessment of all superficial muscles to be achieved, through precise information on the acute and chronic response of the muscle and according to the different training loads (e.g., strength, endurance, speed, flexibility), as well as their internal characteristics, training status or level of application (Rojas-Valverde et al., 2015; Alvarez-Diaz et al., 2016; Garcia et al., 2016; Macgregor et al., 2018; Rey et al., 2020; Fernández-Baeza, González-Millán, 2020; Redd et al., 2021; Fernández-Baeza, Diaz-Urena, González-Millán, 2022; Pajovic et al., 2023; Pakosz et al., 2023).

There are few studies evaluating the impact of Yoga on the performance of the skills used in football, raising concerns that Yoga could reduce the performance of football players due to the use of its long static stretches and that it could decrease the rate of production of strength and agility (Raj, Hamlin, Elliot, 2021; Freund et al., 2016). However, some researchers have reported mixed results when assessing the effects of flexibility on speed, athletic performance and jumping, which has led to some undue interpretation and debate, especially regarding the link that stretching has with subsequent explosive performance (Raj, Hamlin, Elliot, 2021), leading to a great controversy in the literature regarding the effects of static and dynamic stretching (Freund et al., 2016). On the other hand, Afonso et al. (2024) in a wide-ranging systematic review state that there is scientific consensus on the importance of the benefits of stretching on flexibility and ROM (range of movement) (Behm, Blazevich, Kay, McHugh, 2016; Freitas, et. al, 2018; Afonso et al., 2024), and that there is a broad, homogeneous body of research that substantiates this importance, as well as being an integral part of internationally recognised guidelines on the indication of exercises (Afonso et al., 2024).

However, as mentioned above, the effectiveness of stretching in general terms raises some doubts since it is not homogeneous (Afonso et al., 2024). On the other hand, Ajayaghosh & Mahadevan (2018) investigated the effect of functional strength and Yoga training and concluded that the practice of Yoga showed a positive development of strength in footballers, revealing statistically positive effects on strength. Similarly, Kartal & Ergin (2020) concluded that the regular practice of Yoga can promote a higher level of performance in soccer players, positively improving their motor qualities, such as strength, flexibility and balance. Furthermore, the application of Yoga in soccer methodology allows athletes to become more aware of their bodies and the signals it transmits to them, by acquiring a greater ability to recognize small symptoms before they become more widespread and, thus, it will be an important and effective means of preventing injuries.

The present study aimed to analyse the impact of a 12-week Yoga training programme on the contractile properties of muscles in elite football players. We expected that football players undergoing additional Yoga training improve the contractile properties of lower limb muscles, as been demonstrated by Ravi

(2016) and Rey et al. (2020), considering its integration into football training (Arbo, Brems, Tasker, 2020; Polsgrove, Eggleston, Lockyer, 2016).

Method

Participants

The sample totaled twenty-one male professional footballers of the 1st Portuguese Football League, senior sub-23 and B-Team (Age: 19.0 ± 1.89 yr, Height: 182.5 ± 6.02 m, Body mass: 75.55 ± 5.69 kg, Body mass index: 22.4 ± 1.30, Fat mass: 9.7 ± 2.53%, Lean mass: 65.7 ± 4.65 kg), [Table 1] that voluntarily participated in this study and were randomly assigned into one of the following groups: Experimental (EG) and Control (CG). All participants were healthy, with no reports of major injuries in the lower limbs and or use of medication at the time of the intervention. Written informed consent was provided by all participants prior to the study (or by their parents for underage players) after having received an oral explanation of the possible risks and benefits resulting from participation in this investigation. The study was approved by the Ethics Committee of the Faculty of Physical Education and Sport of the Lusófona University of Lisbon (Protocol D1221) and was carried out in accordance with the Declaration of Helsinki. The players were tested before and after a 12-week Yoga program, with 2 weekly 60min sessions, guided by a certified Yoga instructor with more than 40 years of experience.

Table 1. Morphological characterisation of the sample.

Group	Experimental Group (n = 11)	Control Gorup (n = 10)
	M ± SD	M ± SD
Age (years)	18.9 ± 1.9	19.9 ± 1.9
Height (cm)	185.2 ± 6.4	181.6 ± 5.3
Weight (kg)	77.1 ± 6.1	75.8 ± 5.4
BMI (kg/m2)	22.4 ± 1.2	23.0 ± 1.4
Weight (kg)	77.1 ± 6.1	75.8 ± 5.4
Fat Mass (%)	10.4 ± 2.7	9.8 ± 2.5
Lean Mass (%)	67.2 ± 5.3	64.6 ± 4.0

Procedure

Study design

The Yoga intervention was designed exclusively for football players and according to the variables under study, and a quasi-experimental study was carried out. The EG performed a total of 24 Yoga sessions over 12 weeks, with two 60min Yoga sessions per week after football training, guided by a Yoga teacher with over 40 years of professional experience. The Yoga techniques were selected and ordered according to the aim of the study: pránáyáma (breathing techniques), kriyá (abdominal contractions), ásana (psychophysical techniques), yoganidrá (relaxation), samyama (concentration, meditation, etc.). The CG only completed standard football training.

Instrument

Tensiomyography test

TMG works by observing the geometric changes that occur in the muscle belly when the muscle is contracted. In this study we worked on four lower limb muscles, namely: Vastus lateralis (VL); Vastus medialis (VM); Rectus femoris (RF) and Biceps femoris (BF). Muscle contraction is provoked by an electrical impulse through surface electrodes placed at the proximal and distal ends of the muscle, so that the stimulus does not affect the tendons of the insertion muscles. The sensor is placed facing forwards, at the point of greatest preponderance of the muscle belly and perpendicular to it, namely midway between the two electrodes, where the muscle receives the electrical stimulus. In this way, it is possible to detect small changes in the thickness of the muscle when an involuntary contraction takes place, adapted to the intensity caused by the electrical stimulus.

Measurement procedure

The TMG used a highly precise mechanical sensor that is applied directly to the skin, with a constant, pre-defined pressure according to each protocol (0.7-0.8 N/mm2). The sensor must be applied perpendicularly to the muscle belly and directed towards its potential displacement. This ensures that minimal changes in the thickness of a muscle are recognised when it performs an involuntary contraction that is adapted to the intensity produced by the electrical stimulus. The contraction is the response to the bipolar electric current, which lasts one millisecond, with an increasing and/or constant intensity, depending on the protocol used. Thus, the muscle receives an electrical stimulus via two electrodes placed at the proximal and distal ends of the muscle being assessed, so as not to damage the insertion tendons. The variables measured: Delay time (Td, ms), Contraction time (Tc, ms), Sustain time (Ts, ms), Relaxation time (Tr, ms) and Displacement (Dm, mm) (Garcia et al., 2016; Hanney et al., 2022; Buoite Stella et al., 2022; Pajovic´ et al., 2023).

Yoga Practice

At the end of the training session, a 12-week Yoga intervention was carried out on the football pitch, in 24 sessions, twice a week, with each session lasting 60 minutes, of SwáSthya Yoga techniques, adapted, selected and ordered according to the objectives of this research: conscious breathing (pránáyáma), abdominal contractions (kriyá), psycho-physical (ásana), relaxation (yoganidrá) and concentration/meditation (dháraná/dhyána).

The following conscious breathing techniques (pránáyáma) were practised: slow breathing and fast breathing. Slow breathing: abdominal (adhama pránáyáma) or complete (rajas pránáyáma) simple, which also introduced the four main contractions (bandhas). Compression of the tip of the tongue on the roof of the mouth (jíhva bandha), retention with air (kumbhaka) and retention without air (sunyaka) the three contractions together (bandha traya): chin on the chest, on the upper part of the sternum (jalándhara bandha), contracted abdominal muscles creasing the lower ribs (uddiyana bandha) and contraction of the sphincters of the anus and urethra (múla bandha) and the alternating breathing without rhythm (nádí shôdhana pránáyáma). Fast breathing: strong exhalation through the mouth, of the Ha sound (Ha breath); fast breath (bhástrika), nasal inhalation and exhalation, strong, fast and noisy with breathless retention at the end, with the usual contractions (jálandhara, uddiyana and múla bandha) and slow breath (kapálabhati), nasal inhalation, silent and passive, with strong, rapid, noisy and abrupt exhalation.

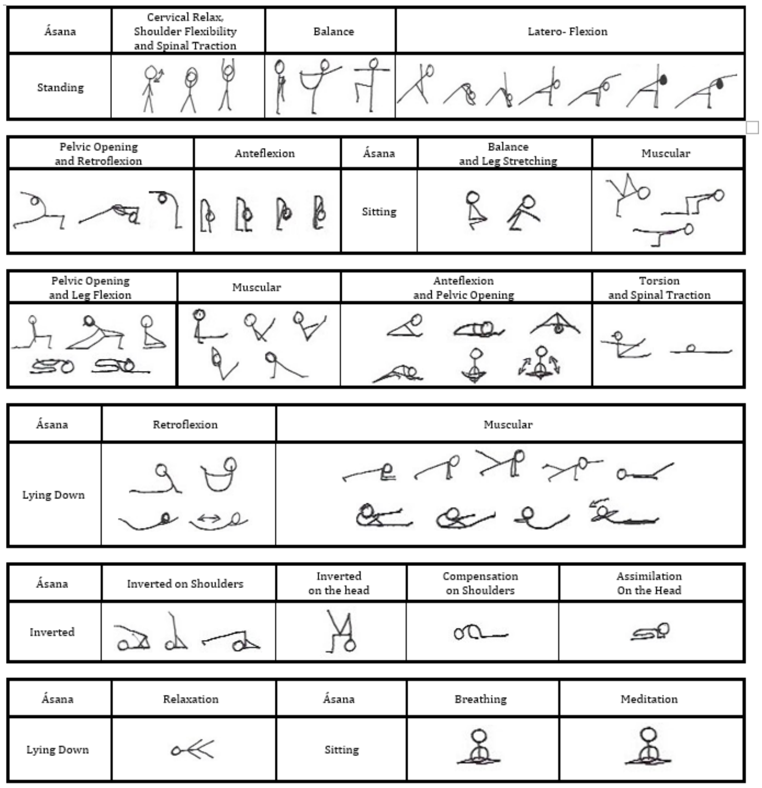
To perform the abdominal contractions (uddiyana bandha), you should stand in both static (tamas uddiyana bandha) and dynamic (rajas uddiyana bandha) positions, with your feet one to two palms apart, legs bent, torso inclined, hands on thighs. When exhaling, the abdomen should be contracted inwards and upwards, holding it like this as long as the breath is held, with empty lungs, and when necessary inhaling to finish a contraction. After performing three static variants, the dynamic variant was also practised, with the difference that the abdomen was dynamically contracted and distended for as long as the air in the lungs remained empty, ending when it was necessary to inhale.

When practising the psycho-physical techniques (ásana), as shown in Table 2, a balanced series was used, without repetitions, consisting of standing, sitting, lying and inverted positions, plus balancing positions, lateral flexion, anteflexion, retroflexion, torsion, spinal traction and pelvic amplitude, in which we remained for the time recommended by the teacher, in coherence with the General Rules of Swásthya Yoga (Yoga of self-sufficiency), Breathing freely, in order to maintain comfort and good sense, (ásana is any firm, stable and comfortable position: classic definition of ásana), returning before there is discomfort. It's important to note that the practice of ásanas (psycho-physical techniques), in the traditional form, such as that used by Swásthya Yoga, is carried out slowly and gradually, with specific or static positions, in which proper breathing and greater concentration on the position are used. In this sense, emphasis is placed on staying static and long in the position, associated with respiratory awareness during the time you stay in the position, emphasising a longer exhalation to facilitate relaxation during the time you stay in the exercise, along with locating your awareness at the culmination point of the position, i.e. where the position is most demanding on your attention, when this is easy and comfortable to do, you can add the visualisation or mentalisation of a colour bathing the place where there is muscular or joint demand, such as sky blue to relax or orange to tone, or you can visualise the most perfect and comfortable execution of that position. As a safety rule, it should be borne in mind that any symptoms of pain or discomfort, respiratory or cardiac acceleration, excessive heat or perspiration should be avoided.

In relaxation (yoganidrá), the induction technique was used, from the feet to the head, followed by assimilation/utilisation (through visualisation), so that the athletes could improve their flexibility, balance, strength, speed, agility and ability to change direction.

In concentration/meditation (dháraná/dhyána), concentration was used on the breath itself, in order to be more aware of it, without analysing or correcting thoughts, letting it flow, without thinking about anything, naturally accepting the dispersions that the mind makes, but always bringing the focus back to the breath. The Yoga techniques were performed with eyes closed to facilitate concentration/meditation and awareness of what was being done.

Figure 1. Ásana Balancing



Data analysis

The statistical analysis was conducted using SPSS (Statistical Package for the Social Sciences) version 28 for Windows, involving descriptive statistics (absolute and relative frequencies, means, standard deviations, and 95% confidence intervals) and inferential statistics. The Student's t-test for independent samples, the Student's t-test for paired samples, the Mann-Whitney test, and the Wilcoxon test were used. Additionally, Cohen's standardised difference or effect size (d) was utilised. Cohen's effect size cut-off values were 0.2 (small), 0.5 (moderate), and 0.8 (large) (Cohen, 1988). The normality of the distribution was analysed using the Shapiro-Wilk test, and the homogeneity of variances using Levene's test. When the homogeneity of variances was not satisfied, the Student's t-test for independent samples with Welch's correction was used. The significance level was set at $\alpha \leq .05$.

Results

The results obtained of Control Group (CG) and Experimental Group (EG) during the implementation phase of the Yoga programme at the first and second time points are present in Table 3 and Table 4.

From the first time point (baseline) to the second time point (final), we observed that the CG shows highly significant differences in the Left Biceps Femoris muscle (BFE), in Td (ms), $t(6) = -3.950$, d = -

1.493, p = 0.008, (20.85 vs 21.39), in Dm (mm), t(6) = -5.262, d = -1.989, p = 0.002, (5.04 vs 7.51) (Table 3). Significant differences were observed in Td (ms) (t(6) = 2.507, d = 0.947, p = 0.046, (19.29 vs 18.46) in the Right Vastus Lateralis muscle. No significant differences were found in the remaining variables.

Table 3. Evolution of the Control Group from the 1st Moment (baseline) to the 2nd Moment (end) of the Yoga Training Programme Implementation.

		Before	After	95% CI			
		M ± SD	M ± SD	LL	UL	d	p
RBF	Tc (ms)	31.55 ± 14.68	33.08 ± 15.27	-22.886	13.241	-0.247	0.538
	Td (ms)	21.73 ± 3.21	21.58 ± 1.84	-2.611	1.516	-0.245	0.541
	Tr (ms)	66.77 ± 26.83	69.32 ± 24.21	-26.678	16.872	-0.208	0.602
	Dm (mm)	7.30 ± 3.90	7.12 ± 3.09	-3.096	2.202	-0.156	0.694
	Ts (ms)	190.60 ± 46.95	192.29 ± 16.79	-53.929	49.775	-0.037	0.925
LBF	Tc (ms)	33.70 ± 14.65	27.72 ± 64.35	-4.487	3.899	-0.065	0.869
	Td (ms)	20.85 ± 2.66	21.39 ± 2.32	-2.494	-0.586	-1.493	0.008**
	Tr (ms)	52.17 ± 16.89	62.59 ± 29.07	-28.377	15.989	-0.258	0.520
	Dm (mm)	5.04 ± 2.28	7.51 ± 2.51	-4.380	-1.600	-1.989	0.002**
	Ts (ms)	196.34 ± 58.00	190.01 ± 24.44	-36.999	65.751	0.259	0.519
RRF	Tc (ms)	29.63 ± 3.35	31.59 ± 6.46	-6.718	3.766	-0.260	0.517
	Td (ms)	23.39 ± 2.00	22.47 ± 1.19	-1.339	2.376	0.258	0.520
	Tr (ms)	63.89 ± 49.03	54.12 ± 51.22	-14.328	50.076	0.513	0.223
	Dm (mm)	8.09 ± 2.37	9.13 ± 2.20	-3.285	0.799	-0.563	0.187
	Ts (ms)	105.60 ± 53.51	98.81 ± 58.58	-18.068	52.031	0.448	0.281
LRF	Tc (ms)	32.61 ± 3.54	29.80 ± 1.99	-0.056	6.136	0.908	0.053
	Td (ms)	22.65 ± 1.14	22.12 ± 2.40	-2.385	2.236	-0.030	0.940
	Tr (ms)	80.22 ± 43.80	49.48 ± 40.54	-28.608	91.174	0.483	0.248
	Dm (mm)	7.44 ± 2.09	9.13 ± 3.48	-6.029	1.589	-0.539	0.204
	Ts (ms)	128.32 ± 54.13	92.49 ± 49.67	-31.777	92.983	0.454	0.275
RVL	Tc (ms)	20.55 ± 2.66	20.78 2.79	-2.775	1.532	-0.267	0.507
	Td (ms)	19.29 ± 1.27	18.46 ± 1.30	0.016	1.318	0.947	0.046*
	Tr (ms)	41.50 ± 31.00	42.08 ± 38.51	-39.342	35.771	-0.044	0.911
	Dm (mm)	4.67 ± 1.78	5.12 ± 1.70	-1.520	0.569	-0.421	0.308
	Ts (ms)	70.32 ± 41.51	77.54 ± 50.97	-46.639	26.474	-0.255	0.525
LVL	Tc (ms)	20.41 ± 1.83	20.42 ± 1.75	-1.936	1.441	-0.135	0.732
	Td (ms)	19.70 ± 1.45	18.53 ± 1.13	-0.178	2.449	0.800	0.079
	Tr (ms)	34.28 ± 21.69	33.29 ± 28.42	-1.329	10.067	0.709	0.110
	Dm (mm)	4.94 ± 1.78	5.55 ± 1.62	-2.276	0.602	-0.538	0.204
	Ts (ms)	63.62 ± 26.87	56.92 ± 29.22	-4.838	26.535	0.640	0.142
RVM	Tc (ms)	23.73 ± 3.75	23.89 ± 2.48	-3.895	3.964	0.008	0.984
	Td (ms)	20.64 ± 1.30	19.52 ± 1.94	-0.677	3.120	0.595	0.167
	Tr (ms)	73.17 ± 62.55	51.41 ± 19.46	-48.578	84.944	0.252	0.530
	Dm (mm)	7.34 ± 2.23	7.23 ± 2.18	-0.669	2.101	0.478	0.253
	Ts (ms)	206.99 ± 39.56	176.12 ± 43.08	-24.343	109.014	0.587	0.171
LVM	Tc (ms)	22.59 ± 2.22	22.53 ± 2.02	-0.350	0.770	0.347	0.394
	Td (ms)	20.09 ± 1.35	19.45 ± 1.13	-0.346	1.506	0.579	0.176
	Tr (ms)	58.48 ± 41.64	63.75 ± 51.57	-46.433	48.493	0.020	0.959
	Dm (mm)	6.59 ± 1.74	7.63 ± 1.44	-2.288	0.862	-0.419	0.311
	Ts (ms)	171.61 ± 66.47	177.05 ± 31.28	-17.670	60.281	0.506	0.230

Right Biceps Femoris (RBF), Left Biceps Femoris (LBF); Right Rectus Femoris (RRF), Left Rectus Femoris (LRF); Right Vastus Lateralis (RVL), Left Vastus Lateralis (LVL); Right Vastus Medialis (RVM), Left Vastus Medialis (LVM).
M – Mean SD – Standard Deviation * $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

When comparing the evolution of the Experimental Group (EG) from the first moment (baseline) to the second moment (final), statistically significant differences were found in Tc (ms), t(8) = 3.153, d = 1.051, p = 0.014, (41.84 vs 30.27) for the Left Biceps Femoris (LBF), as well as in Dm (mm), t(8) = -2.858, d = -0.862, p = 0.017, (7.92 vs 9.46); for the Left Rectus Femoris (LRF). Highly significant differences were also observed in Tc (ms), t(10) = -3.863, d = -1.165, p = 0.003, (20.84 vs 22.49) and significant differences in Tr (ms), t(10) = 2.720, d = 0.820, p = 0.022, (62.53 vs 35.56), and Ts (ms), t(10) = 2.369, d = 0.714, p = 0.039, (97.74 vs 72.78) for the Right Vastus Lateralis (RVL). In the Left Vastus Medialis (LVM), significant differences were found in Tc (ms) t(10) = -2.344, d = -0.707, p = 0.041, (22.30 vs 23.46) and in Tr (ms) Z = -2.490, d = -1.025, p = 0.013, (63.91 vs 103.06). No significant differences were observed in the remaining variables.

Table 4. Evolution of the Experimental Group from the 1st moment (baseline) to the 2nd moment.

		Before	After	95% CI		d	p
		M ± SD	M ± SD	LL	UL		
RBF	Tc (ms)	38.22 ± 15.08	34.14 ± 6.13	-5.931	14.093	0.274	0.385
	Td (ms)	22.31 ± 3.01	23.41 ± 2.28	-3.146	0.948	-0.361	0.259
	Tr (ms)	90.53 ± 31.19	75.48 ± 32.67	-10.432	40.527	0.397	0.218
	Dm (mm)	7.43 ± 3.41	7.80 ± 3.05	-2.734	1.991	-0.106	0.733
	Ts (ms)	182.84 ± 44.60	194.37 ± 31.82	-37.762	14.700	-0.295	0.350
LBF	Tc (ms)	41.84 ± 15.06	30.27 ± 9.35	3.509	22.615	1.051	0.014*
	Td (ms)	23.70 ± 2.80	22.88 ± 2.45	-0.564	2.882	0.517	0.160
	Tr (ms)	80.64 ± 30.20	75.95 ± 48.49	-42.294	48.823	0.055	0.873
	Dm (mm)	8.77 ± 2.82	6.68 ± 3.26	-0.603	4.949	0.602	0.109
	Ts (ms)	186.64 ± 16.19	153.54 ± 67.88	-32.306	67.810	0.273	0.437
RRF	Tc (ms)	29.74 ± 6.24	29.51 ± 6.07	-2.611	3.053	0.052	0.865
	Td (ms)	24.00 ± 3.23	23.27 ± 1.61	-0.991	2.451	0.285	0.367
	Tr (ms)	80.74 ± 53.30	69.51 ± 51.47	-36.786	59.239	0.157	0.614
	Dm (mm)	8.36 ± 1.93	9.07 ± 1.92	-1.555	0.131	-0.567	0.089
	Ts (ms)	124.85 ± 57.05	108.17 ± 52.65	-37.536	70.891	0.207	0.509
LRF	Tc (ms)	30.97 ± 7.17	28.36 ± 5.13	-3.374	8.591	0.293	0.354
	Td (ms)	22.52 ± 2.00	23.05 ± 2.03	-1.721	0.646	-0.305	0.336
	Tr (ms)	64.75 ± 44.96	73.35 ± 56.42	-56.770	39.565	-0.120	0.699
	Dm (mm)	7.92 ± 1.77	9.46 ± 1.30	-2.744	-0.340	-0.862	0.017*
	Ts (ms)	121.10 ± 61.19	110.86 ± 56.84	-46.332	66.803	0.122	0.695
RVL	Tc (ms)	20.84 ± 1.75	22.49 ± 1.27	-2.600	-0.698	-1.165	0.003**
	Td (ms)	19.45 ± 1.01	20.30 ± 1.01	-1.772	0.075	-0.617	0.068
	Tr (ms)	62.53 ± 43.35	35.56 ± 17.58	4.875	49.056	0.820	0.022*
	Dm (mm)	4.62 ± 0.94	5.66 ± 1.50	-2.545	0.471	-0.462	0.156
	Ts (ms)	97.74 ± 49.40	72.78 ± 32.01	1.481	48.432	0.714	0.039*
LVL	Tc (ms)	20.66 ± 2.20	21.32 ± 1.12	-1.830	0.505	-0.381	0.235
	Td (ms)	19.42 ± 1.08	19.96 ± 0.90	-1.371	0.297	-0.433	0.182
	Tr (ms)	49.35 ± 37.70	45.44 ± 41.19	-19.453	27.284	0.113	0.717
	Dm (mm)	5.25 ± 1.16	5.77 ± 1.32	-1.583	0.545	-0.328	0.303
	Ts (ms)	73.03 ± 40.05	70.81 ± 44.03	-22.600	27.053	0.060	0.846
RVM	Tc (ms)	23.32 ± 3.13	24.02 ± 2.57	-3.003	1.594	-0.206	0.510
	Td (ms)	19.98 ± 1.01	20.12 ± 1.11	-1.295	1.012	-0.083	0.790
	Tr (ms)	84.52 ± 54.82	70.84 ± 49.98	-9.041	36.404	0.405	0.209
	Dm (mm)	6.55 ± 1.74	7.88 ± 2.72	-2.758	0.114	-0.618	0.067
	Ts (ms)	179.98 ± 31.51	176.60 ± 42.70	-34.009	40.778	0.061	0.844
LVM	Tc (ms)	22.30 ± 2.42	23.46 ± 2.70	-2.257	-0.057	-0.707	0.041*
	Td (ms)	19.88 ± 1.27	20.07 ± 1.32	-1.155	0.772	-0.134	0.667
	Tr (ms)	63.91 ± 44.67	103.06 ± 48.52	-64.812	-13.491	-1.025	0.013*
	Dm (mm)	7.48 ± 2.32	7.89 ± 2.47	-1.323	0.497	-0.305	0.336
	Ts (ms)	180.01 ± 28.06	189.74 ± 37.10	-32.105	12.645	-0.292	0.355

Right Biceps Femoris (RBF), Left Biceps Femoris (LBF); Right Rectus Femoris (RRF), Left Rectus Femoris (LRF); Right Vastus Lateralis (RVL), Left Vastus Lateralis (LVL); Right Vastus Medialis (RVM), Left Vastus Medialis (LVM).
M – Mean SD – Standard Deviation * p ≤ .05 ** p ≤ .01 *** p ≤ .001

When comparing the values (percentages) obtained between CG with EG at the end of the 12-week Yoga programme (Table 5), we observed statistically significant differences in Tc (ms), t(14) = 2.690, d = -1.356, p = 0.018, (-13.06 vs 0. 29), highly significant differences in Td (ms), t(14) = -2.593, d = -1.479, p = 0.008, (-1.16 vs 1.54), in Dm (mm), t(14) = 3. 879, d = -1. 779, p = 0.003, (-2.17 vs 2.99) in Left Biceps Femoris (BFE) muscle in favour of the EG. In the Right Vastus Lateralis (VLD), there was a decrease in Td (ms), t(17) = 2.276, d = 1.296, p =0.016 (0.85 vs -0.67) in the EG. We also observed a decrease in the Td (ms), t(18) = 2.769, p = 0.018, (0.54 vs -1.14) of the Left Vastus Lateralis (LV) muscle in the EG. In the Right Vastus Medialis (RVM) we observed an increase in Dm (mm), t(18) = 2.769, d = 1.060, p = 0.044, (1.32 vs -0.72), in favour of the EG. There were no significant differences between the groups in the other contractile properties of the muscle.

Table 5. Comparison (%) between EG and CG in terms of evolution from the 1st moment (baseline) to the 2nd moment (final) of the Yoga Training Application.

		Experimental	Control	95% CI		*d*	*p*
		M ± SD	M ± SD	LL	UL		
RBF	Tc (ms)	-4.08 ± 14.90	4.82 ± 19.53	-26.111	8.304	-0.530	0.289
	Td (ms)	1.10 ± 3.05	0.55 ± 2.23	-2.286	3.390	0.199	0.686
	Tr (ms)	-15.05 ± 37.93	4.90 ± 23.54	-54.051	14.150	-0.600	0.233
	Dm (mm)	0.37 ± 3.52	0.45 ± 2.86	-3.445	3.294	-0.023	0.963
	Ts (ms)	11.53 ± 39.04	2.08 ± 56.07	-37.867	56.775	0.205	0.678
LBF	Tc (ms)	-13.06 ± 12.43	0.29 ± 4.53	-24.005	-2.708	-1.356	0.018*

	Td (ms)	-1.16 ± 2.24	1.54 ± 1.03	-4.671	-0.727	-1.479	0.008**
	Tr (ms)	-3.26 ± 59.27	6.19 ± 23.99	-60.774	41.856	-0.199	0.699
	Dm (mm)	-2.17 ± 3.61	2.99 ± 1.50	-8.300	-2.026	-1.779	0.003**
	Ts (ms)	-17.75 ± 65.12	-14.38 ± 55.55	-69.530	62.777	-0.055	0.914
RRF	Tc (ms)	-0.22 ± 4.22	1.48 ± 5.67	-6.629	3.235	-0.353	0.476
	Td (ms)	-0.73 ± 2.56	-0.52 ± 2.01	-2.640	2.217	-0.089	0.856
	Tr (ms)	-11.23 ± 71.47	-17.87 ± 34.82	-55.249	68.544	0.110	0.823
	Dm (mm)	0.71 ± 1.25	1.24 ± 2.21	-2.250	1.188	-0.317	0.522
	Ts (ms)	-16.68 ± 80.70	-16.98 ± 37.90	-69.277	69.886	0.004	0.993
LRF	Tc (ms)	-2.61 ± 8.91	-3.04 ± 3.35	-7.084	7.947	0.059	0.905
	Td (ms)	0.54 ± 1.76	0.07 ± 2.50	-1.658	2.584	0.224	0.650
	Tr (ms)	8.60 ± 71.70	-31.28 ± 64.76	-31.018	110.789	0.577	0.250
	Dm (mm)	-10.24 ± 84.20	-30.60 ± 67.45	-59.928	100.663	0.260	0.598
	Ts (ms)	1.54 ± 1,78	2.22 ± 4.11	-3.642	2.286	-0.235	0.634
RVL	Tc (ms)	1.65 ± 1.42	0.62 ± 2.33	-0.830	2.886	0.567	0.258
	Td (ms)	0.85 ± 1.37	-0.67 ± 0.70	0.317	2.714	1.296	0.016*
	Tr (ms)	-26.97 ± 32.88	1.79 ± 40.61	-65.623	8.121	-0.799	0.118
	Dm (mm)	1.04 ± 2.24	0.48 ± 1.13	-1.391	2.514	0.295	0.551
	Ts (ms)	-24.96 ± 34.94	10.08 ± 39.53	-72.686	2.608	-0.954	0.066
LVL	Tc (ms)	0.66 ± 1.74	0.25 ± 1.83	-1.400	2.231	0.235	0.634
	Td (ms)	0.54 ± 1.24	-1.14 ± 1.42	0.329	3.017	1.276	0.018*
	Tr (ms)	-3.92 ± 34.78	-4.37 ± 6.16	-27.996	28.903	0.016	0.973
	Dm (mm)	0.52 ± 1.58	0.84 ± 1.56	-1.931	1.295	-0.202	0.681
	Ts (ms)	-2.23 ± 36.96	-10.85 ± 16.96	-23.159	40.403	0.278	0.573
RVM	Tc (ms)	0.70 ± 3.42	-0.03 ± 4.25	-3.108	4.586	0.197	0.689
	Td (ms)	0.14 ± 1.72	-1.22 ± 2.05	-0.533	3.260	0.737	0.147
	Tr (ms)	-13.68 ± 33.82	-18.18 ± 72.19	-48.451	57.453	0.087	0.859
	Dm (mm)	1.32 ± 2.14	-0.72 ± 1.50	0.067	4.008	1.060	0.044*
	Ts (ms)	-3.38 ± 55.66	-42.34 ± 72.10	-24.939	102.841	0.625	0.215
LVM	Tc (ms)	1.16 ± 1.64	-0.21 ± 0.61	-0.013	2.747	1.015	0.052
	Td (ms)	0.19 ± 1.43	-0.58 ± 1.00	-0.549	2.093	0.599	0.233
	Tr (ms)	39.15 ± 38.20	-1.03 ± 51.32	-4.489	84.853	0.922	0.075
	Dm (mm)	0.41 ± 1.35	0.71 ± 1.70	-1.832	1.232	-0.201	0.683
	Ts (ms)	9.73 ± 33.31	-21.31 ± 42.14	-6.753	68.825	0.842	0.101

Right Biceps Femoris (RBF), Left Biceps Femoris (LBF); Right Rectus Femoris (RRF), Left Rectus Femoris (LRF); Right Vastus Lateralis (RVL), Left Vastus Lateralis (LVL); Right Vastus Medialis (RVM), Left Vastus Medialis (LVM).
M – Mean SD – Standard Deviation * $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Discussion

The aim of this study was to evaluate the effect of 12 weeks of Yoga training on the contractile properties of male professional football players. To this end, a practice adapted from Swásthya Yoga (the systematisation of Pre-Classical Yoga) was used, with an emphasis on various deep, conscious, controlled, slow and fast breathing exercises (pránáyáma), abdominal contractions (kriyá), various psycho-physical body positions to stretch the muscles (ásana), along with slow, deep and conscious breathing exercises, relaxation to absorb the effects (yoganidrá), finished with a short, simple meditation (dhyána) and used a sensitive, non-invasive method - Tensiomyography (TMG). The results of this study were inconclusive, although the comparison between the two groups showed that the EG had some improvements in some muscle groups after the Yoga sessions, this effect was not seen in other muscle groups, so we cannot confirm our hypothesis.

TMG method measured the contractile properties associated with the muscle's ability to contract and relax quickly (Tc, Td, Tr) and muscle stiffness (Dm). Traditionally, five parameters of TMG curve are checked: Td (Response time), Tc (Contraction time), Ts (Sustaining time), Tr (Relaxation time) and Dm (Maximum displacement). However, the two most commonly used are Maximum Displacement (Dm) and Contraction Time (Tc), which are also the parameters with the highest level of reliability. Dm (Maximum displacement) is a measure that assesses muscle rigidity, while Tc (Contraction time) can predict the composition of the muscle fibre type (Garcia et al., 2016; Hanney et al., 2022; Buoite Stella et al., 2022; Pajovic´ et al., 2023).

Football players, through the practice of Yoga, can improve the flexibility of their legs, hips and joints, particularly the hamstrings, where they generally feel greater stiffness and thus become more focused during games and reduce the tendency to injure themselves during them (Pereira, Monteiro & Madeira, 2024). From this perspective, adding a Yoga protocol to a rehabilitation programme will be useful for athletes (Liu et al., 2021), as Yoga training can adjust and relieve athletes' excessive tension after training and provide relaxation, enabling them to quickly balance their emotions before training and competition with an enthusiastic rather than nervous attitude. In this way, athletes can adjust their physical and mental fatigue immediately after training and also enable them to maintain a good psychological adjustment in training and in life (Wang, 2023).

In football, the quadriceps play a crucial role in running, jumping and shooting, while the hamstrings manage running and give stability to the knee when rotating or trying to clear the ball. Risk factors for injury include fatigue, lack of hydration, previous injury history, imbalanced muscle activation, playing time, and, of course, the number of games played per week (Cancino-Jiménez et al., 2025; Firmansyah et al., 2024). However, it is not well known how the training load in football influences the state of stiffness of these muscles in professional football players, but previous evidence suggests that symptoms of muscle damage and risk of injury are a consequence of muscle stiffness (Rey et al., 2020; Ismaeel et al., 2025). In contrast, the loss of strength and power is related to a decrease in muscle tone, as a consequence of the reduction in the ability to produce force in a short space of time during muscle contractions (Rojas-Valverde et al., 2015). Therefore, the assessment of stiffness should be an important component in the selection of players during the microcycle, as a means of getting an idea of the training overload to which footballers are subjected, since the different acute effects on the stiffness of the knee flexor and extensor muscles can be explained to some extent by the importance of the training load (Rey et al., 2020).

The main results of this study show that a Yoga programme had a positive effect on the Left Bicep Femoris (LBF), with the variables Tc (ms) decreasing significantly (41.84 vs 30.27), which means that explosiveness improved (Fernández-Baeza, Diaz-Ureña, González-Millán, 2022; Pakosz et al., 2023; Macgregor et al., 2018), Td (ms), with an improvement in muscle tone. On the other hand, there was a significant decrease in the Dm (mm) of the LBF (8.77 vs. 6.68; $p = 0.003$), which could mean higher muscle tone and some muscle stiffness (Ismaeel et al., 2025). In Vc (mm/ms), there was again a decrease in contraction speed in the EG.

The results of this study showed that there is a group x time interaction effect on some muscle contractile properties measured by the TMG method between CG and EG football players. Only 8 of the 40 variables (20%) showed a significant interaction with differences between the groups (Tables 5, Figures 2 and 3). These results are in line with other similar studies.

When we compared the CG vs. EG, in percentage, at the end of the 12 weeks of applying a Yoga programme, we observed statistically significant differences in Contraction Time, Tc (ms), $t(14) = 2.690$, $d = -1.356$, $p = 0.018$, (-13.06 vs 0.29), highly significant differences in Delay Time, Td (ms), $t(14) = -2. 593$, $d = -1.479$, $p = 0.008$, (-1.16 vs 1.54), in Displacement, Dm (mm), $t(14) = 3. 879$, $d = -1.779$, $p = 0.003$, (-2.17 vs 2. 99) and in the Left Biceps Femoris (LBF) muscle in favour of the EG. In the Right Vastus Lateralis (RVL), there was a decrease in Delay Time, Td (ms), $t(17) = 2.276$, $d = 1.296$, $p =0.016$ (0.85 vs -0.67) in the EG. We also observed a decrease in the Delay Time, Td (ms), $t(18) = 2.769$, $p = 0.018$, (0.54 vs -1.14) of the Left Vastus Lateralis (LVL) muscle in the SG. In the Right Vastus Medialis (RVM) we observed an increase in Displacement, Dm (mm), $t(18) = 2.769$, $d = 1.060$, $p = 0.044$, (1.32 vs -0.72), in favour of the EG.

On the other hand, when comparing CG and EG, we observe that the values of the Left Biceps Femoris, in Tc (ms), at the 1st moment and 2nd moment, show a significant value in favour of the EG, showing greater slowness in the response of the muscle to the contraction time and in the CG indicates high explosiveness, (Macgregor et al., 2018; Pakosz et al., 2023) and in Td (ms), a significant result in favour of the CG, with a long response time, which represents slowness of the muscle's response, whereas the EG, shows a short response time, which reveals a greater speed of the muscle's response (Macgregor et al., 2018; Pakosz et al., 2023). Although the results of our study were not conclusive, it was observed that the EG after Yoga showed some improvements in some muscle groups and in others there was no such effect. When it comes to the parameters measured and muscle groups, it can be concluded that the greatest effect of a Yoga programme was obtained in the Tc, Td, Dm and in parameter of the BF muscle of the left leg, but some of them with different effects.

These results also suggest that TMG can be an excellent method for maximising training, particularly pre-competition and/or more intense training, in order to ascertain the results that extra training or activity, such as Yoga sessions, can have on muscle contractility (Garcia et al., 2016; Hanney et al., 2022;

Buoite Stella et al., 2022; Pajovic´ et al., 2023). After high-intensity training, athletes are tired, their muscles are tense and they find it difficult to relax, leading to joint stiffness which in the long term also causes muscle damage. Furthermore, the joint is made up of bones and muscles, i.e. a precise structure, so if high-intensity training is not restored effectively, the balance and stability of the joint will easily deteriorate, producing pain and/or sports injuries (Wang, 2023). For this reason, Polsgrove et al. (2016) reinforces the idea that the practice of Yoga makes it possible to reduce the muscle stiffness generated during sports training and that it also provides the increase in flexibility and balance that are fundamental for the practice of sport. In addition, when practising Yoga, an external force is applied to the tense muscle in order to stretch and relax it completely and effectively, so that the active muscle and the antagonist muscle are also relaxed. By relaxing the muscle group and adjusting the joints, they can be effectively flexed and extended in order to strengthen their ability to control the surrounding muscles, making the joints more flexible (Wang, 2023).

Previous studies have shown how Yoga can be very important for athletes, reducing pressure before and during matches, enabling better physical and mental preparation, as it helps to slow down breathing and consequently increase concentration, while simultaneously improving the performance of footballers' strength, balance and flexibility, which is why coaches should consider introducing it into their training plans (Kartal & Ergin, 2020; Polsgrove, Haus & Lockyer, 2019), in order to also improve agility, reaction capacity, ball control, kicking efficiency and accuracy, and the way they touch the ball (Khan & Alam, 2016). Footballers who performed Yoga practices, consisting of ásana (psycho-physical techniques), pránáyáma (breathing exercises) and dhyána (meditation), before their usual football training performed better than players who didn't practice Yoga, so it is possible that the application of Yoga techniques in training, over several weeks and for long periods of time, is more effective than a short Yoga programme and thus improves athletes' performance in football (Sathiyamoorthy & Karthikeyan, 2019).

As mentioned above, the results obtained were not conclusive, but on the other hand, the comparison between the two groups revealed that the EG, after the Yoga sessions, showed some improvements in some muscle groups, but in others there was no such effect. Even so, we can't confirm our hypothesis, and there is a need for further studies to clarify the impact that Yoga can have on muscle contractile properties, in order to improve performance in professional footballers and thus provide players with a viable option that can facilitate injury prevention, adapting the training load and facilitating physical and psychological recovery during and after training.

Based on this research, we recommend that future studies be conducted with Yoga interventions, lasting at least 12 weeks or during a sports season, using a selection of Yoga techniques adapted to the variables under study and with well-defined criteria for selecting the assessment tests best suited to studying the selected variables, as well as the timing of Yoga sessions, before or after training, to achieve greater consistency and accuracy in the results.

Study Limitations

The research was conducted with professional football players during the competitive period, in the 2020/21 season, when the impact of Covid on society was still being felt, which may have influenced the two groups in different ways at the end of the season, due to fatigue from training, competition and the general stress experienced at the time.

Conclusions

The scarcity of scientific research on the impact of a Yoga training programme on muscle contractile properties in elite football players presents great potential for more studies on the effectiveness of Yoga in football and its application in the usual training programmes, as a complementary tool that enhances athletes' abilities and improves their performance. Although the results were not very consistent, improvements were seen in contractile properties in Contraction Time (Tc), Delay Time (Td), Maximum Displacement (Dm) and Contraction Velocity (Vc) of the Left Biceps Femoris (LBF), Maximum Displacement (Dm) and Contraction Velocity (Vc) of the Right Vastus Medialis (RVM) during the Yoga programme. However, the adaptations in contractile properties were muscle-specific. Nevertheless, although there were some improvements, the results are not very consistent and are not totally conclusive as to the improvement that Yoga techniques can have on the contractile properties of muscles, making it possible to test hypotheses in future studies. In any case, the proposed hypothesis, which implies the effect of Yoga on muscle contractile properties measured by the TMG method among football players, cannot be confirmed.

Practical applications

Yoga works the whole body, through the fluidity of varied movements that alternate stretching with shortening of muscles and simultaneously teaches slow, conscious and controlled breathing, allowing athletes to become more aware of their breathing and manage it according to their goals and also improving concentration, aspects with significant implications for improving athletes' performance, so coaches and athletes may want to implement Yoga training as a pre-season regime or a supplementary activity to improve their competitive performance.

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