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# 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 addresses the "Comparison of Foam Roller types by assessing their acute effect on the rectus femoris muscle using Tensiomyography." The use of the Foam Roller is a relatively new myofascial release technique that is experiencing a considerable increase in the sports and health environment. The aim of the study was to compare the various types of FRs by evaluating their acute effect on the rectus femoris muscle using Tensiomyography (TMG), taking into account the variables Maximum deformation (Md) and Contraction Time (Ct).

The second study is entitled "Athletics, rugby and football: assessment of motivation and self-compassion throughout the season." Research based on motivation and self-compassion has shown that they are personal characteristics that influence the development of each individual. The aim of this study was to analyze the evolution of motivation and self-compassion throughout a complete sports season, in order to assess whether there are differences between the different periods of the season taking into account each sport.

The next study deals with the "Effects of dance in patients with Parkinson: systematic review". The aim of this review was to know the effects of different dance programs on the improvement of symptoms and quality of life in patients with Parkinson's disease. A systematic review of different dance programs was carried out in three databases (Google Scholar, Pubmed, and Dialnet).

The fourth study addresses the "Effects of physical exercise on primary dysmenorrhea. Systematic review." Primary dysmenorrhea is the most common menstrual disorder and is defined as painful menstruation. This health problem reduces the quality of life of more than 70% of the women who suffer from it, so the main objectives of this review were to evaluate whether physical exercise was safe for these women and, knowing its effects on primary dysmenorrhea, to compare the different exercises or training methods, analyzing which are the most effective.

The next of the studies is entitled "Effects of the menstrual cycle on the physical and psychological state of an active woman." The main objectives of this research were to analyze the effects of the different phases of the menstrual cycle on two elements of physical fitness, strength-power and dynamic balance, and on the psychological state of a moderately active woman. A 28-year-old woman, who was taking oral contraceptives, participated in this study.

The issue of the journal is completed with an article on "Anterior cruciate ligament injury (ACL) in Cantabrian football players". Anterior cruciate ligament (ACL) rupture is one of the most problematic injuries in the world of soccer, not only because of the period that will keep the subject inactive, but also because of the sequelae that can occur in the athlete. The aim of this study was to know some of the risk factors and mechanisms of ACL injury in Cantabrian soccer players from the 2016 to 2019 seasons.

Dr. Álvaro Velarde Sotres and Dr. Felipe García Pinillos
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# COMPARISON OF FOAM ROLLER TYPES ASSESSING THEIR ACUTE EFFECT ON THE RECTUS FEMORIS MUSCLE USING TENSIOMYOGRAPHY

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**Abstract**. The use of the Foam Roller (FR) is a relatively new myofascial release technique that is experiencing a considerable increase in the sport and health environment. The aim of this study was to compare the various types of FR by assessing their acute effect on the rectus femoris (RF) muscle using Tensiomyography (TMG), taking into account the variables Maximum Deformation (Dm) and Contraction Time (Tc). Ten participants from the Faculty of Physical Activity and Sport Sciences (CAFYD) carried out the study with one type of FR each session, spread over three days. Each subject performed 3 sets of 90 seconds with 30 seconds rest, on the dominant leg only. The TMG measurements were two, before and after the use of the RF. When analyzing the effects produced by all the FR on the total number of participants, no significant differences were found in any of the variables. Although we noticed that, when separating the sample by level of sporting activity, the FR Hard (FRD) and FR Relieve (FRR) caused a significant decrease in Tc, causing activation in the Untrained Subjects (SNE). On the contrary, in the Trained Subjects (TS), the effect of FRD produced an increase in Tc, causing a relaxation of RF. The variations become noticeable depending on the sport practice and probably on the muscle tone. Therefore, the user's physical shape and experience with the Foam Roller must be taken into account, as this will directly influence the effect of its use.

**Keywords:** Foam roller, tensiomyography, rectus femoris, contraction time, maximum deformation.

# COMPARACIÓN DE LOS TIPOS DE FOAM ROLLER EVALUANDO SU EFECTO AGUDO EN EL MÚSCULO RECTO FEMORAL MEDIANTE TENSIOMIOGRAFÍA

**Resumen**. La utilización del rodillo de espuma o Foam Roller (FR) es una técnica de liberación miofascial relativamente nueva que está experimentando un aumento considerable en el entorno del deporte y de la salud. El objetivo de este estudio fue comparar los diversos tipos de FR evaluando su efecto agudo en el músculo Recto Femoral (RF) mediante Tensiomiografía (TMG), teniendo en cuenta las variables Deformación máxima (Dm) y Tiempo de Contracción (Tc). Diez participantes de Ciencias de la Actividad Física y el Deporte (CAFYD) realizaron el estudio con un tipo de FR cada sesión, repartidos en tres jornadas. Cada sujeto llevó a cabo 3 series de 90 segundos con 30 segundos de descanso, sólo en la pierna dominante. Las mediciones en TMG fueron dos, antes y después del uso del FR. Al analizar los efectos producidos por todos los FR en el total de los participantes no se encontraron diferencias significativas en ninguna de las variables. Aunque hemos advertido que, al separar la muestra por nivel de actividad deportiva, el FR Duro (FRD) y el FR Relieve (FRR) causaron una disminución significativa del Tc, provocando una activación en los Sujetos No Entrenados (SNE). Por el contrario, en los Sujetos Entrenados (SE), el efecto del FRD produjo un aumento del Tc, ocasionando una relajación del RF. Las variaciones se vuelven notables dependiendo de la práctica deportiva y probablemente del tono muscular. Por ello, hay que tener muy en cuenta la forma física del usuario y su experiencia con el Foam Roller, ya que esto va a influir directamente en el efecto que le producirá su uso.

**Palabras clave:** Foam roller, tensiomiografía, recto femoral, tiempo de contracción, deformación máxima.

## Introduction

FR is one of the latest trends in the world of fitness and sports training, used both in warm-up and cool-down to improve flexibility, post-workout recovery and sports performance. It is a kind of roller that acts on the fasciae that surround the muscles by releasing the tensions that exist in these, allowing the tissue to be more flexible and soft (Schleip and Müller, 2013). The technique of use consists of rolling the FR over the muscle to be worked, from the proximal part to the distal part of the muscle or vice versa (Paolini, 2009). The application times of the myofascial release technique range from a series of 5 seconds on one muscle to 40 minutes on different muscle areas (Ferreira, 2016). There are different types depending on their stiffness, hardness, contact surface, or vibration. We can find scientific studies showing that the stiffness of the FR influences the pressure on the muscle (Martínez-Cabrera and Núñez-Sánchez, 2016). A multilevel rigid FR achieves greater pressure with a smaller contact area on the muscle while with a bio-foam FR the pressure exerted on the muscle is less and the contact area greater (Curran, Fiore and Crisco, 2008). The study by Cheatham, Stull, and Kolber (2017) provided the information that the use of vibratory FR can increase pain tolerance more than a non-vibratory one. The specific benefits of using FR are far from clear. There is scientific evidence that the use of FR after return to calm improves performance in some tests versus passive stretching (Rey, Padrón-Cabo, Costa, & Barcala-Furelos, 2017), and that, unlike passive stretching, the use of FR improves flexibility without decreasing force production (Halperin, Aboodarda, Button, Andersen, & Behm, 2014). Its use on the triceps surae produces increases in ankle range of motion (ROM) (Škarabot, Beardsley, & Štirn, 2015; Halperin et al., 2014). With respect to strength and activation, no significant changes were found after performing a protocol, of 2 sets of 1 minute with FR, in either the hamstrings or the quadriceps (MacDonald, Penney, Mullaley, Cuconato, Drake, Behm, & Button 2013; MacDonald, Button, Drinkwater, & Behm, 2014). More compelling were the results of Miller and Rockey (2006) making it clear from their analysis that FR did not increase hamstring flexibility. In recent years, its influence on flexibility, strength, recovery, activation or pain is being studied.

New technologies are making it possible not only to directly check the condition of our athletes, but also to evaluate the effects of a program, an exercise, a training program, or a piece of equipment through their assessments or measurements. Neuromuscular function has been the subject of study in recent years. As we see in Martínez and Nuñez (2016), various techniques have been used to know the adaptations generated, such as: magnetic resonance imaging, ultrasound, electrostimulation, TMG, or a combination of them. TMG is a relatively new technique used to know the morphological and anatomical characteristics of the muscle, muscle tone (stiffness), balance between muscle structures, and also for the analysis of the mechanical characteristics and contractile capacity of the muscle (Rodríguez-Matoso, Rodríguez-Ruiz, Quiroga, Sarmiento, De Saa, and García-Manso, 2010). This device was developed in the early 1990s at the faculty of electrical engineering at the University of Ljubljana (Slovenia) by Professor Valencic (Rodriguez-Matoso et al., 2010). In recent years it has been used to assess different types of muscles in different sports modalities (García-García, Hernández Mendo, Serrano Gómez, and Morales-Sánchez, 2013), as well as parameters collected in different control tests (Gil, Loturco, Tricoli, Ugrinowitsch, Kobal, Cal Abad, and Roschel, 2015). According to Rodríguez-Matoso et al. (2010), the TMG is shown to be a non-invasive, reliable, and easily reproducible method of muscle tone assessment that requires no effort on the part of the subject to whom it is applied, evaluating the superficial muscles through the measurement of the Deformation or Maximum Radial Displacement of the muscle belly, Contraction Time, Reaction Time (Td), Time that maintains the contraction (Ts), and Relaxation Time (Tr). Despite being a reliable and valid tool, its use as an evaluation tool in scientific studies is minimal due to its high cost.

As can be seen, there is great controversy in the results of research on the benefit of using FR, although after reviewing abundant literature on the subject, it could be said that the benefits outweigh the detriments and many professionals suggest its use. Rey et al. (2017) advise that soccer coaches and physical trainers working with high-level players use a structured recovery session lasting 15-20 minutes based on FR exercises to improve recovery between training loads. Ferreira (2016) also recommends the use of FR as part of the warm-up and cool-down.

Some studies comparing normal FR with vibratory appear, but there is no reference to a comparison of the different effects produced by different types of stiffness, relief or vibration by means of TMG. Therefore, the study aims to demonstrate that the effects produced by the use of FR will be different depending on the type of material, stiffness, or vibration. Another hypothesis is that the impact caused will be different depending on the level of sport activity, therefore we will divide the sample into Untrained Subjects (UTS) and Trained Subjects (TS). The aim of this study is to compare the different types of FR by evaluating their acute effect on FR muscle by means of TMG (Dm and Tc) in the total sample of CAFYD students. Another of the objectives is to check if there are differences in the results when dividing the sample by whether or not regular and federated sports practice is carried out.

## Method

### *Participants*

A total of 10 CAFYD subjects (age 23.30 ± 2.5 years, height 175.10 ± 6.10 cm, weight 70.90 ± 6.33 kg) from the Universidad Europea del Atlántico (Santander) participated in the study. Before carrying out the study and after an explanation of the study, all subjects signed a consent document in which they authorized the use of the data obtained for the study. In

addition, they completed a questionnaire on personal data, previous injuries, physical activity habits, and sports practice. To meet the inclusion criteria, the participants had to perform moderate physical activity at least 3 days a week during the last year, according to the ACSM classification (3-6 METs). They had to be in optimal health and not have suffered any lower limb injury for at least 3 months prior to the study. When analyzing the results, the sample was also divided into two groups, the UTS, who only performed moderate physical activity, and the TS, who had a regular and federated sports practice. The experimental protocol was approved by the Ethics Committee of the Universidad Europea del Atlántico.

### *Study design*

The various acute effects produced by the use of the different types of FR on the responses of the rectus femoris muscle were evaluated by means of TMG (Tc and Dm). The evaluation was performed in 3 study days, organized in three weeks. On each day, the protocol was performed with one type of FR. Each subject was measured twice through TMG in the rectus femoris of the dominant leg. The first measurement was taken at baseline, followed by the FR protocol and then the second measurement was taken.

### *Procedures*

TMG uses a pressure sensor (GK 40, Panoptik d.o.o., Ljubljana, Slovenia) placed perpendicularly on the belly of the selected muscle with a pressure of approximately 1.5 x 10-2 N/mm2 over an area of 113 m2 (Rodríguez-Matoso et al., 2010). The sensor is placed individually according to the anatomical characteristics of each subject. To provoke the contraction, a bipolar electric current is applied through two electrodes located at the proximal and distal ends of the muscle, avoiding that its placement affects the tendons of insertion of these muscle structures. The thickest part of the muscle belly was determined visually and by palpation in a voluntary concentric contraction and following the anatomical indications of Delagi, Perotto, Lazzeti and Morrison (1975). The electrodes should be separated between 2 and 5 centimeters (cm) with respect to the point of measurement; once placed, the area on which to place the sensor should be marked with a dermatological pencil. The duration of the electrical stimulus should be standardized at 1 millisecond (ms). A TMG-S2 electro-stimulator (EMF-FURLAN & Co. d.o.o., Ljubljana, Slovenia) was used. The position of the tested subject must be comfortable to ensure that the musculature to be tested is relaxed, so the subject should be placed on a stretcher, placing a triangular foam wedge under the leg to achieve the articular angles between segments.

### *Protocol*

The mechanical properties of the rectus femoris muscle in the dominant leg were measured by means of TMG in each subject. Then, they performed a performance protocol with the FR, in the dominant leg, 3 series of 90 seconds resting 30 seconds between series. A digital metronome at 20 beats per minute (BPM) was used to maintain a constant speed during the FR work. And to conclude, the second measurement was performed again with TMG on the rectus femoris on the dominant leg. Before carrying out the FR work, the subjects were explained how to use the FR, loading the body weight on the dominant leg and rolling the FR with the impulse of the arms from the proximal portion of the muscle to the distal portion and vice versa, repeating this movement at a constant speed.

Three types of FR were used for this protocol; a "Blackroll Standard" FR of medium hardness, 15 cm in diameter, and 30 cm long. For the second measurement, a "Domyos" soft hardness FR with a diameter of 12.5 cm and a length of 38 cm was used. For the last measurement, a "Blackroll Booster" vibrating core was used at 56 Hz of intensity inserted in the "Blackroll Standard" used in the first measurement, configuring the vibrating FR (FRV).

### *Statistical Analysis*

The data were analyzed using SPSS 22.0 software (IBM Corp). Descriptive statistics were determined for all variables and the normality of the variables was tested using the Kolmogorov-Smirnov test (2005). A paired samples t-test was performed to determine whether there were statistically significant differences between the variables of each intervention. The effect size (ES) was calculated by Cohen's d using means and standard deviations. The results were analyzed according to Rhea's (2004) table (<0.25 insignificant, 0.25-0.50 small, 0.50-1 moderate, >1 large).

## Results

Table 1 shows the results obtained in the normality tests, all the variables complied with it according to the Kolmogorov-Smirnov values (>0.05).

Table 1
*Normality Test*

| *Type* | *Variable* | *Take* | *N* | *Media* | *SD* | *Z* | *Sig.* |
|---|---|---|---|---|---|---|---|
| **HFR** | **Tc** | **Pre** | | 29.48 | 3.97 | 0.48 | 0.974 |
| | | **Post** | | 28.96 | 4.82 | 0.56 | 0.912 |
| | **Dm** | **Pre** | | 7.52 | 2.15 | 0.41 | 0.996 |
| | | **Post** | | 7.34 | 2.16 | 0.70 | 0.704 |
| **FRR** | **Tc** | **Pre** | | 32.09 | 4.63 | 0.47 | 0.982 |
| | | **Post** | | 31.43 | 6.49 | 0.54 | 0.930 |
| | **Dm** | **Pre** | | 6.70 | 2.51 | 0.50 | 0.965 |
| | | **Post** | | 6.40 | 1.48 | 0.92 | 0.362 |
| **FRV** | **Tc** | **Pre** | | 30.50 | 3.85 | 0.43 | 0.992 |
| | | **Post** | | 29.38 | 3.39 | 0.31 | 1000 |
| | **Dm** | **Pre** | | 7.59 | 1.78 | 0.62 | 0.841 |
| | | **Post** | | 7.44 | 2.18 | 0.89 | 0.413 |

*Note:* HFR= Hard Foam Roller; FRR= Foam Roller Relief; FRV= Foam Roller Vibratory; Tc= Time of Contraction; Dm= Maximum Deformation; N= Number of participants; SD= Standard Deviation; Z= Kolmogorov-Smirnov Z statistic; Sig.= Significance Normality Test

Table 2 shows the p-values obtained by means of the t-test Related Samples. There are no significant differences in any of the variables.

Table 2
*Test Related Samples*

| *Type* | *Variable* | *Media* | *p* |
|---|---|---|---|
| **HFR** | **Tc** | 0.52±4.09 | 0.696 |
| | **Dm** | 0.17±1.18 | 0.657 |
| **FRR** | **Tc** | 0.65±3.96 | 0.615 |
| | **Dm** | 0.29±1.38 | 0.522 |
| **FRV** | **Tc** | 1.12±3.06 | 0.279 |
| | **Dm** | 0.15±1.52 | 0.769 |

*Note:* HFR= Foam Roller Hard; FRR= Foam Roller Relief; FRV= Foam Roller Vibratory; Tc= Time of Contraction; Dm= Maximum Deformation; p= significance of related samples.

Table 3 shows the effect size, where most of the results are inconsequential, except for the FRV, which has a small effect on Tc.

Table 3
*Effect size*

| *Type* | *Variable* | *ES* | *Result* |
|---|---|---|---|
| **HFR** | **Tc** | 0.12 | Intranscendent |
| | **Dm** | 0.08 | Intranscendent |
| **FRR** | **Tc** | 0.11 | Intranscendent |
| | **Dm** | 0.15 | Intranscendent |
| **FRV** | **Tc** | 0.31 | Small |
| | **Dm** | 0.08 | Intranscendent |

*Note:* HFR= Foam Roller Hard; FRR= Foam Roller Relief; FRV= Foam Roller Vibratory; Tc= Time of Contraction; Dm= Maximum Deformation; ES= Effect Size; Res. =Results

Figure 1 shows the averages of the results obtained in the different FRs by means of TMG. The pre and post evaluation of Tc and Dm are compared. It can be seen that there are no major differences, and the results in the two variables remain identical or decrease minimally.

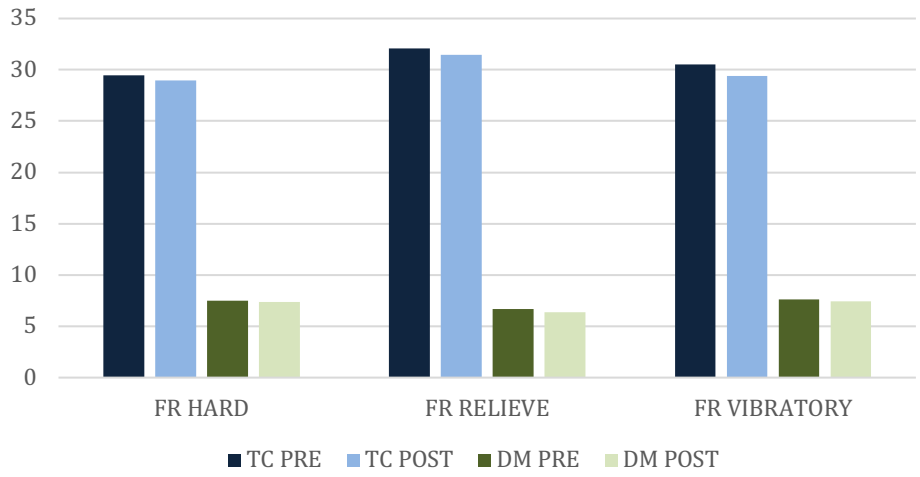


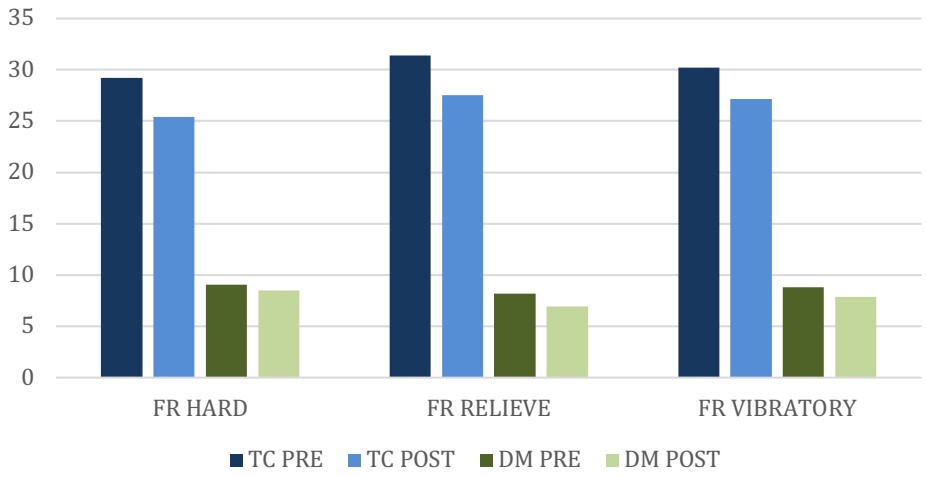

*Figure 1*. Pre and post results for FR (Tc and Dm)

Once the convenient statistics for the complete sample have been evaluated, the effects produced by the FRs will be presented below, dividing the sample according to the performance of Physical Activity. Table 4 presents the products of the same statistics performed above, but only for the Untrained Subjects (UTS). In the p-values for Related Samples, significant results were obtained for the Tc of the HFR and FRR. The effect size also reveals that HFR and FRR are likely to have larger effects on Tc. Figure 2 graphically compares the means of the pre and post data collection results for the 3 types of FR in the UTS.

Table 4
*Test results in untrained subjects*

| ***Type*** | ***Variable*** | ***Take*** | ***N*** | ***Media*** | ***SD*** | ***p*** | ***TE*** | ***Res.*** |
|---|---|---|---|---|---|---|---|---|
| **HFR** | **Tc** | Pre | 5 | 29.24 | 4.52 | 0.047 | 1.05 | Grande |
| | | Post | 5 | 25.41 | 2.49 | | | |
| | **Dm** | Pre | 5 | 9.05 | 1.79 | 0.380 | 0.27 | Small |
| | | Post | 5 | 8.50 | 2.32 | | | |
| **FRR** | **Tc** | Pre | 5 | 31.41 | 2.68 | 0.023 | 1.10 | Grande |
| | | Post | 5 | 27.55 | 4.16 | | | |
| | **Dm** | Pre | 5 | 8.21 | 2.75 | 0.050 | 0.52 | Moderate |
| | | Post | 5 | 6.96 | 2.00 | | | |
| **FRV** | **Tc** | Pre | 5 | 30.20 | 4.62 | 0.086 | 0.8 | Moderate |
| | | Post | 5 | 27.16 | 2.68 | | | |
| | **Dm** | Pre | 5 | 8.80 | 1.60 | 0.280 | 0.41 | Small |
| | | Post | 5 | 7.87 | 2.79 | | | |

*Note:* HFR= Foam Roller Hard; FRR= Foam Roller Relief; FRV= Foam Roller Vibratory; Tc= Shrinkage Time; Dm= Maximum Deformation; N= Number of participants; SD= Standard Deviation; p=significance of related samples; TE= Effect Size; Res. =Results



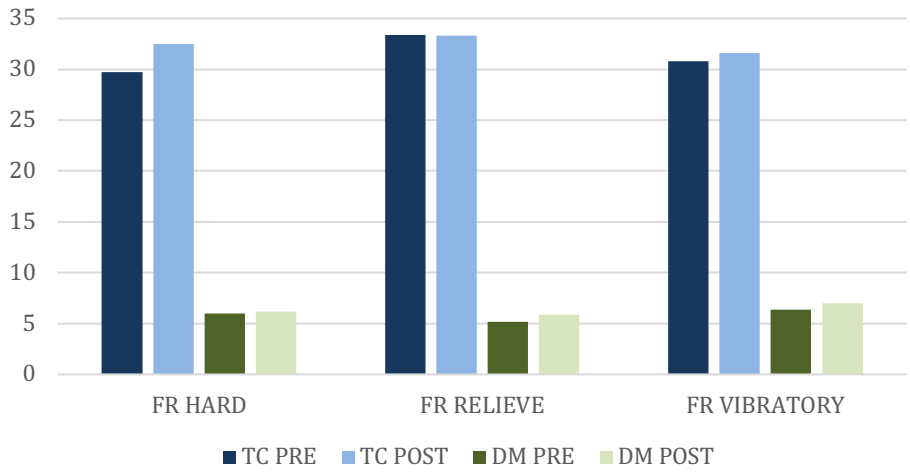

Pre and post results for FR (Tc and Dm) in untrained subjects.

Table 5 reveals the statistics of the Trained Subjects (TS). The p-values for Related Samples indicate the significance on Tc of the HFR. The effect size also reveals that HFR is likely to have greater effects on Tc. Figure 3 presents graphically the means of the results for the TSs.

Table 5
*Test results in trained subjects*

| *Type* | *Variable* | *Take* | *N* | *Media* | *SD* | *p* | *ES* | *Res.* |
|---|---|---|---|---|---|---|---|---|
| **FRD** | **Tc** | Pre | 5 | 29.72 | 3.85 | 0.004 | -0.72 | Moderate |
| | | Post | 5 | 32.50 | 3.83 | | | |
| | **Dm** | Pre | 5 | 5.98 | 1.15 | 0.695 | -0.17 | Intranscendent |
| | | Post | 5 | 6.19 | 1.31 | | | |
| **FRR** | **Tc** | Pre | 5 | 33.36 | 6.43 | 0.973 | 0.01 | Intranscendent |
| | | Post | 5 | 33.32 | 7.72 | | | |
| | **Dm** | Pre | 5 | 5.18 | 0.95 | 0.189 | -0.92 | Moderate |
| | | Post | 5 | 5.85 | 0.40 | | | |
| **FRV** | **Tc** | Pre | 5 | 30.80 | 3.45 | 0.345 | -0.27 | Small |
| | | Post | 5 | 31.61 | 2.53 | | | |
| | **Dm** | Pre | 5 | 6.37 | 0.92 | 0.198 | -0.5 | Moderate |
| | | Post | 5 | 7.01 | 1.55 | | | |

*Note:* HFR= Foam Roller Hard; FRR= Foam Roller Relief; FRV= Foam Roller Vibratory; Tc= Time of Contraction; Dm= Maximum Deformation; N= Number of participants; SD= Standard Deviation; p=significance of related samples; ES= Effect Size; Res. =Results




Pre and post results for FR (Tc and Dm) in trained subjects.

## Discussion and conclusions

The main objective of this study is to compare the acute effects of HFR, FRR and FRV on Tc and Dm of the rectus femoris muscle, measured by TMG. Despite the fact that the 3 types of FR produce changes in the two variables, no significant differences were observed for the total sample, thus refuting our first hypothesis. Regarding the Effect Size, based on Rhea's (2004) table, it was observed that the FRV causes small changes in Tc.

Another objective was to check whether there were variations in the results when the sample was divided according to whether or not sport was practiced. We have noticed that when separating the sample into UTS and TS, statistically significant differences are obtained in both Tc and Dm. On performing the statistical analyses and comparing the baseline means of both variables between trained and untrained individuals, we found several changes with respect to the total sample. In the UTS, with higher Dm and lower muscle tone, the effect of HFR and FRR produced an activation of the Rectus Femoris. In addition, Tc and Dm values decreased to a greater or lesser extent with the three FRs, activating the muscle and increasing its stiffness. In the TS, with a lower Dm and greater muscle tone, the effect of the HFR produced a relaxation of the Rectus Femoris and the Tc and Dm variables increased in most cases with the three FR, relaxing the muscle and decreasing its stiffness. The variations in the impact produced depending on the group accept our other hypothesis.

Although there is little scientific evidence on the comparison of the types of FR by means of TMG, we can find some studies that compare them by studying the physiological adaptations they provoke. Cabrera (2009) evaluates by means of TMG the acute effects on the mechanical properties of the rectus femoris muscle in Chinese soccer players, after a protocol of 4 series of 15" in the dominant leg, no significant differences were obtained in the Dm and Tc of the rectus femoris. The Dm was maintained in the dominant leg while, in the non-dominant leg, on which no FR protocol was performed, the Dm is higher. It concludes that short duration protocols with FR can be a good strategy to activate the muscles before exercise.

In a study conducted by Cheatham, Stull, and Kolber (2017) comparing FR with vibration and without vibration on ROM in knee flexion, similar results have been obtained between both types of FR, increasing in both cases the acute effect on ROM in knee flexion. In another comparison of FR with vibration and without vibration on ankle dorsiflexion carried out by Sierra (2017) no significant differences have been found between the different groups,

although the Effect Size shows that the combination of FR with vibration is the best procedure to increase dorsiflexion during warm-up.

Curran, Fiore, and Crisco (2008) compare a bio-foam FR with a rigid multilevel FR, finding that the multilevel FR exerts more pressure on the soft tissue. Showing that the design of the FR affects the contact area, being significantly lower in the multilevel FR.

For this study, a protocol of 3 series of 90" was carried out, resting 30" between series and at a speed of 30 beats per minute. According to Ferreira and Martin (2016) these values would be within the recommendations for the use of FR as a means of relaxation, since they establish a set duration of 45" to 90", a pace of 2"-3" and 30" rest between sets. They also make recommendations for the use of FR as a means of preparation, 30"-60" per set, pace 1"-2" and 30" rest between sets. This contrasts with the results obtained in our study, since for untrained subjects the relaxation protocol causes activation.

Our findings suggest that there are differences in the effect produced by the Foam Roller depending on its surface, stiffness, or vibration. The variations become noticeable depending on the sports practice and probably on the muscle tone. Therefore, the user's physical shape and experience with the Foam Roller should be taken into account, as this will directly influence the effect produced by its use.

These results should be evaluated in future studies with a larger, homogeneous, and sport-specific sample. The assessment could be carried out on more muscles and thus also compare the effect produced by the different FR according to the type of superficial musculature. Other important factors to be determined would be the guidelines of the protocols appropriate to the objective, duration, speed, and pressure.

Several limitations should be considered in this research. The sample size varied due to the difficulty of evaluating the subjects after 48 hours of non-exercise, having problems with some participant's shots and therefore not validating their results. The used FRR was of soft compound and the FRV was tested at a frequency of 56 Hz; other FRRs with other compound and other FRVs at other frequencies could have different results. The FR protocol used throughout the study is recommended for recovery, other protocols changing the time and number of sets may get other results. The test examiner was not blinded to the results of the study.

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# ATLETISMO, RUGBY Y FÚTBOL: VALORACIÓN DE LA MOTIVACIÓN Y AUTOCOMPASIÓN A LO LARGO DE LA TEMPORADA

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**Resumen**. Las investigaciones basadas en la motivación y la autocompasión han demostrado que son características personales que influyen en el desarrollo de cada individuo. El objetivo de este estudio fue analizar la evolución de la motivación y de la autocompasión a lo largo de una temporada deportiva completa, con el fin de valorar si existen diferencias entre los distintos periodos de la misma teniendo en cuenta cada deporte. En la investigación participaron 48 deportistas (42 hombres y 6 mujeres) de edades comprendidas entre los 15 y 53 años (media= 23,5) que practicaban fútbol (29,2%), atletismo (31,3%) o rugby (39,6%) en un equipo de la Comunidad Autónoma de Cantabria. Respondieron a dos pruebas: un cuestionario de motivación (BRSQ) y una escala de autocompasión. Los resultados obtenidos mostraron que ambas variables se mantienen estables a lo largo de la temporada deportiva si se realiza el análisis de manera globalizada. En cambio, si se comparan los deportes entre sí, se encontraron diferencias estadísticamente significativas en la mayoría de las variables de la motivación lo que implica que esta está influenciada por el deporte que se practique. En el caso de la autocompasión, únicamente la variable Mindfulness contaba con significancia, por lo que está sujeta también a la influencia de las diferentes características de cada deporte.

**Palabras clave:** Motivación, autocompasión, rugby, atletismo, fútbol.

# ATHLETICS, RUGBY, AND FOOTBALL: ASSESSMENT OF MOTIVATION AND SELF-COMPASSION THROUGHOUT THE SEASON

**Abstract**. Research based on motivation and self-compassion has shown that they are personal characteristics which influence the development of each individual. The aim of the present study is to analyze the evolution of motivation and self-compassion throughout a complete sport season, in order to assess if there are differences between its periods taking into account each sport. The research involved 48 athletes (42 men and 6 women) between the ages of 15 and 53 (average = 23.5) who played soccer (29.2%), athletics (31.3%) or rugby (39, 6%) in the Autonomous Community of Cantabria. They answered two tests: a motivational questionnaire (BRSQ) and a self-compassion scale. The results obtained showed that both variables remain unchangeable throughout the season if the analysis is carried out in a general manner. On the other hand, if sports are compared to each other, statistically significant differences were found in most of the motivation variables, which implies that this is influenced by the sport that is practiced. In the case of self-compassion, only the Mindfulness variable had significance, so it is also subject to the influence of the different characteristics of each sport.

**Keywords:** Motivation, self-compassion, rugby, athletics, football.

## Introduction

Physical exercise, physical activity and sport are conditioning factors of the quality of life, health and well-being of people, producing benefits both on a psychological and physical level (Bro, Ballart, Juan, Valls & Latinjak, 2012). Sport is a means for people to challenge themselves, gaining a sense of identity, learning about their physical abilities, and developing skills and social relationships (Sutherland, Kowalski, Ferguson, Sabiston, Sedwick & Croker, 2014). The reasons -why people carry out this activity- are social involvement and pleasure obtained from them (Corbí, Palermo-Cámara & Jiménez-Palmero, 2019), mainly linked to optimal development (Ferguson, Kowalski, Mack & Sabiston, 2014). Some authors affirm that there are differences in the motives of men and women, emphasizing that women tend to practice it due to a relationship with body image and weight control (Corbí et al., 2019). On the other hand, the positive experiences that arise help the athlete to develop greater self-confidence and self-esteem, in addition to promoting self-reliance, regardless of gender (Sutherland et al., 2014).

A set of implicit and explicit signals that define the keys to success or failure in the sporting experience, called the motivational climate. This climate is created by the athlete's environment (parents, coaches, colleagues, friends) (Almagro, Sáenz-López, González-Cutre & Moreno-Murcia, 2011) and can be of two types: task-oriented motivational climate or mastery and motivational climate towards the ego or competitive (Cervelló, González-Cutre, Moreno & Iglesias, 2016). If the motives are task-oriented, there is an increase in interest in the practice of physical activity supported by feelings of joy and satisfaction, which facilitates the prolongation of the practice (Ramírez-Granizo, Zurita, Sánchez-Zafra & Chacón, 2019). The approach is focused on the process, effort and personal improvement of each of the individuals and what is important is persistence and collaboration (Almagro et al., 2011). On the other hand, if the climate is oriented towards the ego, the goals are approached as a personal prestige and fame is sought (Ramírez-Granizo et al., 2019), the process focuses on the result and the comparison between colleagues prevails. It is usually promoted through the absence in the variety of tasks, authoritarian leadership and public recognition based on social comparison, in

addition, there would be an evaluation of success or failure based on victory or defeat (Almagro et al., 2011).

From the perspective of the Theory of Self-Determination (Deci and Ryan, 1985), the motivational climate is considered a social factor that influences motivation through three main basic needs: competence, autonomy and social relationship (Almagro et al., 2011). That is why this theory suggests that motivation should be taken into account as a multidimensional variable (Martín & Guzmán, 2012) that includes social, causal, contextual and behavioral factors (Monteiro, Moutao & Cid, 2018). In this sense, motivation is defined by Martín, Navas, Notari, Olmedo and Pinilla (2014) as the "set of social and individual variables that determine the choice, intensity and persistence in a task, as well as performance". This conceptualization describes the construct as a stable factor being an individual trait (Martín, Navas, Notari, Olmedo & Pinilla, 2014). In addition, it consists of two types of components: energy or impulse intensity (which is why people invest time and energy in sport) and directionality (indicates why people are oriented to one goal and not another) (Fradejas & Espada, 2018).

Traditionally, this theory identified three major types of motivation: intrinsic, extrinsic, and demotivation (Martín & Guzmán, 2012; Shokri, Viladrich, Cruz & Alcaraz, 2014; Pulido, Sánchez-Oliva, González-Ponce, Amado, Montero & García-Calvo, 2015), referring to the type of motivation adopted by the athlete regarding their participation, or not, in a specific activity and whose regulation can be internal or external (Pestillo, Andrade, Nickenig, Ferreira, Norraila & López, 2016).

Intrinsic motivation is mainly characterized by pleasure or satisfaction that a person obtains by a mere fact of performing an activity (Pulido et al., 2015). It encompasses the activities that the individual performs voluntarily, due to factors such as the pleasure that it produces, personal satisfaction of reaching a goal, new experiences lived or an internalization of the behavior (Pestillo et al., 2016). This is the prototype of self-determined motivation (Deci & Ryan, 1985).

Extrinsic motivation can be divided into the following motivational continuum: integrated regulation, identified regulation, introjected regulation and external regulation (Balaguer, Castillo & Duda, 2008; Almagro et al., 2012; Pulido et al., 2015). Integrated regulation refers to activities that are immersed in the person's lifestyle, and highlights characteristics that have to do with values, personal needs, goals ... (Balaguer et al., 2008; Pulido et al., 2015). The regulation identified is composed of those activities that entail a benefit for an individual who performs them (Almagro et al., 2012; Pulido et al., 2015). Introjected regulation is defined by the feeling of guilt that appears for not having participated or for participating in the activity out of pride (Haney, Ramos & Agudelo, 2015; Pulido et al., 2015). External regulation refers to participation for a reward or prize (Pulido et al., 2015). In all cases it is supported by contingencies (Haney et al., 2015).

Finally, demotivation is defined as the absence of any type of motivation, so the individual would not find a reason to continue practicing sports (Pulido et al., 2015). It is related to the lack of desire to act (Monteiro et al., 2018), which could be due to a perception of incompetence and low self-esteem and self-concept (Martín et al., 2014). It usually manifests with feelings of frustration, fear or depression, since the subject does not express intention to carry out any activity (Haney et al., 2015).

In addition to this division, three research models are defined on motivation in sport and physical exercise: global, contextual and situational. The first refers to the general motivational orientation of the athlete, the second refers to motivation towards a specific context, for example, physical exercise, and the third refers to motivation directed to a specific activity, such as a sport concrete. The consequences of situational motivation can be of three types: cognitive, if the subjects are focused on the task; behavioral, if they

spend more time and effort on activities; and affective consequences, related to more positive states (Bro et al., 2012). Some studies have observed that those tasks with cognitive consequences need more procedural, more elaborate, structured, sophisticated and organized knowledge, so athletes must be quick subjects in decision-making (Cervelló et al., 2016).

The Self-Determination Theory affirms that human beings are active organisms that tend to personal growth and to optimally and effectively involve ourselves in our environment (Balaguer et al., 2008). Motivation is inclusive in competition and performance to achieve sporting achievements and its study is considered important since it helps to understand the reason why people initiate, maintain or discard participation in sport (Haney et al., 2015). That is why in order to maximize adherence to physical-sporting activity, it is essential to know the variables that intervene when adopting said commitment or not. This is how the athlete could be perceived as more competent and confident in certain activities, which would imply a greater satisfaction of the basic needs postulated by the Self-Determination Theory (Moreno-Murcia et al., 2011). In addition, in this way, all possible benefits would appear, such as psychological well-being, emotional development and self-esteem (Reis, Kowalski, Ferguson, Sabiston, Sedwick & Croker, 2015).

Despite all the benefits mentioned above, sport can lead to situations of social comparison and evaluation, which are common experiences that can generate difficulties in the personal context (Mosewich, Kowalski, Sabiston, Sedwick & Tracy, 2011). These judgments give rise to concern about body image, fear, guilt, shame, worry or anxiety, before which it has being seen that certain athletes have difficulty handling it. In addition, athletes experience a wide variety of setbacks, which are often emotionally painful, which is why a good method of coping with them is necessary (Reis et al., 2015). Thus arises the development of self-compassion, which is strategy characterized by being an emotional regulation to face the different situations that occur throughout the development of physical-sports activity, such as negative thoughts, emotions associated with failure or negative events (Mosewich, Croker, Kowalski & DeLongis, 2013).

Self-compassion is a term that comes from Buddhism and it was presented as a way of self-knowledge that facilitates an improvement of well-being and maximum enlightenment (Pauley & McPherson, 2010). It has been practiced and studied for more than 2,600 years (Araya & Moncada, 2016) since it allows the observation of one's thoughts and emotions (Ferreira, Pinto-Gouveia & Duarte, 2013) being kind and accepting, particularly when facing a poor execution (Walsylkiw & Clairo, 2016). It has been defined as the ability to be open to one's own suffering, without avoiding it or disconnecting from it, but rather generating the desire to alleviate it and heal with kindness (García-Campayo, Navarro-Gil, Andrés, Montero-Marín, López-Artal & Marcos, 2014). This is how it presents a healthy way of relating to oneself, accepting all one's own aspects without taking into account social comparisons and evaluations (Ferguson et al., 2014), which allows facing emotions with a greater degree of understanding of them (Pauley & McPherson, 2010).

Self-compassionate people are aware of their own well-being and sensitive to the discomfort of others, being able to be more tolerant of themselves and without exercising self-criticism or judgment (Araya & Moncada, 2016; Walsylkiw & Clairo, 2016). It consists of three interrelated components that form a continuum (Gálvez, 2012; Dunne, Sheffield & Chilcot, 2016): Self-Kindness, defined as kindness to oneself (Araya & Moncada, 2016) which implies being kind and understanding with oneself instead of exercising self-criticism or Self-Judgment (Gálvez, 2012; Dunne et al., 2016); Common Humanity defined as recognizing that others go through difficulties similar to ours instead

of resorting to isolation, known as Isolation (Gálvez, 2012; Araya & Moncada, 2016; Dunne et al., 2016); and Mindfulness, which consists of realizing what is happening in the present moment, taking distance from one's own thoughts and feelings, the opposite effect would be Over-Identification or avoidance of them (Araya & Moncada, 2016; Magnus, Kowalski & Mchugh, 2014). This last element, Mindfulness, allows stress management and coping with sports situations, focusing on objectives and information relevant to the task being performed (Mosewich, Croker & Kowalski, 2013). Together, these three components ensure self-acceptance and a positive attitude towards the self (Walsylkiw & Clairo, 2016).

Although self-compassion has often been conceptualized as an individual experience, it can develop through relationships that are maintained with others, since the presence of others can act as a facilitator or catalyst for self-compassion experiences (Crozier, Mosewich & Ferguson, 2018). The most self-compassionate individuals tend to present more satisfaction, greater emotional intelligence, and less anxiety and depression (Dosil, 2008). Its influence on pain has also been studied, since it is associated with greater acceptance of it, which in sporting terms could be related to the subjective experience and coping with injuries, both muscular and bone (Gálvez, 2012). It is associated with a better quality of life, well-being and happiness, having the potential to attenuate and neutralize negative emotions and their effects (Ingstrup, Mosewich & Holt, 2017). In the sports context, these details can determine the optimal performance (Serpa, Guerrero & Boleto, 2019). Likewise, differences have been found depending on whether it is a team or individual sport, since the partner factor can affect commitment and self-compassion (Crozier et al., 2018). In the sports field, it is considered a resource to manage stressful experiences, improving adaptation to new situations (Mosewich et al., 2013).

In this study, they assessed the psychological, motivational and self-compassion variables in athletes who practice rugby, soccer and athletics. Rugby is characterized by being a highly demanding sport both physically and mentally, since it produces physical wear and tear as it is a contact sport, which is practiced internationally in which it is necessary to have numerous psychological skills such as concentration or strength mental (Kerr, 1987). Along with soccer, they are two of the most common team sports worldwide. Soccer is considered the most popular sport in the world, in whose practice a large number of factors intervene in turn, such as the technical resources of each athlete, physical and physiological conditions, tactical knowledge and psychological abilities (Castro-Sepúlveda, 2015). Furthermore, we consider relevant its comparison with an individual sport, such as athletics, since it is influenced by variables other than team sports.

With all it, this study aims to understand the evolution of motivation and self-compassion throughout a complete season, in order to assess whether there are differences in these psychological variables throughout the season and between different sports.

## Method

### *Analysis of data*

A descriptive analysis was performed using the SPSS 22 statistical package (IBM SPSS).

### *Design*

It is a longitudinal design with a survey methodology.

### *Participants*

In this study we have 48 subjects (42 men and 6 women) with an age range that goes from 15 to 53 years (mean = 23.54 and standard deviation = 8.83), practicing different sports modalities (athletics 31.3%, soccer 29.2% and rugby 39.6%). As study inclusion criteria, the subjects were considered to be totally healthy, and fit for the test. The exclusion criteria of the study, leaving out the subjects who had one or more of them, were established those who had suffered an injury, recent or old, in the upper body, those who had taken some type of medication, and those who had performed in the 24 hours prior to the test a strength training or another type of exercise that limited them for this type of measurement, since in both cases the range of motion in the joints could be affected.

As sociodemographic variables, age, sex and the sport they practice were taken into account.

### *Instruments*

*Self-compassion scale* (SCS; Neff, 2003b) is a scale that consists of 12 items which must be scored using a Likert scale in which 1 represents "almost never" and 5 means "almost always", in order to measure the level of self-compassion of each subject individually. From this scale, three separate subscales are developed, which include self-kindness, common humanity, and mindfulness, as well as their opposites: Self-judgment, isolation, and over-identification. It has a strong internal consistency (Cronbach's Alpha> 0.86) and a good correlation between its items (r> 0.97) (García-Campayo et al., 2014).

*Behavioral Regulation in Sport Questionnaire* (BRSQ; Lonsdale et al., 2008) the Spanish version of the same "*Cuestionario de Regulación Conductual en el Deporte"* (Viladrich, Torregrosa, & Cruz, 2011), designed to assess motivation in the practice of sport. It is made up of six subscales, of four items each, designed to measure amotivation, regulations: external, introjected, identified and integrated, and intrinsic motivation. Each item is answered on a Likert-type scale, which ranges from 1 (completely false) to 7 (completely true). All the statements are direct and the total score for each subscale is obtained by averaging the responses to its four items, so that a higher score is interpreted as greater regulation of the type measured by the scale. This questionnaire has a 95% confidence interval presenting a Cronbach's Alpha = 0.78 (Lonsdale, Hodge & Rose, 2008).

### *Procedure*

The person in charge of the chosen clubs was contacted to inform about the objectives and ask for their collaboration. The administration of the questionnaires to the athletes took place in front of the main researcher, who previously made a brief explanation of the objective of the study and how to correctly fill in the instruments, highlighting the importance of the sincerity and anonymity of the data. Initially, they were given the information sheet and informed consent to later offer them the tests. In the case of the underage participants, it was their parents or guardians who signed the informed consent. In addition, they remained close at all times to solve any possible doubts that arose. The time required to fill in the scale and the questionnaire was approximately 10 minutes. The data obtained was treated with the utmost confidentiality and scientific rigor, reserving its use for research work following the scientific method required in each case, in compliance with Organic Law 15/1999 of December 13 on the protection of Personal Data (LOPD) (*Ley Orgánica 15/1999 de 13 de diciembre de protección de datos de Carácter Personal (LOPD))* and the procedures used respect the ethical criteria of the

committee responsible for human experimentation (local or institutional) and the Declaration of Helsinki of 1975, amended in 2013.

## Results

In order to carry out the comparative analyzes, we have first proceeded to determine whether the variables present a normal distribution. Consequently, the results of the Shapiro-Wilk test show that the data of the variables do not present a normal distribution, since the coefficient obtained is significant (p> .05). For this reason, non-parametric statistics will be used for the following statistical analyzes.

Next, the *Friedman Test* was performed, which is a non-parametric test that is equivalent to the *ANOVA* test, in order to compare whether there are significant differences in the different variables throughout the season. This is how the six variables of the Motivation Questionnaire were analyzed (internal motivation, external motivation, introjected motivation, identified motivation, integrated motivation and demotivation) and the three variables of the Self-Compassion Scale (self-kindness, common humanity and mindfulness). After performing this analysis, non-significant results were obtained (p> .05), as can be seen in Table 1, so it can be stated that there are no statistically significant differences between the different moments of the season.

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Table 1

*Friedman Test: Comparison throughout the season.*

| | | Sig. |
|---|---|---|
| Motivation | External | .75 |
| | Internal | .49 |
| | Introjected | .67 |
| | Identified | .76 |
| | Integrated | .55 |
| | Demotivation | .50 |
| Self pity | Self-kindness | .50 |
| | Common humanity | .13 |
| | Mindfulness | .39 |

*Note:* * $p < 0.05$

The *Kruskal-Wallis test* was administered in order to find out if there were significant differences between the different sports studied (soccer, athletics and rugby) throughout the season. Like the previous test, it was carried out with the nine variables (six of motivation and three of self-compassion).

Table 2
*Kruskal-Wallis test: Comparison between sports.*

| | | Sig. |
|---|---|---|
| Motivation | External | .05 |
| | Internal | .03* |
| | Introjected | .00* |
| | Identified | .01* |
| | Integrated | .52 |
| | Demotivation | .07 |
| Self pity | Self-kindness | .26 |
| | Common humanity | .91 |
| | Mindfulness | .00* |

*Note:* *p < 0.05

In Table 2 it can be seen that there are significant differences (p <.05) in almost all the motivation variables, so it can be stated that there are differences between the sports analyzed. In some of the variables these differences are very significant (p <.01) such as introjected motivation or identified motivation, while others do not present significance such as external motivation, integrated motivation and demotivation, therefore, these factors are they remain stable regardless of the sport that is practiced.
Regarding the self-compassion variables, it is observed that only the Mindfulness factor presents statistically significant differences (p <.05), so it is the only factor that varies depending on the sport that is practiced.

## Discussion and Conclusions

The main objective of the present study is to understand the evolution of self-compassion and motivation throughout a complete season in athletes who practice rugby, soccer and athletics. To carry it out, the two variables were analyzed separately and in the different proposed sports, thus obtaining a breakdown of results that facilitate the understanding of the development of these factors over time.

Due to its multidimensional nature, studying the different variables in combination is very fruitful to understand the motivation and self-compassion of athletes towards sports practice and thus suggest strategies to be able to develop them adaptively. That is why in this work the subscales of the two variables have been taken into account, and the differences between the subfactors throughout the season have been analyzed.

Motivation has been one of the major concerns of sports establishments, that want to get to know what are the reasons that lead to sports practice (Torralba, Braz & Rubio, 2014). The results in this regard reveal that the athletes maintained both their extrinsic and intrinsic motivation in the same values throughout the season. Intrinsic motivation presented high values while extrinsic motivation maintained lower values. This information shows that the pressure exerted by the environment and the need to satisfy other people (Corbí, Palermo-Cámara & Jimenez-Palermo, 2019) is not so high. This is the case of the study carried out by Pelletier et al. (1995) who affirm that the athlete is proud of the recognition of others and that is why in competitive times it has a high regulation towards prizes focused mainly on the search for prestige and respect (Almagro et al., 2011).

The results showed that intrinsic motivation remained high, which is related to high intrinsic satisfaction, being able to act as a protective factor against burnout (Ramis, Torregosa, Viladrich & Cruz, 2013). In addition, it shows that the participants practice the corresponding sport voluntarily because it generates pleasure and satisfaction both for

the experiences and for the possibility of reaching a goal (Pestillo et al., 2016). In fact, another study has linked intrinsic motivation to well-being, continuous participation, sports performance, and ethics (Martinent et al., 2014).

In this sense, Deci and Ryan (200) affirm that we can consider some profiles as functional or adaptive and others as dysfunctional or maladaptive, considering intrinsic motivation as highly adaptive. On the contrary, extrinsic motivation is related to exhaustion or burnout (Lonsdale & Hodge, 2011; Madigan et al., 2016) and low levels of performance (Martinent, Cece, Elferink-Gemser, Faber, & Decret, 2018). That is why the modifications throughout the season would increase the need to establish programs to maintain self-determined motivation throughout the process. This is not the case in our sample, since it remains stable, but it is considered important to have the means and strategies to be able to act in the event of a fluctuation.

Regarding the self-compassion variable, no significant differences were found either in relation to the sport practiced or at the time of the season, therefore, according to our results, we can affirm that self-compassion remains stable and high throughout the period. These results agree with those obtained by Ferguson et al. (2014), who also affirm that self-compassionate athletes are more autonomous and have greater intrinsic motivation. They have higher "constructive reactions" which means that they are more persistent and positive in the face of adversity, and they have fewer "destructive reactions", which is related to less ruminant thoughts and less negative self-criticism. In this way, athletes with high self-compassion respond in a more adaptive way to the difficulties of sport (Leary et al. 2007; Neff 2003a, b) and do not usually give up, thus obtaining positive results (Gilbert et al., 2011). Also corresponding to our results, Mosewich et al. (2014) state that self-compassionate individuals intend to modify and improve their personal weaknesses to overcome their failures. This demonstrates the importance of self-compassion in all those subjects who do sports since it will facilitate good performance.

This is how we conclude that both motivation and self-compassion are personal variables that substantially affect sports performance and may vary depending on the context. These variations can be decisive in predicting the performance of athletes, being then necessary to take them into account in the preparation of the sessions throughout the season, being able to include different activities and practices that facilitate the increase of the most appropriate values. That is why, although it is shown that motivation and self-compassion remain stable, it is advisable to have effective intervention programs in the event of possible modifications.

In future research, it would be interesting to replicate the study with another type of intercultural population and a greater variety of sports. A greater number of competitive seasons should be included to advance in the knowledge about the longitudinal development of these variables and, in addition, it would be very useful to know the type of motivation and self-compassion in any sporting context, regardless of the modality that is practiced. It would also be interesting to compare the different sports between them, being able to check if the individual / team variable influences or if what the differences are according to the type of sport. In addition, other variables such as motivational climate, cohesion in team sports and its influence on motivation and self-compassion could be included.

On the other hand, the practical implications would be aimed at generating an intervention program that facilitates maintaining the most appropriate type of motivation and self-compassion at each moment of the season.

Finally, this study presents some limitations that should be corrected in future research. In the first place, it is considered necessary to design interventions under more

controlled conditions, also checking other factors that influence athletes such as sociocultural or economic level. Second, only one questionnaire was used for each variable, so it would be interesting to use other instruments to check and compare the results.

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# EFFECTS OF DANCE IN PATIENTS WITH PARKINSON: SYSTEMATIC REVIEW

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**Abstract**. The aim of this review was to find out the effects of different dance programmes on the improvement of symptoms and quality of life in patients with Parkinson's disease (PD), as well as to determine the possible differences depending on the type of dance modality used. A systematic review of different dance programmes was carried out in three databases (Google Scholar, Pubmed and Dialnet). We included 14 trials with a total of 469 participants and evaluated different dance modalities, which showed favourable results on motor function, cognitive function and quality of life in people with PD. The modality of tango, followed by samba, seems to be the most suitable for this type of disease, producing greater improvements in balance, speed of movement and gait pattern, due to its variety of movements and characteristic marked rhythm. However, the two most challenging dances were the waltz and the cha-cha-cha, due to the crossing of the feet, changes of direction and less grip. Although there is a need for continued research and longer programs, the analysis of results suggests that dancing can be an effective treatment for PD patients, as there is a decrease in symptoms and therefore an improvement in quality of life.

**Keywords:** Physical activity, dance, Parkinson disease, quality of life, and health.

# EFECTOS DEL BAILE EN PACIENTES CON PÁRKISON: REVISIÓN SISTEMÁTICA

**Resumen.** El objetivo de esta revisión fue conocer los efectos de distintos programas de baile en la mejora de los síntomas de pacientes con enfermedad de párkinson (EP), así como determinar las posibles diferencias en función de la modalidad de baile a utilizar. Se llevó a cabo una revisión sistemática de diferentes programas de baile en tres bases de datos (Google académico, Pubmed y Dialnet). Se incluyeron 14 ensayos con un total de 469 participantes y se evaluaron distintas modalidades de baile, los cuales mostraron resultados favorables en la función motora, cognitiva y calidad de vida de las personas con EP. La modalidad del tango, seguida de la samba parece ser la más idónea para este tipo de enfermedad, produciendo mayores mejoras en el equilibrio, velocidad de movimiento y patrón de marcha, debido a su variedad de movimientos y característico ritmo marcado. Sin embargo, los dos bailes más desafiantes fueron el vals y el cha-cha-cha, debido al cruce de los pies, cambios de dirección y menor sujeción. A pesar de existir la necesidad de una continua investigación y programas de mayor duración, el análisis de resultados sugiere que el baile puede ser un tratamiento efectivo en pacientes con EP, ya que se aprecia una disminución de los síntomas y por lo tanto una mejora de la calidad de vida.

**Palabras clave:** Actividad física, danza, enfermedad de Párkinson, calidad de vida y salud.

## Introduction

Parkinson's disease (PD) is a progressive neurodegenerative disorder that affects dopamine-producing cells in the substantia nigra, within the basal ganglia (Lötzke et al., 2015; Poewe et al., 2017; Pereira et al., 2019). Other cell groups in the central and peripheral autonomic nervous system are also affected. It is the second most common neurodegenerative disorder in the elderly and it is projected that by 2030 more than 9.3 million people will be diagnosed (Poewe et al., 2017). Given its epidemiological importance, the disease can be considered a public health problem (Tillmann et al., 2017). Its main clinical diagnosis is based on bradykinesia, referred to as slowness and difficulty in moving (Lötzke et al., 2015; Poewe et al., 2017).

This disease is associated with deficits in motor, cognitive, and emotional domains, impairing the quality of life of people who suffer from it (Ventura et al., 2016). Among the main motor symptoms are postural instability, tremors, lack of balance, as well as difficulties in the gait pattern, symptoms highly related to falls in this type of population, which generate devastating consequences, such as hip fractures, immobility, reduced quality of life and high medical expenses (Duncan & Earhart, 2014; Lötzke et al., 2015). Freezing of gait is the motor deficit that promotes the highest risk of falls in PD patients, potentially causing death or even psychological trauma resulting in fear of further falls (Pereira et al., 2019). Regarding non-motor symptoms, according to Bognar et al., (2017), fatigue, cognitive changes, as well as mood disorders are noteworthy. People with PD also cope with psychosocial aspects of chronic diseases, such as social isolation, decreased self-efficacy, and depression, affecting these symptoms to health-related quality of life (Sharp & Hewitt, 2014; Bognar et al., 2017).

It should be noted that as the disease progresses, the person's ability to perform activities of daily living (ADLs) may be impaired, leading to dependence on others (Foster et al., 2013). As mentioned above, the risk of falls is present in the lives of these people, so postural instability is a major risk factor for disability, worsening their health and leading to an increased risk of long-term hospitalization (De Natale et al., 2017).

More than half of the general population does not achieve the recommended daily levels of physical activity, and activity levels in people with Parkinson's disease are lower than in healthy older adults (McNeely et al., 2015b). Currently, sedentary lifestyles are a leading cause of death, as well as a high-risk factor for many chronic diseases, making this a major problem (McNeely et al., 2015b). (Kruk, 2014). This has become a global public health problem in the 21st century (Kruk, 2014; Gaetano, 2016). It is therefore necessary to raise public awareness of the negative effects of physical inactivity on health and the development of diseases (Gaetano, 2016). Participation in physical-sports activities is positively correlated with functional status and life satisfaction. (Foster et al., 2013). It also protects against physical and cognitive deterioration as people get older, this aspect being more relevant in people with Parkinson's disease. (Foster et al., 2013).

Often people with PD reduce their level of physical activity due to impaired mobility, fear of falling, or low outcome expectations (Lötzke et al., 2015). However, physical activity has been an effective adjunct to PD treatments, but sometimes the practice of some activities or exercises may not be sufficiently engaging or socially appealing (Duncan & Earhart, 2014). Consequently, approaches to therapies for people with Parkinson's disease aim to counteract the physical impairments and impairments of the disease, but often do not take into account what kind of exercises or activities are interesting for the target group and how to increase long-term participation (Lötzke et al., 2015).

Therefore, according to Duncan & Earhart, (2014), it is necessary to look for innovative activities that arouse the interest of the target group. To this end, dance can be seen as a nonpharmacological alternative (Bearss et al., 2017), as older adults believe that dance is more enjoyable than traditional exercise, and in turn promotes adherence and motivation (Duncan & Earhart., 2014).

Since ancient times, dance has had a therapeutic connotation, which today is still present in some cultures (Valverde Guijarro & Flórez García, 2012), keeping this discipline related to wellness and different healing rituals, tracing these aspects to the history of mankind. (Kalyani et al., 2019). Nowadays, dance is considered a form of expression and movement that contains elements of rhythm and corporal action. (Sanchez et al., 2011). It is characterized by its way of exercising the body and mind simultaneously, activating the organism to optimal effort thresholds and stimulating the memory by remembering certain sequences. (Sanchez et al., 2011). Nowadays, dance is also understood as a form of expression and/or communication in many societies around the world. (Kalyani et al., 2019).. However, there is great ignorance about the contributions of dance in the health and quality of life of people, not only physically but also psychologically (Sanchez et al., 2011).

Dance is a physical activity that can challenge gait and balance impairment in people with PD. Many dance styles include walking as a primary step, which encourages task-specific practice. Dynamic balance challenges are often incorporated into dance, as the subject has to adapt to a constantly changing environment while moving (Duncan & Earhart, 2014). Dance can improve motor and cognitive performance, as well as facilitate long-term physical activity compliance because it incorporates exercise and socialization which helps motivate individuals with PD to engage in physical activity. (De Natale et al., 2017; (Prewitt et al., 2017).

As an enjoyable activity, dance combines a number of factors that benefit PD patients through: auditory cues, aerobic and strength exercises, stretching, and a supportive social community (Sowalsky et al., 2017). This is a multidimensional activity that offers auditory, visual, and sensory stimulation, as well as a musical experience, increased social interaction, and enhanced motor development (Sharp & Hewitt, 2014). Tillmann et al., (2017), state that activities that have a cultural aspect to the population in question, and are enjoyable, allow participants to engage in the long term. According to McNeely et al., (2015b), the contributions of this discipline to patients suffering from Parkinson's disease can generate numerous benefits when it comes to counteracting their symptoms, and thus improving their quality of life.

It is necessary to emphasize that music plays a primordial role in dance, being one of the most universal forms of expression of humanity (Welch et al., 2020). It is present in the daily lives of people of all ages and from all cultures around the world (Welch et al., 2020). When the body is in movement, and we follow a music, a relationship between both is created, because our body seeks to accompany that rhythm and the music facilitates the realization of controlled and rhythmic movement. (Sanchez et al., 2011). Movement therapy based on dance and music for patients with PD combines cognitive movement strategies, balance, and physical activity, while focusing on the enjoyment of movement to the rhythm of the music. (Lötzke et al., 2015; Fragnani & Bezerra, 2018).

Each discipline and/or style of dance presents different characteristics and qualities; however, the contributions of each of them in patients with PD are currently unknown, as well as the lack of consensus on the durations of dance classes and whether any particular modality generates greater benefits with respect to others (Bearss et al., 2017).

Therefore, the objective of this review is to determine the benefits of a dance program in patients with Parkinson's disease, as well as to determine if there are differences depending on the dance modality used.

## Method

A systematic review was carried out, conducting the search during the months of February and March 2020. The following databases were used to explore the articles: Google Scholar, Pubmed, and Dialnet. The Spanish keywords used for the search were: "danza", "párkinson", "baile terapéutico", "tango en párkinson" and "enfermedad de párkinson", as well as the English terms: "dance", "Parkinson", "therapeutic dance", "tango in Parkinson" and "Parkinson disease".

As for the inclusion/exclusion criteria, we selected those articles no more than 10 years old and those that related Parkinson's disease to different dance programs and their benefits.

A total of 61 articles were identified in the initial search. After a first analysis, 4 articles that were repeated were eliminated, leaving 57 articles for further screening. After title/abstract analysis, 13 records were eliminated, leaving 41 articles selected for full-text analysis. Fourteen studies were included, which met the inclusion/exclusion criteria. In this last analysis, 3 articles were discarded because they did not meet the inclusion criteria.

## Results

In total, 469 participants (233 women and 236 men) were analyzed in the studies present in this review. Table 1 describes the objectives of each intervention, participants, scales used, methodology, and main results. Of these, seven articles investigated the effects of dance on PD using only one dance modality; tango (Duncan & Earhart, 2012; McKay et al.,2016; Holmes & Hackney, 2017; Rawson et al., 2019; Poier et al., 2019), dance therapy (Michels, et al., 2018) and Thai dance (Khongprasert et al., 2012). The rest of the studies used more than one style of dance; Latin, ballroom, ballet, jazz, contemporary, or Zumba (Hackney & Earhart, 2010; Heiberger et al., 2011; Hashimoto et al., 2015; Delextrat et al., 2016; Kunkel et al., 2017; Hulbert et al., 2017; Kunkel et al., 2018). Two studies compared during their intervention a dance program with another type of physical activity; tango, stretching, and treadmill (Rawson et al., 2019) tango and Tai Chi (Poier et al., 2019). All interventions had objectives focused on finding benefits at the level of motor control, cognitive functions, and quality of life.

Table 1
*Selected studies on dance programs in Parkinson's disease patients*

| Article | Target | Participants | Scales used | Methodology | Results |
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| (Hackney & Earhart, 2010) | To determine the effects on balance and mobility of people with Parkinson's disease when dancing with and without a partner. | 39 participants, with a minimum age of 40 years old<br>Women (n=11)<br>Men (n=28)<br>Divided into two groups: dancing with a partner and dancing without a partner.<br><br>Partner dancing (N= 19)<br><br>Dance without partner (N= 20) | Berg Balance Scale (BBS)<br><br>Timed Up and Go | Participants received 1 hour of dance class, 2 times per week for a period of 10 weeks.<br><br>Pre- and post-intervention testing | Better results were demonstrated in both groups on the Berg Balance Scale (BBS), as well as improvements in mobility.<br><br>However, the unpaired dance group obtained higher results in lower limb mobility. |
| (Heiberger et al., 2011). | The effects of dance on motor control in individuals with PD and on quality of life. | 11 participants<br><br>Ages between (58-85 years)<br><br>Women (n=6)<br>Men (n=5) | Accelerated Timing Test (TUG) Test Semitandem (SeTan)<br>Quality of Life Scale (QOLS) | Participants received ballet, jazz, and contemporary dance classes 1.5 hours a week for 8 months.<br><br>Analyses were performed before and after the intervention. | There were improvements in stiffness scores, followed by improvements in hand movements, finger movements, and facial expression.<br>No significant changes were found in TUG or SeTan.<br>The questionnaires showed positive effects of dancing in the lives of the participants. |

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| (Khongprasert et al., 2012). | To determine the impact of a Thai dance program on mobility and quality of life in patients with Parkinson's disease. | 21 participants<br><br>Men (n=10)<br>Women (n=11) | Timed Up and Go Test (TUG)<br><br>8-item Parkinson's Disease Questionnaire (PDQ8) | Participants received a Thai dance program 3 times per week (1 hour each session), for 12 weeks.<br><br>Functional mobility and quality of life were assessed before and after the intervention. | Significant improvements of 4" in the TUG test.<br>It was found that participants significantly improved PDQ8, claiming to improve their quality of life. |
| (Duncan & Earhart, 2012) | To determine the effects of a tango program for individuals with PD. | 62 participants<br><br>Men (n=35)<br>Women (n=27)<br><br>Experimental group (EG) N=32<br><br>Control group (CG) N=30 | Motor symptoms of the disease (MDS-UPDRS-3)<br>MiniBESTest balance test;<br>Freezing of Gait Questionnaire (FOG_Q);<br>6-minute walk test (6MWT)<br>Walking speed, dual task, and backward walking; and nine-hole pin test (9HPT). | Experimental group:<br>They received 2 tango classes per week of 1 hour each session for 12 months.<br><br>Tests performed at 3, 6 and 12 months.<br><br>Control group:<br>They had no prescribed exercise and were instructed to continue with their daily lives. | (MDS-UPDRS-3) improved only in GE.<br>Motor symptoms were significantly better at 3, 6 and 12 months compared to baseline and better at 6 and 12 months compared to 3 months.<br>Balance improved in the EG and slightly worsened in the CG over the course of the study.<br>There were no differences in (FOG_Q) for any group.<br>(6MWT) It remained stable in the EG and decreased in the CG.<br>The EG had a higher walking speed than the CG at 6 and 12 months.<br>(9HPT) improved in the EG and slightly worsened in the CG. |
| (Hashimoto et al., 2015) | To examine the effectiveness of | 46 participants<br>Women (n=34) | Time and Gait Test (TUG) | Dance group: | The dance group showed improvements in TUG time and |

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| | dance on motor and cognitive functions in PD. | Men (n=12)<br><br>Dance group<br>N=15<br><br>Group exercises EP<br>N= 17<br><br>Control group<br>N=14 | Berg Balance Scale (BBS)<br><br>(MRT) for assessing cognitive function<br>Self-assessment Depression Scale (SDS) | 1 session of 60'per week for 12 weeks of different dance styles.<br><br>Group exercises EP:<br>1 session of 60' per week for 12 weeks. Focused on improving balance and range of motion.<br>Control group:<br>They continued with their daily routines.<br>All groups were evaluated before and after the intervention. | number of steps and BBS after the intervention, while the EP exercise group showed improvements in TUG time and number of steps, but not in BBS.<br><br>TUG time also improved in the control group, but the number of steps did not.<br><br>No improvements in MRT were found. Improvements in SDS were also obtained for the dance group. |
| (Delextrat et al., 2016) | Assessing the feasibility of Zumba in people with PD. | 11 participants<br><br>Women<br>N= 6<br><br>Men<br>N=5 | 2 min walk test (2MWT)<br><br>Rated Perceived exertion (RPE) | 1 Zumba session (60') per week during 6 weeks<br>RPE after each session<br>During each session, physical activity levels were measured using: triaxial accelerometers, average heart rate (HR mean) | The RPE recorded after all sessions ranged from 9 to 12, between the first and the last session performed.<br><br>The average HR during the six sessions was (56.5 ± 9.2%) of max HR (56.5 ± 9.2%). |
| (McKay et al., 2016) | To investigate the efficacy of a high-volume tailored tango intervention. | 22 participants<br><br>Women (n=15)<br>Men (n=7) | 6-minute walk test (6MWT38) | 15 sessions of 1.5 hours each during 3 weeks<br>Pretest 1 week before the intervention and Posttest 1 week after the intervention. | There were some improvements in the walking test, but not in the freezing gait. |

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| | | | Freezing of Gait Questionnaire (FOG42) | | |
| (Kunkel et al., 2017) | To determine the effectiveness of a ballroom dancing program in patients with PD. | 51 participants<br><br>Average age 75 years<br>Men (n=25)<br>Women (n=26)<br><br>Experimental group N= 36<br><br>Control group N=15 | The Berg Balance Scale (BBS)<br>6-minute walk test (6MWT38) | Experimental group: Participants received 2 sessions per week of 1 hour each for 10 weeks.<br>Control group: Continued with their daily life.<br>Tests were performed before and after the intervention. | In the test (6MWT38) there was an increase in the distance walked by those in the dance group by an average of 20m, while the control group decreased their distance by an average of 1m.<br><br>No significant improvements in the balance of any group were found. |
| (Hulbert et al., 2017) | To determine the effects of ballroom and Latin dancing on the coordination of PD patients. | 27 participants<br><br>Men (n= 13)<br>Women (n=14)<br><br>Experimental group N= 15<br><br>Control group N=12 | Three-dimensional motion analysis Coda (Charnwood Dynamics Ltd) | Experimental group:<br>They received 20 1-hour dance classes for 10 weeks.<br>Control group:<br>They continued with their usual routines.<br>Analysis of body coordination by means of 12 turns before and after the intervention. | Those who danced were better able to coordinate their axial and perpendicular segments, representing a closer coupling of axial and perpendicular segments. |
| (Holmes & Hackney, 2017) | To explore the perceived impact of a tango program on PD quality of life. | 27 participants<br><br>Men (n=15)<br>Women (n=12) | Perceived quality of life survey and changes since the conclusion of the intervention. | 2 tango classes per week, 1 hour and a half for 12 weeks.<br>Data collection was performed during the intervention and at the end of 6 months. | Some participants reported perceived improvements in motor skills, physical endurance, and self-confidence after receiving the dance classes. However, some participants indicated no perceived improvements. |

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| (Michels et al. , 2018) | To explore the safety and feasibility of dance therapy in PD. | 13 participants<br>Men (n=6)<br>Women (n=7)<br><br>Dance therapy N=9<br><br>Control group N=4 | Unified Parkinson's Disease Rating Scale (MDS-UPDRS)<br>Satisfaction Questionnaire | Dance therapy group:<br>60' sessions per week for 10 weeks<br>Control group: Continuity of daily life<br>Evaluations were completed 1-2 weeks prior to the first session and upon completion. | The greatest improvement in motor measures occurred in MDS-UPDRS in the dance group.<br><br>In the dance group, 7 out of 9 felt they had benefited from the classes. |
| (Kunkel et al., 2018) | Exploring the views of people with Parkinson's on receiving partner dance classes. | 14 participants<br>Men N=7<br>Age range (65-79)<br>Women N=7<br>Age range (49-81) | Semi-structured interviews to explore participants' experiences and points of view | Received a dance program 2 times a week for 10 weeks<br><br>Interviews conducted after the end of the intervention | When dance couples were able to develop a good relationship, they gained a greater enjoyment and sense of accomplishment from dance classes compared to couples who did not enjoy dancing together or had conflicting approaches. |
| (Rawson et al., 2019) | To assess the impact of tango, treadmill walking and stretching on gait, balance, motor function, and quality of life. | 96 participants<br>Average age of 67<br>Men (n=56)<br>Women (n=40)<br><br>Tango N=39<br><br>Tape N=31<br><br>Stretching N=26 | Mini-BESTestest) for measuring dynamic equilibrium<br><br>Spacetime march using a 5 m GAITRite gateway (CIR Systems Inc.)<br><br>6-minute walk (SMWT) | The sessions for the 3 groups were 1 hour, twice a week for 10 weeks.<br>Assessments performed before and after the intervention. | Only the treadmill improved forward gait, while backward gait improved with treadmill and stretching.<br><br>All 3 groups presented improvements in backward walking.<br><br>Tango was the group that achieved the greatest improvement in endurance |

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| (Poier et al., 2019) | To investigate the influence of Argentine Tango on the quality of life of people with PD in comparison with Tai Chi. | 29 participants<br>Tango<br>N=14<br>Men (n=9)<br>Women (n=5)<br>Tai Chi<br>N=15<br>Men (n=3)<br>Women (n=12) | Quality of life of patients, measured with the Parkinson's Disease Questionnaire (PDQ-39). | Both groups received one 60' session per week for 10 weeks.<br><br>The analysis was performed before, at 5 weeks and at the end of the program. | They found a significant improvement in the PDQ-39 "Mobility" dimensions in the tango group. |

## Discussion and conclusions

Dancing simultaneously affects motor function, cognitive function, and mental symptoms (Hashimoto et al., 2015; Holmes & Hackney, 2017). Notably, dance is associated with improvements in balance, freezing of gait, walking performance, and well-being (Aguiar et al., 2016), so dance therapy appears to be a complementary tool in treatment with PD (Hashimoto et al., 2015).

During dance programs, there is a risk of falls; however, partner dancing is potentially a safe intervention as subjects can serve as a support and has been shown not to create dependence or loss of balance, in addition having a dance partner fosters social support and self-perceived improvement (Hackney & Earhart, 2010; De Dreu et al., 2015; Poier et al.,2019). It is important during dance classes, the rhythm of the music, since when strong and marked rhythms are used, it provides a time frame, allowing precise synchronization of movements similar to external auditory signals (De Dreu et al., 2015; Hashimoto et al., 2015; Aguiar et al.,2016).

Within the different dance modalities, the tango modality has proven to be one of the most beneficial for this type of disease, increasing the speed of movement and balance. (McKay et al., 2016). The tango includes great variety of movements; walking backwards, speed changes, frequent stops, and starts (McNeely et al., 2015a). Tango movements, following a well-defined and precise rhythm, are associated with increased activation of neural areas that are not normally activated in PD patients and with stimulation of cortical activation by increasing motor skills (Hashimoto et al., 2015; De Dreu et al.,2015; Tillmann et al.,2017; Michels et al., 2018). Another of the most effective modalities, is the samba, due to the fact that its lateral steps, forward and backward, performed rhythmically, can stimulate cortical activation, as in tango, increasing attention and concentration (Tillmann et al.,2017). Highlighting that the two most challenging dances were the waltz (due to the crossing of the feet and changes of direction) and the cha-cha-cha (due to its speed and less holding) (Kunkel et al., 2017). Understanding the similarities and differences in the impacts of different dance styles on motor function may be important to inform the development of PD-based dance programs (McNeely et al., 2015a).

The European guideline for Parkinson's disease recommends dancing as a meaningful approach to improve functional mobility and balance (De Dreu et al., 2015). However, at present, there is no clear consensus on program durations, but several studies agree that a duration of 60-90 minutes per session twice a week for a period of 10-12 weeks is adequate for this type of subject. (Hackney & Earhart, 2010; Khongprasert et al., 2012; Hashimoto et al., 2015; McNeely et al., 2015b; Kunkel et al., 2017; Holmes & Hackney, 2017).

This review has analyzed the effects of dancing in patients with PD. The information provided is of great interest since improvements in health and quality of life can be observed, especially when the tango modality is used. However, there is a need for continued research and analysis of this type of alternative therapy, as well as a prior assessment of the patient's condition and disease, in order to offer a treatment according to their needs using the optimal durations and modalities for their condition.

As for the limitations encountered during the development of the work, it is worth highlighting the lack of studies that directly compare different dance modalities in their intervention, as well as studies with longer durations, which could determine whether the benefits can last over time.

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métodos de entrenamiento analizando cuáles son los más eficaces. En este trabajo se revisaron artículos procedentes de la base de datos PubMed, seleccionando aquellos escritos en castellano e inglés, que no tuviesen más de 5 años y escogiendo estudios de intervención para realizar el análisis. Además, se completó la información con la página web del Colegio Americano de Obstetras y Ginecólogos. Las intervenciones señalaron al ejercicio físico como un tratamiento positivo para la DP. Las mejoras más significativas se obtuvieron en el dolor e intensidad de la menstruación. También hubo reducciones en la angustia menstrual, la duración del dolor y en los analgésicos consumidos, así como mejoras en la calidad de vida. Se concluye que el ejercicio físico realizado de una forma regular es un método seguro y eficaz para reducir los síntomas producidos por la DP. La práctica prolongada en el tiempo también tendrá efectos beneficiosos a largo plazo, reduciendo aún más estos síntomas y mejorando la salud en general de la persona. Además, cabe destacar que este tratamiento no genera efectos secundarios en el organismo. El ejercicio aeróbico parece ser el método de entrenamiento más efectivo para los síntomas dismenorreicos, seguido de algunos ejercicios de estiramiento o el yoga.

**Palabras clave:** Menstruación, dolor menstrual, síntomas dismenorreicos, entrenamiento, salud.

## Introduction

The term *dysmenorrhea* derives from the Greek terms *dys* (difficult), *mens* (month), and *rhoia* (flow); it means difficult menstrual flow and is defined as painful menstruation (Carroquino-Garcia et al., 2019). According to the American College of Obstetricians and Gynecologists (ACOG, 2015), dysmenorrhea is pain associated with menstruation, being the most common menstrual disorder. There are two types, primary dysmenorrhea (PD) and secondary dysmenorrhea. PD is defined as menstrual pain in the absence of any organic cause and usually begins within the first 3 years of menarche (first menstrual period) (Armour, Smith, Steel, & Macmillan, 2019). In contrast, secondary dysmenorrhea is caused by a disorder in the reproductive system (ACOG, 2015).

The hallmark symptom of PD is cramping, cramping spasms of cramping pain below the umbilicus. In addition to these cramps, many women experience back and thigh pain, headaches, diarrhea, nausea, and vomiting (Armour, Smith et al., 2019). Cramping is primarily caused by natural chemicals called prostaglandins, generated in the lining of the uterus (ACOG, 2015). These substances stimulate myometrial contractions by reducing uterine blood flow and causing uterine hypoxia. This hypoxia is responsible for the characteristic painful cramping (Armour, Smith, et al., 2019). The pain usually appears just before menstruation begins, as does the level of prostaglandins in the uterine lining. On the first day of the menstrual period, levels are high. As menstruation continues and the lining of the uterus sheds, levels decrease (ACOG, 2015).

Menstrual pain affects about three-quarters of all women during their reproductive life, especially in adolescence and early adulthood (Armour, Smith, et al., 2019). This

prevalence decreases after the age of 25, although according to Carroquino-Garcia et al. (2019), it is associated more with gynecological age than with chronological age. Pain can be classified from moderate to severe (Carroquino-Garcia et al., 2019) and is responsible for decreased quality of life, absenteeism from work or school, decreased participation in sports and social activities, altered pain perception, and sleep problems (Armour, Smith, et al., 2019).

The main goal of dysmenorrhea treatment is to reduce pain and improve the functionality of patients, with nonsteroidal anti-inflammatory drugs and hormone therapy being most common (Garro, Thuel, & Robles, 2019). Armour, Smith, et al. (2019) note that these treatments are effective for many women, but approximately 25% continue to have pain. In addition, they noted that cultural differences also affect the use of analgesics and the oral contraceptive pill, with Chinese women ingesting significantly less than Australian women. Most women manage their symptoms with over-the-counter analgesics (ibuprofen, acetaminophen) and self-care (rest and heat application), rather than seeking medical advice. This is largely due to the perceived lack of effectiveness of these medications or the rejection of their use due to side effects. Armour, Smith, et al. (2019) indicate that there are non-pharmacological self-care techniques, either physical or psychological, that can be practiced by women themselves such as, for example, physical exercise.

It has been observed that physical activity reduces stress, has antinociceptive properties and reduces levels of the prostaglandin subtype most closely related to PD (Matthewman, Lee, Kaur, & Daley, 2018). These same authors comment that it has been an activity recommended by physicians for this health problem since the 1930s and can currently be contemplated in the recommendations to patients provided by ACOG. Furthermore, Carroquino-Garcia et al. (2019) specify that the use of physical exercise as therapy not only improves pain symptoms and mental health, but also quality of life. At the same time they emphasize that it is a low-cost option with no side effects.

Because this health problem reduces the quality of life of more than 70% of women who suffer from it (Carroquino-Garcia et al., 2019), this study aims to corroborate the efficacy of physical exercise as a treatment for PD. Armour, Ee, et al. (2019) warn that this method does not have too much evidence, it is not entirely clear, and even less is known what types of exercise could be beneficial or when they should be performed

(Matthewman et al., 2018). Likewise, Carroquino-Garcia et al. (2019) mention in their article that many women with PD are hesitant to engage in physical exercise out of ignorance or fear that the pain will increase, or simply because of the presence of pain, which negatively affects their lives.

Taking into account all the above information, a series of **objectives** are determined in the present work. The general objectives are:

- Study the most recent scientific information on the effects of physical exercise on PD.
- Evaluate the safety of physical exercise to reduce PD symptoms.

The specific objectives are:

- Determine and compare different training methods to decrease PD symptoms.
- Analyze what effects different training methods have on PD.
- Analyze which methods or exercises are most effective in reducing PD symptoms.

## Material and methods

For this review, a search for articles was carried out using the PubMed database and inserting the keywords "*primary dysmenorrhea*" and "*exercise*" between January 15 and February 17, 2020. The selection of articles was carried out using several criteria. The inclusion criteria used were articles from the last 5 years. The exclusion criteria were articles that focused on problems specific to secondary dysmenorrhea and those written in a language other than Spanish or English. In addition, a total of 19 were intervention studies (*Randomized Control Trial*), whose method was the performance of physical exercise in women. Likewise, 5 bibliographic reviews from the last 2 years have been used in order to acquire the most complete and updated information possible on this subject. Finally, for the same purpose, information on PD was acquired from the web page of the American College of Obstetricians and Gynecologists.

## Results

Figure 1 represents the flow diagram showing the number of articles that were eliminated in each phase of the literature search. Table 1 shows the studies in which PD was treated by different physical exercise methods.

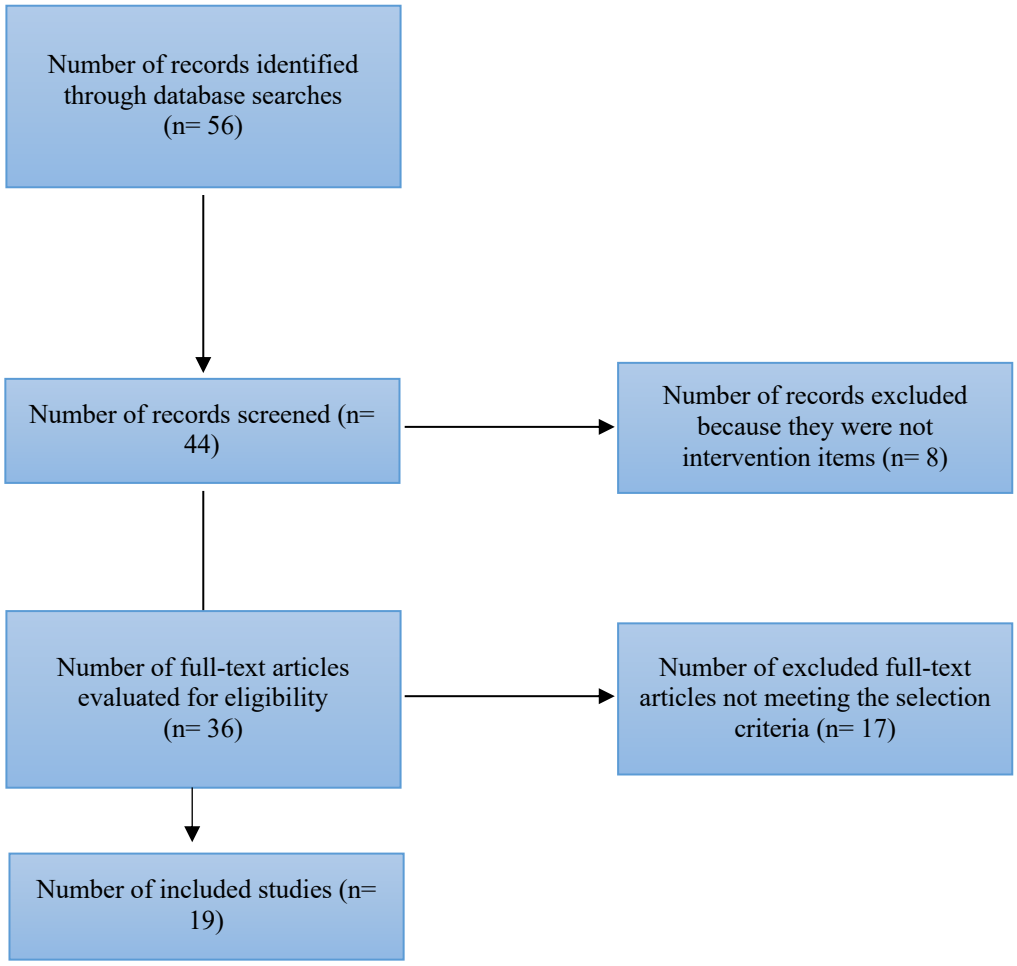



*Figure 1.* Flow diagram

Table 1

Description of intervention studies

| Authors | Participants | Intervention | Results |
|---|---|---|---|
| Aboushady and El-saidy (2016). | N= 80<br>- 40 women performed stretching exercises (E)<br>- 40 women did not undergo the intervention (CG) | 8 weeks<br>- E: 3 days/week, 2 times/day performed 5 stretching exercises at home (20-30') combined with their usual care.<br>- CG: They continued with their usual care. | Instruments for data collection:<br>- Structured interview questionnaire for adolescents<br>- Menstruation Evaluation Questionnaire<br>- Visual analog scale<br>Pain was significantly reduced in E (from 12.5% before intervention to 37.5% after). The symptoms that were most reduced included fatigue, headache, mood changes, constipation, and excessive sweating. The duration of pain and the amount of analgesics consumed also decreased significantly. |
| Azima et al. (2015). | N= 102<br>- 34 women received massages (M)<br>- 34 women did isometric exercises (I)<br>- 34 women did not perform any intervention (CG) | 8 weeks<br>- M: Effleurage massage with oil on the upper part of the symphysis pubis and the navel in a clockwise direction (each 15').<br>- I: 5 days/week, 2 times/day 8 isometric exercises repeated 10 times per session. | Instruments for data collection:<br>- Visual analog scale<br>- Duration was measured in hours<br>- Spielberger Questionnaire for Anxiety<br>The intensity and duration of pain decreased significantly in groups M and I, although the reduction was greater in M. In addition, a decrease in the level of anxiety was also observed in M after the third cycle. |
| Dehnavi et al. (2018). | N= 70<br>- 35 women did aerobic exercise (AE).<br>- 35 women did not exercise (CG) | 8 weeks<br>- AE: 3 days/week. 30' of moderate aerobic exercise with warm up and cool down. | Instruments for data collection:<br>- Questionnaire on personal data and symptoms of dysmenorrhea<br>- Pain intensity scale from 0 (no pain) to 10 (maximum pain)<br>PD pain intensity was significantly reduced in AE compared to CG. |
| Fallah and Mirfeizi (2018). | N= 78<br>- 19 women performed stretching (E)<br>- 19 women received massages (M)<br>- 21 women had a combination of the above (C)<br>- 19 women did not exercise (CG) | 8 weeks<br>- E: 3 days/week, 2 times/day 20' of 6 stretching exercises on abdomen, pelvis, and groin.<br>- M: 3 days/week, 2 times/day 10' massage.<br>- C: 3 days/wk, 2 times/day 20' of combined massage and stretching exercises. | Instruments for data collection:<br>- Questionnaire on demographics, characteristics of menstrual periods, and medications<br>- Visual analog scale<br>- Mc Gill Pain Intensity Questionnaire<br>Significant decreases in pain, intensity, and bleeding volume were observed in M, as well as in C. In E, duration also decreased. Pain severity decreased more after the intervention in all groups compared to CG, where analgesic use was higher. |
| Gmoorthy et al. (2018). | N= 30<br>- 15 women performed stretching exercises (SE)<br>- 15 women did aerobic dance (AD) | 8 weeks<br>3 days/week.<br>- SE: 45' of stretching of the muscles of the whole body.<br>- AD:<br>45' including 10' warm up and 10' cool down. | Instruments for data collection:<br>- Visual analog scale<br>- Depression, anxiety, and stress scale<br>Both groups showed a reduction in pain and stress, but AD showed a greater reduction in symptoms. |
| Heidarimoghadam et al. (2019). | N= 86<br>- 43 women performed exercise based on the FITT protocol (E). | 8 weeks<br>- E: F: 8 weeks, 3 days/wk; I: 40-60 FCmax; T: Started with 20' per session until reaching 47'; T: Varying aerobic exercises, the basis being walking (5' warm-up and 5' cool down). | Instruments for data collection:<br>- McGill Pain Scale<br>- Duration was measured in days |

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| | - 43 women did not perform resistance exercise (CG). | - CG: They attended 2 physical education classes once a week and performed group exercises such as volleyball and badminton for 1h 30'. | Sports activities based on a FITT exercise program reduce pain, intensity, and duration of dysmenorrhea compared to CG. |
| Kannan et al. (2019). | N= 70<br>- 35 women performed aerobic exercise (AE).<br>- 35 women continued their usual care (CG) | 7 months<br>- AE: 3 days/wk. supervised aerobic training (70-85% FC) (including 10' warm-up and 10' cool down with stretching) for 4 weeks. Followed by unsupervised home exercise for 6 months. | Instruments for data collection:<br>- McGill Pain Questionnaire<br>- Health Survey for quality of life<br>- Women's Health Initiative Insomnia Scale<br>- Patient Global Impression of Change scale for participants' perception of improvement.<br>- Attendance at the session to assess adherence<br>In 4 weeks AE significantly improved the quality and intensity of pain. In 7 months significant benefits were maintained for pain, intensity, quality of life, and functionality. |
| Kanwal et al. (2016). | N= 66<br>- 33 women underwent TENS (T).<br>- 33 women performed stretching exercises (E) | 4 weeks<br>- T: 2 times/day 30' high frequency TENS was applied when pain started. 2 pads on lower abdominal area and 2 on thigh muscles. TENS settings were 100 pulses/second x 100 microseconds.<br>- E: 3 days/week stretching exercises with warm-up and cool-down. | Instruments for data collection:<br>- Visual analog scale<br>- SF 36 for quality of life<br>Pain was significantly reduced in T. In E, functionality was significantly improved. In addition, significant differences were found in some domains of quality of life in T and E. Some of these did not show significant changes probably because of the duration of the intervention. |
| Kiranmayi et al. (2016). | N= 98<br>- 50 women participated in an aerobic exercise program (A)<br>- 48 women underwent a stretching program (E). | 3 months<br>- A: 3 days/week. 40' session with 1.10' of stretching, 2.20' of aerobic exercises (walking or cycling) with 12-14 Borg scale and 3.10' of relaxation exercises (deep breathing).<br>- E: 3 days/week 2 times/day 4 stretching and strength exercises with 10-20 repetitions. | Instruments for data collection:<br>- Numerical pain rating scale<br>- MOOS Menstrual Distress Questionnaire<br>Pain intensity and menstrual symptoms decreased in A and E, although the results did not have a significant difference between them. However, A had a better score on the menstrual distress questionnaire. |
| Kirthika et al. (2018). | N= 30<br>- 15 women did yoga asana (YA)<br>- 15 women performed exercises with fitball (EF) | 12 weeks<br>3 days/week.<br>YA: 60' of yoga asana (Ustrasana, Janusirsasana, and Dhanurasana).<br>- EF: 3 sets of 3 knee and hip flexion-extension exercises with fitball. | Instruments for data collection:<br>- Visual analog scale<br>- MOOS Menstrual Distress Questionnaire<br>Both groups demonstrated a clinical difference in menstrual pain. However, only EF demonstrated a difference in menstrual distress. |
| Motahari-Tabari et al. (2017). | N= 122<br>- 61 women did stretching exercises (SE).<br>- 61 women took mefenamic acid (MA). | 8 weeks<br>- SE: 3 days/week. 15' session: Warm-up (5') and 6 stretching exercises of the belly and pelvis.<br>- MA: 250 mg/8h until pain relief. | Instruments for data collection:<br>- Questionnaire for demographic and menstrual characteristics<br>- Visual analog scale<br>Greater pain in SE during the first cycle. Greater reduction of pain in SE in the second cycle. |
| Ortiz et al. (2015) | N= 160<br>- 83 women underwent a physiotherapy (PP) program<br>- 77 women had no intervention (CG) | 3 months<br>- PP: 3 days/week 50' of general and specific stretching, Kegel exercises, jogging, and relaxation exercises. | Instruments for data collection:<br>- Visual analog scale<br>Significant reduction of pain in the second and third cycle in PP compared to CG. |

| | | | |
|---|---|---|---|
| Saleh et al. (2016). | N= 126<br>- 44 women performed active stretching (AE)<br>- 44 women strengthened their CORE (SC)<br>- 38 women did not intervene (CG) | 8 weeks<br>- AE: 3 days/week. 3 times/day 10' of 4 stretching exercises performed at home.<br>- SC: 4 days/week. 3 times/day 20' of 4 exercises to strengthen the CORE. | Instruments for data collection:<br>- Visual analog scale<br>- Duration was measured in hours<br>Pain intensity and duration were significantly reduced in the exercise groups compared to CG. There were no significant differences between intervention groups. |
| Samy et al. (2019). | N= 98<br>- 49 women performed Zumba (Z)<br>- 49 women had no intervention (CG) | 8 weeks<br>- Z: 2 days/week 60' of Zumba including a warm up song and a cool down song. | Instruments for data collection:<br>- Visual analog scale<br>- Duration was measured in hours<br>- Questionnaire on menstruation characteristics<br>The intensity and duration of menstrual pain decreased significantly in Z compared to CG. |
| Shirvani et al. (2017). | N= 122<br>- 61 women exercised (E)<br>- 61 women took ginger (G) | 8 weeks<br>- E: 3 days/week 5' of warm-up movements in standing position, followed by 6 stretching exercises for the abdomen and pelvis for 10'.<br>- G: 250 mg/6h of ginger capsules until pain relief. | Instruments for data collection:<br>- Visual analog scale<br>- Questionnaire for demographic and menstrual characteristics<br>E was significantly more effective than G for pain relief, dysmenorrhea intensity, and decreased menstrual duration in the second cycle. |
| Sutar et al. (2016). | N= 100<br>- 50 women undertook aerobic exercise (A)<br>- 50 women did not perform physical exercise (CG) | 8 weeks<br>- A: 3 days/week. Aerobic dance with an intensity of 60-80% FCmax. with 10' warm-up and 10' cool down. | Instruments for data collection:<br>- Visual analog scale<br>- SF 36 for quality of life<br>Pain in A decreased significantly from the beginning of the intervention and continued to decrease during the following 3 cycles. In addition, a significant difference in quality of life was also seen in A. |
| Vaziri et al. (2015). | N= 105<br>- 35 women did aerobic exercise (A)<br>- 35 women performed stretching exercises (E)<br>- 35 women had no intervention (CG) | 8 weeks<br>- A: 3 days/week on a 20' treadmill (4 stages of 5'). Stages 2 and 3 were those of maximum intensity. Same intensity for all participants.<br>- E: 3 days/wk. 10 stretching exercises of abdomen, pelvis, and groin repeated 5 times. Started by holding 10" and each session added 1'. | Instruments for data collection:<br>- Menstrual symptom questionnaire, rating intensity from 1 to 5.<br>Significant difference between A and CG, as well as between E and CG in terms of dysmenorrhea intensity. However, no differences were shown between the intervention groups. |
| Yang and Kim (2016) | N= 40<br>- 20 women did yoga program (Y)<br>- 20 women did not participate in the yoga program (CG) | 12 weeks<br>Y: 1 day/week 60' of yoga combining exercise, relaxation, and meditation. | Instruments for data collection:<br>- Visual analog scale<br>- Menstrual Distress Questionnaire<br>Pain intensity and menstrual distress scores decreased significantly in Y compared to CG. |
| Yonglitthipagon et al. (2017). | N= 34<br>- 17 women practiced yoga (Y)<br>- 17 women did not receive any form of exercise (CG). | 12 weeks<br>- Y: 2 days/week. 30' of yoga at home with clear instructions and poses. | Instruments for data collection:<br>- Visual analog scale<br>- SF 36 for quality of life<br>Significant improvement in menstrual pain, fitness, and quality of life in Y more than in CG. |

As can be seen, 100% of the articles shown in Table 1 pointed to physical exercise as a positive treatment for PD, improving some of its symptoms. 94.7% showed a reduction in menstrual pain and intensity, in 42.1% of the articles the duration of pain was reduced, and in 26.3% the menstrual distress scores improved. Important aspects such as improved quality of life and functionality were noted in 21.1% of the interventions. In addition, 10.5% of the women reduced the amount of analgesics consumed.

## Discussion

Nowadays, non-medical approaches are also studied for the treatment of PD and its symptoms. One of them is exercise and physical activity (Motahari-Tabari et al., 2017). As can be seen in the previous section, among all the interventions performed, it is perceived how women who exercise show less severe dysmenorrhea and greater positive effects than sedentary women (Sutar et al., 2016).

Numerous experts claim that this improvement is due to the increase in blood flow and metabolism of the uterus during exercise, being effective in reducing symptoms of dysmenorrhea (Saleh et al., 2016). So, as stated by Gmoorthy et al. (2018), increasing metabolism is a key to the reduction of these symptoms. Shirvani et al. (2017) justify it with that this improvement in pelvic blood circulation, what it prevents is the aggregation of prostaglandins. In other words, as Dehnavi et al. (2018) point out, exercise can lead to a more rapid transfer of waste and prostaglandins from the uterus.

Another studied cause that helps in the reduction of PD symptoms is that exercises also stimulate the production of endorphins, which act as natural painkillers in the body (Aboushady and El-saidy, 2016). The same is the opinion of Sutar et al. (2016), who note that exercise increases the release of several neurotransmitters and hormones such as endorphins, estrogens, and dopamine. The feeling of euphoria and satisfaction after athletic exertion is accompanied by the release of endogenous opioids and the production and release of other hormones and catecholamines, an effect that could help reduce pain sensitivity and other symptoms experienced by women with PD (Ortiz et al., 2015).

Kannan et al. (2019) highlight endocannabinoids as another mechanism contributing to exercise-induced analgesia. Endocannabinoids are molecules that

contribute to the control of pain transmission within the brain and spinal cord where cannabinoid receptors are found. What is interesting that these authors expound is that elevations in endocannabinoid concentrations have been observed in peripheral blood following aerobic exercise (Kannan et al., 2019). Similarly, they also comment that exercise induces the production of regulatory macrophages in physically active muscles. These macrophages are known for their ability to secrete anti-inflammatory cytokines and counteract the effect of other macrophages that secrete proinflammatory cytokines. Accordingly, Kannan et al. (2019) gather that after physical activity, the overall effect is an increase in anti-inflammatory cytokines that are responsible for pain reduction.

For Heidarimoghadam et al. (2019), the role of adipose tissue is very important in controlling the balance of sex hormones. This tissue stores a variety of lipids that can metabolize steroids, including androgens, and increase prostaglandin production. In fact, Heidarimoghadam et al. (2019), point to Body Mass Index (BMI) as a factor to watch in PD. This can be regulated by physical activity, as recalled by Ortiz et al. (2015), this being a tool that mobilizes accumulated energy and, therefore, fundamental to achieve energy balance and adequately control the person's weight. On the other hand, Sutar et al. (2016) point out the effect of blood leptin in women with PD. Leptin is a hormone secreted by fat cells and regulates the metabolism of the hypothalamic-pituitary-gonadal axis, as well as having an important role in human reproduction. This hormone exerts its metabolic and neuroendocrine effects through its receptors in the emotional control area of the hypothalamus. Sutar et al. (2016) corroborate that physical activity reduces the amount of leptin in the blood to 30-34% as a consequence of the reduction in the amount of adipose tissue, the main producing tissue of this hormone.

Sutar et al. (2016), also add another interesting element to the relationship between PD and exercise: the involvement of stress. As Shirvani et al. (2017) specify, stress increases uterine contractions, with an effect on the nervous system. Furthermore, Vaziri et al. (2015) argue that stress increases sympathetic activity; therefore, as physical exercise reduces and moderates stress, sympathetic activity also decreases in the short-medium term. Likewise, it increases parasympathetic activity during rest, thus reducing menstrual symptoms (Dehnavi et al., 2018). Also, Ortiz et al. (2015) subscribe that there is a relationship between physical activity and decreased anxiety and depression, increased self-esteem, academic performance, decreased use of some substances of abuse, and appreciation of a more fulfilling life. Thus, exercise can decrease ruminations and

promote positive thoughts, thereby decreasing short-term depression, increase concentration, and improve mood and behavior (Sutar et al., 2016).

Moving on to discuss the different interventions performed by the authors, the most commonly used training method is stretching exercises. According to the observed studies, all these interventions have a positive effect on PD (Aboushady and El-saidy, 2016; Fallah and Mirfeizi, 2018; Gmoorthy et al., 2018; Kanwal et al., 2016; Kiranmayi et al., 2016; Motahari-Tabari et al., 2017; Saleh et al., 2016; Shirvani et al., 2017 and Vaziri et al., 2015). As Saleh et al. (2016) write in their article, contracted ligamentous bands in the abdominal region are the causative factor of physical compression of the nerve pathways and their irritation. Consequently, as they point out in some reviewed studies, stretching exercises have a positive effect by decreasing abdominal spasms and pressure on the nerves (Motahari-Tabari et al., 2017 and Shirvani et al., 2017). Likewise, it can be observed how stretching generates greater benefits than ginger (Shirvani et al., 2017), mefenamic acid (Motahari-Tabari et al., 2017), or massages (Fallah and Mirfeizi, 2018).

In contrast, comparing stretching exercises with aerobic exercises, it can be perceived how the benefits of the latter are greater (Gmoorthy et al., 2018 and Kiranmayi et al., 2016). Large improvements in PD with this method are found in the articles studied (Dehnavi et al., 2018; Kannan et al., 2019; Kiranmayi et al., 2016; Sutar et al., 2016 and Vaziri et al., 2015), including modalities such as dance (Gmoorthy et al., 2018) and Zumba (Samy et al., 2019). These benefits are quite related to those discussed above on the general effects generated by physical exercise on PD. Sutar et al. (2016) suggest that aerobic exercises involving pelvic tilt, such as walking, cycling, or swimming, can improve blood flow, relax abdominal muscles, reduce pelvic pain, and relieve pressure on nerve centers, pelvic organs, and the digestive tract. In addition, among the numerous benefits of regular aerobic exercise are increased cardiovascular capacity, increased bone density, and reduced stress, thereby decreasing depression and improving mood, behavior, and concentration (Gmoorthy et al., 2018 and Sutar et al., 2016). Likewise, Kannan et al. (2019) add that moderate to vigorous intensity aerobic exercise improves sleep. It is also important to note that most aerobic exercise protocols feature a cool-down return, which gets the body to eliminate muscle acidosis and allows for faster venous return, which in turn helps prevent muscle cramps and sudden drop in blood pressure (Sutar et al., 2016).

Another article by Ortiz et al. (2015) focuses on the study of Kegel exercises as a method for PD improvement. In the early 1940s, gynecologist Kegel creates this series of exercises of the perineal musculature. Kegel exercises are beneficial for PD for the same reason as all other exercises, they increase local blood supply, which promotes faster elimination of prostaglandins (Ortiz et al., 2015). Similar effects were found by Saleh et al. (2016) in their study, in which core strengthening allowed the small intrinsic musculature surrounding the lumbar spine to be conditioned for greater performance, increasing blood flow and metabolism of the uterus, being effective in reducing PD symptoms.

Azima et al. (2015) used massages and isometric exercises as a study method. These exercises did not have as much benefit as the group that performed massages, but both succeeded in decreasing PD symptoms. According to Azima et al. (2015), the effect that isometric exercises have is to increase blood pressure by stimulating baroreceptors, decreasing pain, and stimulating the brainstem, which has centers for pain regulation and blood pressure control.

Yoga is a modality that is on the rise, and three of the included articles use this method to reduce menstrual pain (Kirthika et al., 2018; Yang and Kim, 2016 and Yonglitthipagon et al., 2017). One of the reasons why yoga is a good intervention method according to Yonglitthipagon et al. (2017) is because it can activate the pain modulatory system in the brain that projects to the spinal cord and promotes the secretion of beta-endorphin, which is a natural analgesic in the body. Simultaneously, it improves the quality of life (functional capacity, vitality, mental health, social aspects, bodily pain, and general health domains) by linking body movement with breathing, activating the "relaxation response" in the neuroendocrine system and parasympathetic nervous system, resulting in improved metabolism, with breathing, heart rate, blood pressure, and adequate muscle tension (Yonglitthipagon et al., 2017).

Yang and Kim (2016) performed a type of yoga called Namaskara and Nidra, with which they also had great improvements in PD symptoms. They give as an answer that Namaskara induces pain relief and nervous/endocrine balance. On the other hand, the deep relaxation techniques of yoga Nidra lead to a relaxation response, thus reducing sympathetic nervous system activity and oxygen consumption, decreasing oxidative stress and increasing pain relief (Yang and Kim, 2016).

Lastly, in the study by Kirthika et al. (2018), they evaluated yoga asana, with which several benefits were also found. This type of yoga is divided into Ustrasana, Janusirsasana, and Dhanurasana. The first of these helps to relieve menstrual cramps by stretching the anterior aspect of the trunk and also by strengthening the back region, it improves spinal flexibility and also improves posture (Kirthika et al., 2018). Janusirsasana stimulates the reproductive organs and thus menstrual cramps are reduced, stretches the hip abductor and hamstring muscles and also relieves headaches, anxiety, and fatigue and also improves insomnia. In addition, the women in the Kirthika et al. (2018) study also performed Dhanurasana, a modality that increases blood flow to the uterus and keeps the body relaxed.

This study compared yoga asana with fitball exercises, which had a slight improvement over yoga alone on the distress questionnaire (Kirthika et al., 2018). The improvements in symptoms are due to the fact that the proposed fitball exercises, like yoga, improve blood supply and nutrients to the lower abdomen and lower back region, helping to relieve menstrual cramps (Kirthika et al., 2018).

Finally, the study by Heidarimoghadam et al. (2019) is based on the FITT principle, whose initials correspond to the frequency, intensity, time, and type of exercise. This has great advantages, as it helps to create a more effective plan to achieve the proposed objectives, controlling and performing a correct progression of the exercises; aspects that must be taken into account in any other training program (Heidarimoghadam et al., 2019).

This review has some limitations, which are described below: there is a lack of studies with a specific method studied that is effective for PD, since there is controversy in some results due to the difference in protocols. This makes it difficult to compare them and, consequently, to recognize which ones generate the greatest benefits. Along these lines, the time period of the interventions is different and generally short, with very few (n= 6) interventions being longer than 8 weeks, making many adaptations by exercise barely able to be reflected in the results. Similarly, the sample size is too small. On the other hand, as many of the selected studies point out, there are some data such as the diet of the participants, the hours of sleep, age or the number of analgesics taken, which have not been monitored in the studies and which may have repercussions when extracting the results.

## Conclusions

This review allows us to affirm that regular physical exercise is a safe and effective method to reduce the symptoms produced by PD. Prolonged practice over time will also have long-term beneficial effects, further reducing these symptoms and improving the overall health of the individual. Aerobic exercise appears to be the most effective training method for symptoms of dysmenorrhoea, followed by some stretching exercises or yoga. In addition, another important part of this treatment for PD is that it does not generate side effects in the body. Future research with real and continuous interventions, with larger sample sizes and longer follow-up periods are recommended. It would be of great interest to record the comments of the people who have intervened in the studies in order to know their impressions and have feedback. Similarly, it is considered essential to record the type and quantity of analgesics consumed before, during, and at the end of the intervention. Likewise, a future line of research in this work could be based on studying the effects of pain on other aspects of life, such as psychological and emotional effects.

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# EFFECTS OF THE MENSTRUAL CYCLE ON THE PHYSICAL AND PSYCHOLOGICAL STATE OF AN ACTIVE WOMAN

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**Abstract**. The main objectives of this research were to analyze the effects of the different phases of the menstrual cycle (MC) on two elements of the physical condition, strength-power and dynamic balance, and on the psychological state of a moderately active woman. A 28-year-old woman participated in this study, who used oral contraceptives. In total, 6 sessions were recorded, corresponding to 2 complete menstrual cycles and each of its phases (menstrual, follicular and luteal). In each session, three tests were carried out to evaluate the physical condition variables (Leg extension in Kineo, Press Bench in Multipower and Y Balance Test) and a test for psychological variables (POMS Test). The results obtained showed that during the luteal phase the participant achieved the lowest values in the 3 physical tests of power and dynamic balance, being the follicular phase (FP) where she obtained the best performance. In the psychological test, the menstrual phase (MP) stands out for having the highest values in the fatigue-inertia dimension, in contrast to the FP where higher values were observed for the vigor-activation dimension. The personal questionnaire on MC revealed the presence of menstrual and premenstrual symptoms in the two cycles studied. It is suggested that the changes produced in the physical and psychological variables of the subject are due to the presence of premenstrual symptoms, without being able to confirm the hormonal influence as blood or urine tests have not been performed.

**Keywords:** menstrual cycle, woman, strength, balance, mood.

# EFECTOS DEL CICLO MENSTRUAL EN EL ESTADO FÍSICO Y PSICOLÓGICO DE UNA MUJER ACTIVA

**Resumen.** Los principales objetivos de esta investigación fueron analizar los efectos de las diferentes fases del ciclo menstrual (CM) sobre dos elementos de la condición física, la fuerza- potencia y el equilibrio dinámico, y sobre el estado psicológico de una mujer moderadamente activa. En este estudio participó una mujer de 28 años, la cual consumía anticonceptivos orales. En total se registraron 6 sesiones que correspondieron a 2 ciclos menstruales completos y a cada una de sus fases (menstrual, folicular y lútea).

En cada sesión se realizaron tres pruebas para evaluar las variables de la condición física (Leg extensión en Kineo, Press Banca en Multipower e Y Balance Test) y un test para las variables psicológicas (Test de POMS). Los resultados obtenidos mostraron que durante la fase lútea (FL) la participante consiguió los valores más bajos en las 3 pruebas físicas de potencia y equilibrio dinámico, siendo la fase folicular (FF) donde mejor desempeño obtuvo. En la prueba psicológica, se destaca la fase menstrual (FM) por tener los valores más altos en la dimensión de fatiga-inercia, en contraposición con la FF donde se observaron valores más altos para la dimensión de vigor-activación. El cuestionario personal sobre el CM reveló la presencia de síntomas menstruales y premenstruales en los dos ciclos estudiados. Se sugiere que los cambios producidos en las variables físicas y psicológicas de la sujeto, se deban a la presencia de síntomas premenstruales, sin poder confirmar la influencia hormonal al no haberse realizado análisis de sangre u orina.

**Palabras clave:** ciclo menstrual, mujer, fuerza, equilibrio, estado de ánimo.

## Introduction

Over the last decades, the practice of physical exercise and sports participation by women has increased dramatically. The most important characteristic of contemporary female sport is the intense dominance of sport modalities that, until recently, were considered the privilege of men (Konovalova, 2013). Despite this, there are obvious differences between the two genders in many psychological and physiological aspects that influence their response to training. That implies the need to use training methods that suit their individual particularities.

In this sense, one of the processes that most influences a woman is the functioning of her reproductive system, that is, her menstrual cycle (MC). This is a process through which the female gametes (eggs or oocytes) develop and a series of changes take place aimed at establishing a possible pregnancy. The MC consists of four stages (menstruation, pre-ovulation, ovulation, post-ovulation), each characterized by the predominance of certain hormones, including gonadotropins, follicle stimulating hormone (FSH), luteinizing hormone (LH), progesterone, and estrogens.

Specifically, many studies have shown that both progesterone and circulating estrogens cause variations in many cardiovascular, respiratory, and metabolic parameters, with consequences on aerobic and anaerobic strength and performance (Constantini et al., 2005).

There are those who claim that the MC does not produce significant alterations in sports performance, even alluding to world and Olympic records obtained in any phase of the cycle (Kapilen and Arrey, 1984; Bone, Leng and Neil, 1979), which reinforces the idea that the higher the level of training the lower the effect of each phase (Ramirez Balas, 2014). This statement also coincides with a much earlier study by Kolka and Stephenson (1982) who concluded that the higher the level of training, the less effect the menstrual cycle has on performance, whatever the test. Recent studies have also found no significant change during the different phases of the cycle (Ramirez, 2014; Wilmore, Costill and Padró, 2010).

On the other hand, other researchers affirm that there are differences to be taken into account depending on the menstrual phase. According to Misael Rivera and Elena Konovalova (2002), during the post-ovulatory and post-menstrual phases of the female biological cycle, physical capacities such as strength, endurance, and speed increase, as

opposed to the menstrual, premenstrual, and ovulatory phases, where they decrease. In the menstrual cycle, during the pre-ovulatory and post-ovulatory phases, the increased production of both estrogens and progesterone are determinant in improving the performance of high-performance athletes. These authors obtained the same conclusions years later in another investigation carried out with 226 female athletes from Valle del Cauca (Colombia) with an average of 16 years of age in 21 sports modalities. (Konovalova & Rivera Echeverry, 2017).

On the other hand, the influence of premenstrual syndrome (PMS) should be highlighted, since women who present it have a greater tendency to decrease their performance (Lebrun, 1993). The presence of this factor and its symptoms are related to an increase in traumatic musculoskeletal injuries during the pre-menstrual and menstrual period (Lebrun, 1993).

In view of the above, the objectives of this work are as follows:

- Test the influence of the different phases of the menstrual cycle on the physical performance of a moderately active woman through power and dynamic balance tests.
- Determine the influence of menstrual phases on their emotional and mood state.

## Method

### *Design*

This is a single longitudinal descriptive case study, in which two consecutive menstrual cycles of a woman were followed and various tests were applied in three phases of the cycle (menstrual, follicular, and luteal). In this way we tried to analyze the influence of the different phases on the elements of the physical condition under study (power and dynamic balance) and on the psychological and emotional variables of the subject.

### *Participant*

A 28-year-old woman participated in the study. She was not an athlete or a regular exerciser, but she was moderately active and had healthy lifestyle habits. She had been using oral contraceptives for 12 years. For this study, she was asked not to modify any of her daily habits and to report any change that could affect the results to be taken into account (illness, stressful or traumatizing event, etc.).

### *Instruments*

The Y Balance Test was used to assess dynamic balance and neuromuscular control of the trunk. The material used for the test was a tape measure and 3 Y-shaped lines placed on the floor with adhesive tape, so that an angle of 135º was formed between the anterior line with the posterior-lateral and posterior-medial lines and an angle of 90º between the posterior-lateral and posterior-medial lines. For the analysis of the measurements obtained, the formulas proposed in the study by Shaffer et al. (2013) were used:

- Relative reach distance (RRD, %) = Reach Distance / Leg Length x 100
- Composite range distance (CRD, %) = Sum of the 3 directions of range / 3 times the leg length x 100

The machine 7.0 version Kineo was used to evaluate the power of the lower body, with which a dynamic power test was performed with incremental loads using the Leg Extension exercise.

To perform the upper body power test, the Multipower machine was used to perform the bench press exercise. The test results were evaluated with a linear encoder and analyzed with the Smartcoach program.

To keep track of the days of the menstrual cycle, the participant downloaded the "MY TRAKE" mobile application. In addition, to assess the general characteristics of the MC, the "Personal questionnaire on menstrual cycle and physical activity" was used; the same that was constructed and validated by the Department of Physiology of the Faculty of Sports Sciences of the Universidad de Extremadura Ramírez (2014), which also includes various symptoms of the menstrual cycle.

For the assessment of mood, an index was obtained from the reduced 15-item version of the Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1971) scale obtained from the MenPas Psychosocial Assessment On-Line platform.

### *Procedure*

All sessions were always held in the same place, a training room, and generally during the same time slot (12:00 a.m.), due to the greater availability of the participant. In addition, a series of pre-test requirements were stipulated in an attempt to reduce the influence of other variables:

- Sleep a minimum of 8 hours
- Do not eat anything for at least two hours before, but do not fast.

For each menstrual cycle, considering the start on the first day that menstruation appeared to the participant, three measurement sessions were carried out, coinciding with the three phases to be analyzed:

- Menstrual Phase (day 2-3): low estrogen and progesterone levels
- Follicular phase (12-13): high estrogen and low progesterone levels.
- Luteal Phase (21-22): high progesterone levels

Before the physical tests, the participant always completed the POMS test. After this, the participant performed a warm-up previously registered for each session. The warm-up consisted of:

- 5' of elliptical at moderate intensity
- General joint mobility, from head to toe.
- 5 full squats and 3 finishing with a jump
- Kneeling on the floor with knees supported (6 repetitions)

The first test performed was the Leg Extension on the Kineo machine. Before starting, 2 sets of 10 repetitions were always performed with low loads of 5 and 6 kg as a way of activating the limbs, leaving 30" of recovery between them. After this, the test was started with a load of 8 kg, which was progressively increased by 3 kg at a time until the subject could not mobilize any more.

The second test was the bench press on the Multipower machine, which was performed after 5' of recovery with the previous exercise. The activation was done with the same series and repetitions as before and without load. Then the test began, which consisted of 4 sets x 4 repetitions. In each series, the weight was progressively increased from 5 kg, 10 kg, 15 kg and 20 kg. Between sets, 3' of recovery time was left.

The last test was the Y Balance Test, which was also started after 5'of recovery. To begin with, 3 warm-up attempts were made with each leg in the 3 directions, also leaving a few moments of recovery between them. The participant had to stand barefoot

in the center of the figure where she rested the heel of her foot and with her hands on her hips, she had to reach as far as possible over the line. To mark the distance, she used the tip of her big toe, which she had to rest lightly on and then return to the starting position.

The order of directions was first the anterior, then the posterior-medial and finally the posterior-lateral. Of the three attempts, the best one was selected with each foot and in each direction. The reach direction was not valid if:

- She could not support her finger to mark the distance.
- She would not return to the starting position without losing control
- She did not keep her hands resting on her hips throughout the movement
- She did not keep the support of her foot fully supported or lost balance.

***Data analysis***

The Microsoft Office program, Excel 2016, was used for the descriptive analysis of the data. The statistics used were the mean and standard deviation, the results of which were reflected in tables and graphs.

## Results

The following is a description of the results obtained in the three physical tests, which are presented in tables and graphs showing the averages of each phase.

The data obtained in the Leg extension test (Figure 1) show that in the follicular phase (FP) the subject reached the highest values in all the parameters analyzed, followed by the menstrual phase (MP) and finally the luteal phase (LP), which only surpasses the menstrual phase in the mobilized load (LP: 21 ± 1.41 and MP: 20 ± 0).

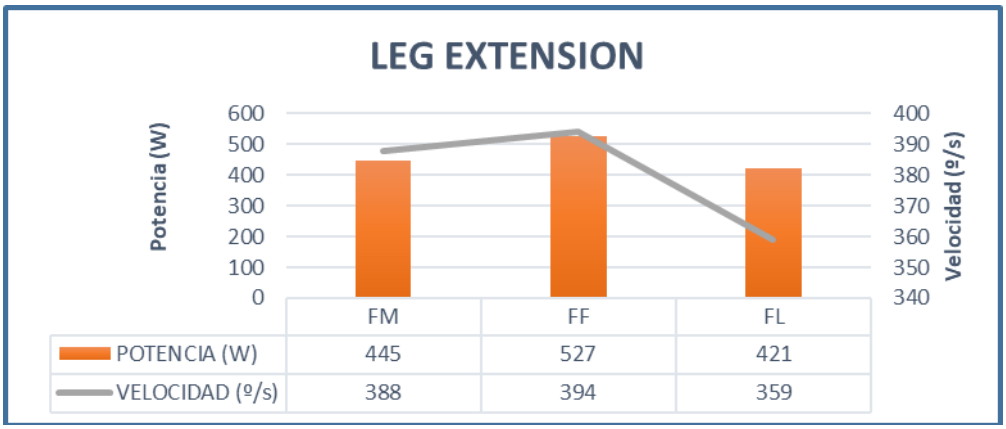



*Figure 1.* Average values of Leg extension

In the bench press test, the data obtained (Figure 2) also show that the phase with the highest power levels is the FP, followed by the MP and finally the LP with the lowest values achieved, although there is not a great difference between this and the MP.

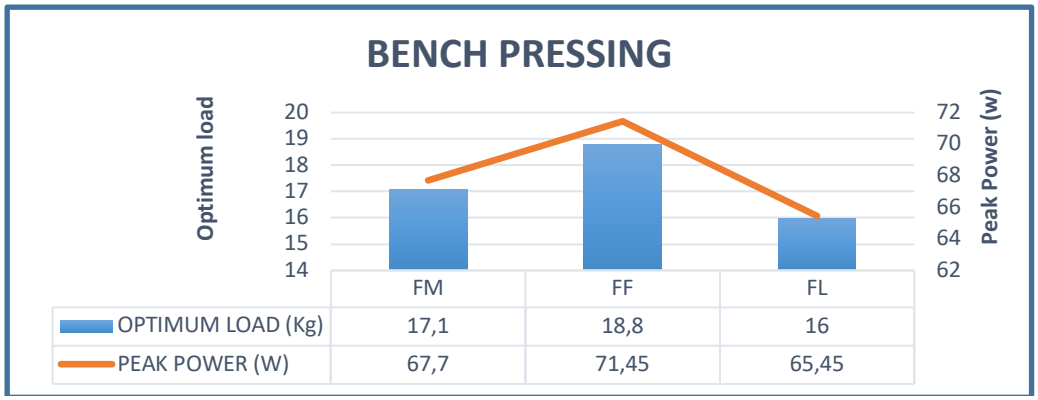



*Figure 1.* Average values of the Bench Press

In the Y Balance Test (Figure 3), it was again found that the FP had the greatest range for the three directions with both feet. The direction with the least changes between phases was the posterior-medial. On the other hand, in the anterior and posterior-lateral directions there are greater variations. The right foot presents greater distances in all directions in both the FP and MP, while in the LP the left foot has a greater anterior reach. There are no marked differences between the two feet in each phase, except in the FP, where there is a variation of 4.93% for the posterior-lateral reach.

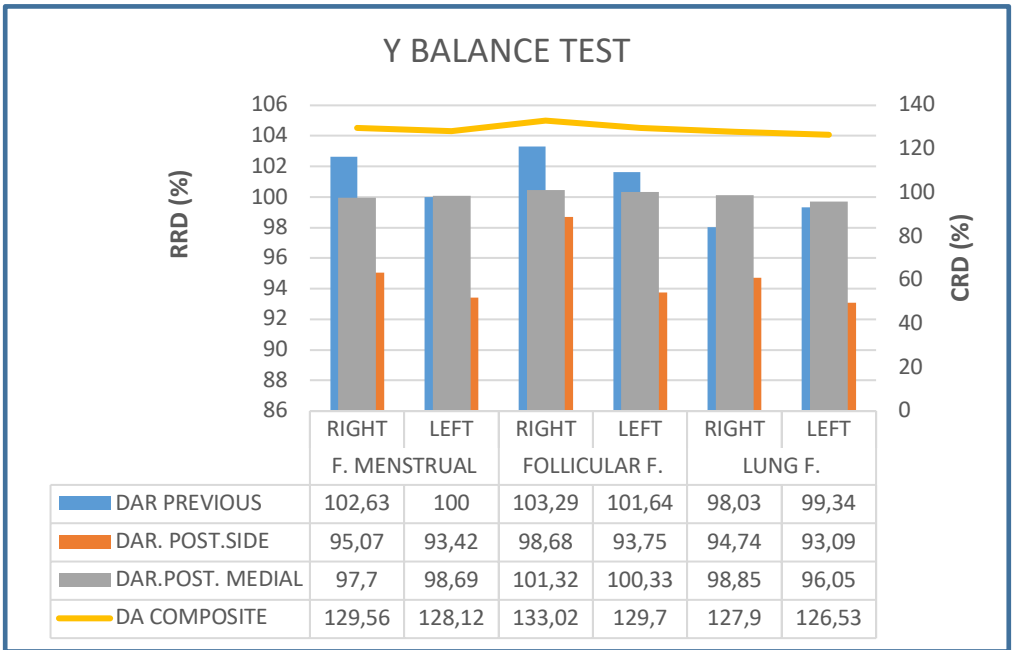



*Figure 2.* Mean values of the Y Balance Test

In the POMS test (Figure 4), it is observed that the MP stands out for presenting the highest values in the fatigue-inertia dimension and the lowest in the vigor-activation dimension, followed by the LP. On the other hand, the FP shows the opposite, higher values in the vigor-activation state and lower values in fatigue-inertia.

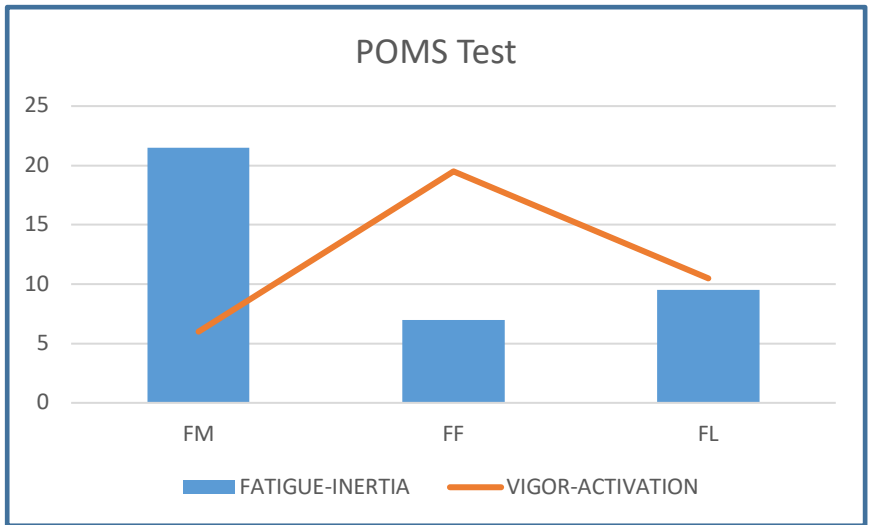



*Figure 3.* Mean values of the POMS test

In relation to the questionnaire on the characteristics of the MC (Table 1), it can be observed that the subject suffered in both MCs a great variety of symptoms both in the menstrual and premenstrual phases, which are shown in both tables. The 2nd MC stands out for presenting a greater number of symptoms.

Table 1

*Menstrual and premenstrual symptoms*

| **Premenstrual symptoms** | **1st MC** | **2nd MC** |
|---|---|---|
| Headache | YES | YES |
| Breast pain and swelling | NO | YES |
| Fluid retention or weight gain (feeling bloated) | YES | YES |
| Alterations in the psychic area (bad mood, depressed, indifferent, etc.). | YES | YES |
| **Menstrual symptoms** | **1st MC** | **2nd MC** |
| Nausea | NO | NO |
| Low tension | NO | YES |
| Intestinal disorders | NO | YES |
| Low back pain | YES | YES |
| Thigh pain and weakness | NO | NO |
| Abdominal pain | YES | YES |
| Sweating | NO | NO |
| Headache | NO | YES |

## Discussion

The hypothesis of this study suggests that the different phases of the MC could induce differences in the power levels, dynamic balance, and mood of the studied subject derived from the hormonal fluctuations that occur throughout the different phases of the cycle.

Most of the research that has analyzed the effect of the menstrual phases of the cycle on cardiovascular, ventilatory, thermoregulatory, and metabolic responses, both at rest and during aerobic, anaerobic, and recovery exercise has mostly shown that there are no differences, except in specific aspects, although there are contradictory results (Janse

de Jonge, 2003). Therefore, in this study we want to determine whether there are appreciable differences over two MCs in the different physical capacities and also in the state of mind evaluated.

Most of the studies that have assessed lower body power have not found variations in the MC, such as that of Nácher et al. (1995) with female students of the INEF of Catalonia, who were evaluated by means of the arm-free CMJ. No changes in lower body power were observed in the different phases of the menstrual cycle, nor with athletes who were members of national handball and rhythmic gymnastics pre-selections with the same CMJ test but without the help of hands (Izquierdo and Almenares, 2002). Another study in which active women participated and the same CMJ test was applied, but without the help of arms, it did not find significant changes either (Ramírez, 2014).

In contrast, in the study by Giacomoni et al, (2000) in which 17 women were evaluated using three anaerobic tests (strength-velocity, multiple jump, and squat jump tests) and hormonal analyses to determine the phases, no significant differences were found between phases, but there was an 8% reduction in maximal jumping power in menstruation relative to FP in those women suffering from premenstrual syndrome, regardless of contraceptive use or not. It was concluded that the reason for the decline in power may be due to hormonal changes and the presence of premenstrual symptoms, both of which could have an effect on the shortening and stretching cycles of tendons and ligaments (Giacomoni et al., 2000).

Giacomoni et al. (2000) cite that Wearing et al. (1972) in a study in which the phases of the menstrual cycle were not identified by hormonal analysis, showed that performances in the long jump and isometric strength were poorer during the menstrual phase and/or the late luteal phase, the latter being generally attributed to the existence of menstrual and premenstrual symptoms.

On the other hand, although phase hormone levels were not tested in this study, it is known that during early MC (MP) there are low levels of estrogen and progesterone; and that in the late follicular phase (FP) there is a peak in estrogen levels, followed by another peak in estrogen and progesterone in the middle of the luteal phase (LP) (Darlington, Ross, King, & Smith, 2001; and Friden et al., 2006).

Related to this, there are studies where it has been proposed that estrogens may have a skeletal muscle strengthening effect, which would benefit muscle strength through an underlying mechanism based on estrogen receptors that would improve the intrinsic quality of skeletal muscle, by binding myosin tightly to actin during contraction (Lowe, Baltgalvis and Greising, 2010), but it has also been suggested that progesterone may have an antagonistic effect to these and restrict muscle strength levels during the LP (Dos Santos Andrade et al., 2017).

All of the above could explain the findings found in this test. First, due to the characteristics of the subject, who presented premenstrual and menstrual symptoms in her 2 MCs, which according to the literature reviewed could affect her performance in the LP and MP, where the lowest power levels occurred, especially in the LP. And secondly, due to hormonal fluctuations, since the tests with the worst performance coincide with the times of lower estrogen and progesterone levels (MP) and when the levels of these two hormones are high (LF), and there could be, as mentioned, an antagonistic effect between both hormones. Although the latter cannot be conclusive due to the lack of hormonal analysis and more scientific evidence to support it.

In the upper body power test, there was again a drastic decrease in the levels achieved in the LP compared to the FP, in which the highest results were obtained, followed by the MP.

After reviewing the scientific literature, no study has been found that has evaluated upper body power. Most of the investigations have carried out manual dynamometer tests to assess maximum isometric strength or strength endurance tests. Therefore, the relationship of the data obtained with those of other studies has been quite controversial since they do not analyze the same capacity. In spite of this, different conclusions have been reached in relation to grip strength and MC. On the one hand, some have found that muscle strength (e.g., grip strength and bench press strength) does not seem to fluctuate significantly during MC (Constantini et al., 2005). But in another later study, a higher peak of strength was shown just before ovulation, in the quadriceps strength and manual dynamometer hand grip test. Concluding that the possible cause of this change is due to increased estrogen levels occurring before ovulation (Sarwar, Niclos and Rutherford, 1996).

The contradictions found in the results of the studies reviewed have not allowed us to reach a clear conclusion on the cause of the variations in upper body power. It is likely that the same pre-menstrual and menstrual symptoms, suffered by the subject, have caused the results in this test, as in the anterior (Leg extension), to be worse in the LP and lower in the MP compared to the FP.

In the results obtained in the Y Balance Test, variations were observed in the reach distances during the phases of the 2 MCs analyzed, finding that the greatest differences occurred in the anterior and posterior-lateral directions, with the posterior-medial direction being more equal in all cases. The FP stands out for presenting the greatest distances reached for the 3 directions and the LP for having the smallest distances and the greatest difference with respect to the other two phases. This would indicate that the postural control in the LP is more altered, resulting in a lower dynamic balance and worse reaches in the mentioned directions.

In relation to these findings, there are studies that verify changes in postural control as a consequence of the MC (Friden et al., 2003; Friden et al., 2005; Friden et al., 2006).

The study by Friden et al. (2003) investigated the influence of MCs and premenstrual syndrome (PMS) on postural sway and knee joint kinesthesia in 13 women. In it, it was shown that women with PMS had greater postural sway and higher knee joint motion detection threshold in the middle of the luteal phase than women without PMS. This was confirmed in a later study (Friden et al., 2005). These statements were again reinforced in the study by Friden et al. (2006) in which they evaluated the neuromuscular control of 32 moderately active women, obtaining that the best performances were in the late follicular phase compared to MP and LP. In all three studies the phases were determined by hormonal analysis, and although in this study it was not done, the results found here coincide with those described, which can be related due to the presence of premenstrual symptoms.

In contrast, Ericksen and Gribble (2012) investigated sex differences, hormonal fluctuations in the pre-ovulatory and post-ovulatory phase, ankle stability, and dynamic postural control using the Star-Excursion-Balance test. The results found showed that, although women had greater ankle laxity in inversion-eversion and less dynamic postural control than men, hormonal fluctuations in both phases did not have a significant influence on these differences.

Mood changes such as anxiety, emotional instability, irritability, lethargy, among others, have long been associated with the menstrual cycle (Moos, 1977). Specifically, the premenstrual phase has been associated with an increase in these negative psychological and physical aspects (headache, fatigue, etc.) (Angst, Sellaron, Merikangas, & Endicott, 2001; Schmidt & Rubinow, 1997; and Nillni, Toufexis, & Rohan, 2011). But studies have also been found that allude to the combined effect of daily physical health status, perceived stress, and social support as the variables that best explain women's daily mood, rather than MP phases (Romans et al., 2013). Regarding this, in our study we did observe a variation in mood, highlighting the negative aspects, in LP and MP, but especially in the latter, which would be related to the premenstrual symptoms suffered by the subject in her two MCs. These results agree with those found by Corney and Staton (1991), who reported that 63% of women experience mood changes up to 3 days after the onset of menstruation, while 5% claimed to have debilitating effects until the end of menstruation.

This study had a series of limitations that should be taken into account. To begin with, after reviewing the existing scientific literature on the subject, no study with similar methodological characteristics was found. Both the instruments and the power tests used in this study differ from those used in others, since most of them have performed jumping tests to assess this capacity in the lower body or manual grip tests for the upper body. Therefore, the relationship of these findings with those of other studies may not be entirely conclusive.

On the other hand, in this study only a descriptive assessment of the observed results was made, but no statistical programs were used to verify whether the degree of variation in the tests performed during the two MCs were truly significant. Another limitation refers to the determination of the beginning and end of each of the MC phases. In this study an indicative calculation was made taking the first day of bleeding as the starting time, but no blood or urine tests were performed, which is relevant when checking for hormonal influences and would have given greater consistency to the results.

Finally, in this study the sample taken was small compared to others, since the subject was only evaluated during 2 consecutive MCs due to technical problems with the assessment instruments. It would have been preferable to have evaluated more cycles to check the variations between them, in addition to controlling or eliminating other possible variables that could affect the results.

## Conclusion

In this study, variations were observed in the power (upper and lower body), dynamic balance, and mood of the subject studied during the 3 phases of the 2 MCs analyzed. Of the 3 phases of the cycle, the LP was the one that presented the worst values in all the tests analyzed. It is suggested that the reason for the decrease in physical performance and the worsening of mood during the LP may be due to the presence of premenstrual symptoms derived from hormonal influence, although the latter could not be empirically confirmed since no confirmatory blood or urine tests were performed.

In view of the above, it is suggested that in future studies a longer follow-up should be carried out, including a greater number of menstrual cycles, as well as a biochemical analysis to determine hormone levels in the different phases of the cycle.

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# ANTERIOR CROSS LIGAMENT INJURY (ACL) IN CANTABRIAN FOOTBALL PLAYERS. DESCRIPTIVE ANALYSIS OF RISK FACTORS

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**Abstract.** Introduction: The rupture of the Anterior Cruciate Ligament (ACL) is one of the most problematic injuries in the world of football, not only because of the period that it will keep the subject inactive, but also because of the consequences that it can produce in the athlete. Objectives: To know some of the risk factors, as well as the mechanism of ACL injuries in the last three seasons in Cantabrian football. Material and methods: Data was collected on different risk factors of all ACL injured Cantabrian soccer players in the last 3 seasons (2016 to 2019). These data were recorded through an interview conducted by the Cantabrian Football Federation. The initial sample was 93 people, 84 being men (H) and 9 women (M). Results: The competition turned out to be more harmful than the training (H: 88.5%; M: 77.8%), being the first part of the match where there were more injuries (H: 47.8%; M: 66.7 %). Defenders in men (50.7%) and midfielders in women (55.6%) were the most affected positions. With 87% in men and 100% in women, the injuries occurred on artificial grass with the use of Artificial Grass (AG) studs (H: 46.4%; M: 77.8%) and during the month of April (H: 4.5%; M: 33.3%). In addition, the injuries occurred without contact (H: 73.9%; M: 77.8%) and 66.7% in both groups did not perform preventive work. Conclusions: ACL injury occurs mainly without contact, with the use of AG cleats on artificial turf, during the first part of the game and in April. Defenders in men and midfielders in women were the most affected positions.

**Keywords:** Epidemiology, soccer, causes, anterior cruciate ligament, incidence, risk factors.

# LESIÓN DE LIGAMENTO CRUZADO ANTERIOR (LCA) EN FUTBOLISTAS CÁNTABROS. ANÁLISIS DESCRIPTIVO DE LOS FACTORES DE RIESGO

**Resumen.** Introducción: La rotura de Ligamento Cruzado Anterior (LCA) es una de las lesiones más problemáticas dentro del mundo del fútbol, no solo por el periodo que mantendrá inactivo al sujeto, sino también por las secuelas que puede producir en el deportista. Objetivos: Conocer algunos de los factores de riesgo y mecanismos de lesión de LCA en futbolistas cántabros de las temporadas 2016 a 2019. Material y métodos: Se recogieron datos sobre diferentes factores de riesgo de todos los jugadores/as del fútbol cántabro lesionados de LCA en las últimas 3 temporadas (2016 al 2019). Estos datos se registraron mediante una entrevista realizada por la Federación Cántabra de Fútbol. La muestra inicial fue de 93 personas, siendo 84 hombres (H) y 9 mujeres (M). Resultados: La competición resultó ser más lesiva que el entrenamiento (H: 88,5%; M: 77,8%), siendo la primera parte del partido donde más lesiones hubo (H: 47,8%; M: 66,7%). Los defensas en los hombres (50,7%) y los mediocentros en mujeres (55,6%) fueron las posiciones más afectadas. Con un 87% en hombres y 100% en mujeres, las lesiones se produjeron sobre hierba artificial con el uso de tacos Artificial Grass (AG) (H: 46,4%; M: 77,8%) y durante el mes de abril (H: 4,5%; M: 33,3%) . Además, las lesiones se produjeron sin contacto (H: 73,9%; M:77,8%) y el 66,7% en ambos grupos no realizaba trabajo preventivo. Conclusiones: La lesión de LCA se produce principalmente sin contacto, con el uso de tacos AG sobre césped artificial, durante la primera parte del partido y en abril. Los defensas en hombres y los mediocentros en mujeres fueron las posiciones más afectadas.

**Palabras clave:** Epidemiología, fútbol, causas, ligamento cruzado anterior, incidencia, factores de riesgo.

## Introduction

Soccer is one of the most played sports worldwide. According to data from the Fédération Internationale de Football Association (FIFA), it has 270 million participants (Noya and Sillero, 2012). In Spain there are 92.3805 licenses, of which 12.891 are in Cantabria, where the data for the present analysis come from (RFEF, 2017).

Due to the characteristics of this sport and the high number of people who practice it, a large number of injuries occur, specifically between 6 and 9 per 1000 hours (h) of exposure (Noya and Sillero, 2012).

Establishing a universal definition of "sports injury" is really complicated. We can find an infinite number of meanings depending on the author and different criteria such as loss of playing or training time, need for medical assistance, injured tissue (Salces, 2015), severity of the injury or location of the injury (Pujals et al, 2016).

FIFA adopted the proposal of Ekstrand, Waldén, and Hägglund (2004), who consider a sports injury as "an injury occurring during the training session or match schedule that causes absence for the next training session or match."

To group these injuries, we will follow the classification used by Romero and Tous (2010) and from which institutions such as the UEFA have benefited to carry out different investigations (Cos, Cos, Buenaventura, Pruna and Ekstrand, 2010). There are two main categories: acute or traumatic and chronic or overuse. Within the first group, we distinguish between sprains, contusions, fractures, dislocations, and others (not included in previous points).

In addition, taking into account the period of sick leave, we found minor (1-7 days), moderate (8-21 days), and severe (more than 21 days) injuries (Tegnander et al, 2007).

One of the most problematic injuries in the world of soccer is the anterior cruciate ligament (ACL) injury. We understand this as the partial or complete rupture of this ligament, incapacitating the athlete for sports practice for a period of time of approximately 6 to 9 months (Leyes, Pérez and de Olano, 2011). As Paredes, Martos, and Romero (2011) point out, "it can mean for some athletes the end of their career, or produce sequelae that can remain for the rest of their sporting life or, on the other hand, the partial deterioration of sporting practice and its consequence on physical fitness for their performance." Furthermore, only 63% manage to recover their pre-injury level (Ardern, Webster, Taylor and Feller, 2011).

Another important element that increases the need to reduce the number of injuries is the high cost of ACL surgery, amounting to between 17,000 and 25,000 euros (Hewett, Ford, Hoogenboom, and Myer, 2010).

Looking at the number of injuries that occur per season and the average time off work, Waldén, Hägglund, Magnusson, and Ekstrand (2011) found that, in different professional soccer teams in Sweden, 0.4 ACL injuries occurred per team and season, with an average time off work of 237.5 days. These same authors, in another study (2016) where they analyzed different teams from various European leagues, observed that the ratio of ACL injuries was 0.066 per 1000 h of exposure and that, per season, there were 0.43 such injuries with an estimated sick leave period of 225 days.

Schiffner et al (2018), saw that the ratio of ACL injuries, in professional Bundesliga players, was 0.040 per 1000 h of exposure and that, per team, over the course of the season, 0.53 injuries occurred. In this case, the average downtime was about 244 days.

Thus, although the ratio of ACL injuries produced per 1000 h of exposure is not high, or even the number of them per team and season either, we note that the time that the injured athlete will have to remain inactive is remarkable, so knowing the factors or characteristics that can enhance it, as well as trying to correct those that are modifiable (Price, Tuca, Cordasco and Green, 2017) becomes extremely important.

Regarding the ACL injury, we can find both intrinsic factors (inherent to the subject) and extrinsic factors (independent of the athlete) and it is the sum of both and their interaction that increase the probability of suffering an injury during sports practice (Cos et al, 2010).

Female gender, high joint laxity (Price et al, 2017; Leyes et al, 2011), age, muscle fatigue (Alentorn-Geli et al, 2009; Garin, Reyes, & Penagos, 2016), excessive genu recurvatum, small intercondylar notch size (Price et al, 2017), body mass index (BMI), family history (Griffin et al, 2006), previous injuries (McCall et al, 2014) or improper movement patterns such as dynamic valgus (Acevedo, Rivera-Vega, Miranda, & Micheo, 2014; Griffin et al, 2006), in addition to alterations in the quadriceps-ischial relationship (Barber-Westin, Noyes, Smith, & Campbell, 2009; Alanís-Blancas, Zamora-Muñoz, and Cruz-Miranda, 2012) are some of the factors inherent to the athlete.

On the other hand, as extrinsic factors we have the playing field that increases the friction between the ground and the foot or the type of footwear and the frictional resistance it offers (Acevedo et al, 2014; Alentorn-Geli et al, 2009), the weather conditions or the characteristics of the sport itself (Griffin et al, 2006), as well as whether we are in competition or in training (Acevedo et al, 2014).

Another important aspect is the mechanism of ACL injury. The most common injuries are associated with changes of direction combined with deceleration, turns, and

jump receptions, although they can occur in actions such as internal-external rotation of the tibia, varus-valgus in the last degrees of extension (20-30º), a load in flexion, or an anterior translation of the tibia generated by an excess of tension in the quadriceps (Hewett et al, 2010).

As mentioned above, this type of injury is usually of considerable severity, not only because it keeps the athlete out of the field for a long period of time, but also because of the possible consequences of the injury. That is why the proposed objectives are to know some of the risk factors and ACL injury mechanisms from the 2016 to 2019 seasons in Cantabrian soccer players.

## Material and Method

In the present descriptive analysis, data were collected retrospectively from the last 3 consecutive seasons (2016-2017, 2017-2018, and 2018-2019) in which all male and female soccer players in Cantabria from base to 3rd division categories, who suffered an ACL rupture, were included together.

Information was obtained on different risk factors for each subject at the time of injury (sex, age, type of turf, dominant leg/leg injured, injury mechanism, type of studs, whether it was in a match or in training, minute, month of injury, position, and whether or not he/she was doing preventive work) in addition to the type of injury suffered.

The sample included in the study was 93 persons, of whom 84 were men and 9 women. The exclusion criterion used was not having all the data analyzed in full.

The recording of the data was carried out by the Cantabrian Football Federation by means of an oral interview carried out on the first day the subject arrived at the sports readaptation area, in which different items were indicated according to the data provided by the patient.

The classification used for the type of studs used by the injured subjects was the one proposed by Thomson, Whiteley, Wilson, and Bleakley (2019), where it divides these into: Artificial Grass (AG), Firm Ground (FG), and Soft Ground (SG). In addition, two more types were added: Turf and Hard Ground (HG) (Queen, Charnock, Garrett, Hardaker, Sims, and Moorman et al, 2008).

## Results

After applying the exclusion criteria, the sample selected for the study was 78 players, of whom 69 were male (19.1 ±4.0 years) and 9 female (19.7 ±4.8 years).

In the group of women, the most recorded injury was the ACL, exclusively, with 8 cases (88.9%). In the case of men, a total of 42 ACL injuries (60.9%) were recorded, this being the most representative. The rest, in addition to ACL, also presented other associated structures. Among them we found 8 ACL with internal meniscus (IM), 9 with external meniscus (EM), and 5 in which both menisci were affected. The remaining 5 injuries were classified as "other" and included, in addition to ACL rupture, involvement of the internal lateral ligament (ILL) or posterior cruciate ligament (PCL).

The results obtained for the different factors analyzed are as follows (table 1):

| | MEN | | WOMEN | |
|---|---|---|---|---|
| **FACTORS ANALYZED** | **Sample** | **Percentage** | **Sample** | **Percentage** |
| **TYPE OF INJURY** | **n** | **%** | **n** | **%** |
| ACL | 42 | 60,9 | 8 | 88,9 |
| ACL + IM | 8 | 11,6 | 1 | 11,1 |
| ACL + EM | 9 | 13,0 | - | - |
| ACL + BOTH MENISCI | 5 | 7,2 | - | - |
| ACL + OTHERS | 5 | 7,2 | - | - |
| **TIME OF OCCURRENCE** | **n** | **%** | **n** | **%** |
| Competition | 59 | 85,5 | 8 | 88,9 |
| Training | 10 | 14,5 | 1 | 11,1 |
| **MINUTE OF INJURY** | **n** | **%** | **n** | **%** |
| From min 1 to 22 | 10 | 14,5 | 5 | 55,6 |
| From min 22 to halftime | 23 | 33,3 | 1 | 11,1 |
| From halftime to min 67 | 12 | 17,4 | 1 | 11,1 |
| From min 68 to the end | 14 | 20,3 | 1 | 11,1 |
| **POSITION** | **n** | **%** | **n** | **%** |
| Goalkeeper | 3 | 4,3 | - | - |
| Defender | 35 | 50,7 | | 33,3 |
| Midfielder | 26 | 37,7 | 5 | 55,6 |
| Striker | 5 | 7,2 | 1 | 11,1 |
| **PLAYING FIELD** | **n** | **%** | **n** | **%** |
| Artificial | 60 | 87,0 | 9 | 100 |
| Natural | 9 | 13,0 | - | - |
| **TYPE OF STUDS** | **n** | **%** | **n** | **%** |
| FG | 19 | 27,5 | 1 | 11,1 |

| | | | | |
|---|---|---|---|---|
| SG | 4 | 5,8 | - | - |
| AG | 32 | 46,4 | 7 | 7,77 |
| HG | 11 | 15,9 | 1 | 11,1 |
| TURF | 3 | 4,3 | - | - |
| **MECHANISM OF INJURY** | **n** | **%** | **n** | **%** |
| Contact | 18 | 26,1 | 2 | 22,2 |
| No contact | 51 | 73,9 | 7 | 77,8 |
| **DOMINANCE** | **n** | **%** | **n** | **%** |
| Injury to dominant leg | 34 | 49,3 | 5 | 55,6 |
| Non-dominant leg injury | 35 | 50,7 | 4 | 44,4 |
| **PREVENTIVE WORK** | **n** | **%** | **n** | **%** |
| They did perform preventive work | 23 | 33,3 | 3 | 33,3 |
| They did not perform preventive work | 46 | 66,7 | 6 | 66,7 |
| **MONTH** | **n** | **%** | **n** | **%** |
| January | 9 | 13,0 | - | - |
| February | 9 | 13,0 | - | - |
| March | 6 | 8,7 | 1 | 11,1 |
| April | 10 | 14,5 | 3 | 33,3 |
| May | 6 | 8,7 | 2 | 22,2 |
| June | 7 | 10,1 | - | - |
| July | 1 | 1,4 | - | - |
| August | 3 | 4,3 | 1 | 11,1 |
| September | 4 | 5,8 | - | - |
| October | 2 | 2,9 | - | - |
| November | 6 | 8,7 | 2 | 22,2 |

| | | | | |
|---|---|---|---|---|
| December | 6 | 8,7 | - | - |

*Table 1*Summary of the results obtained. *Min: minute; FG: Firm Ground; SG: Soft Ground; AG: Artificial Grass, HG: Hard Ground.*

***Time of onset of injury***

In competition, a greater number of injuries were recorded in both men (59 cases, 88.5%) and women (8 cases, 88.9%) as opposed to training injuries (men: 10 cases, 14.5%; women: 1 case, 11.1%), with the first half being the period with the highest number of injuries for both groups (men: 33 cases, 47.8%; women: 6 cases, 66.7%). Analyzing this first period in men, we saw that from the 23rd minute until halftime most injuries occurred (23 cases), while the first few minutes presented fewer cases (10). On the other hand, women suffered 55.5% of the injuries (5 cases) in the first 22 minutes, the rest being distributed evenly throughout the match.

***Position***

In men, the most affected field position was defense, with a total of 35 cases (50.7%), followed by midfielders (26 injuries; 37.7%), forwards (5 injuries; 7.2%) and finally, with only 3 records (4.3%), the goalkeeper.

In the case of women, the most injured position was midfielder, with 5 incidents (55.6%). This was followed by defenders (3 cases, 33.3%) and forwards (1 case, 11.1%).

***Playing field and type of studs***

Regarding the playing surface, 87% of the men (60 cases) and 100% of the women (total cases) were injured on artificial turf, while the remaining 13% of cases in men (9 cases) were injured on natural grass.

Regarding the type of cue, the Artificial Ground (AG) type was the most used at the time of injury with 32 cases (46.4%) in men and 7 (77.8%) in women. In addition, the Firm Ground (FG) type was the second most represented with 19 cases in men (27.5%) and 1 in women (11.1%).

***Injury mechanism***

The predominant injury mechanism in both samples was non-contact, with a total of 51 cases (73.9%) in men and 7 (77.8%) in women. The remaining injuries were contact, with 18 episodes (26.1%) in men and 2 (22.2%) in women.

***Dominance***

Regarding the dominance of the injured leg, in men 50.7% of injuries were recorded in the non-dominant leg (35 cases), while in women 55.6% of injuries occurred in the dominant leg (5 cases).

***Preventive work***

In 66.7% of both men (46) and women (6) did not carry out any type of preventive work in their club, in contrast to the remaining 33.3% who did carry out this type of work.

***Month***

Both the male and female groups had the highest number of injuries in April, with 10 (14.5%) and 3 (33.3%) cases, respectively.

This was followed by January (9 cases, 13%) and February (8 cases, 11.6%) for men (Figure 1).

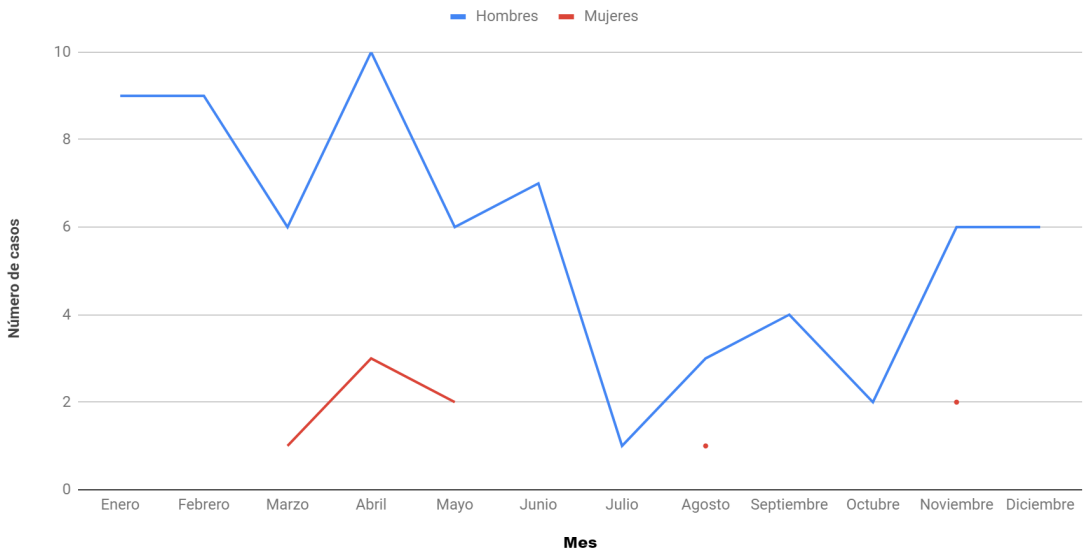



*Figure 1.* Distribution of lesions throughout the year.

## Discussion and conclusions

ACL rupture is one of the most worrying injuries in Cantabrian soccer. Thus, the objective of this study was to determine several of the risk factors that may be involved in the occurrence of this injury.

The main findings show that competition affects ACL injuries to a greater extent, being the first part where the greatest number of injuries are concentrated. In addition, it can be seen how the artificial grass turf combined with the type of AG studs has registered a large number of injuries and the failure to carry out preventive work can lead to an increase in the probability of non-contact injuries.

In the study carried out by Ekstrand, Hägglund, and Waldén (2011), they analyze the characteristics of all the injuries produced over several seasons in different professional European soccer teams, seeing that the highest percentage of these occur in competition and not during training. Following this line, Schiffner et al (2018), shows how in the German professional soccer league (Bundesliga) the highest percentage of ACL injuries occurs in competition (72%). These results are similar to those obtained in this study, where ACL tears occur mainly in competition for both sexes, which may be due to the fact that the intensity in matches is different from that in training (Gaspar-Junior, Onaka, Barbosa, Martinez, & Oliveira-Junior, 2019).

Regarding the period of the match in which most people are injured, we find disparate results. Faunø and Jakobsen (2006) point out that the second half of the match is the most injury-prone period, in contrast to Waldén, Hägglund, Magnusson, and Ekstrand (2011), whose results show that the period with the most injuries is the first half, specifically the first 15 minutes. This second proposal is the one that agrees with the results obtained in this analysis where the highest number of injuries for both sexes appear in the first part.

In men, attending to the positions that players occupy on the field, we see how defenders are those who accumulate more injuries followed by midfielders. In the case of goalkeepers, the percentage of the injured is very low, as in other publications (Schiffner et al, 2018). In contrast to our study, Barth et al (2019) analyze that the midfield position shows the most records (42.5%), but again, the goalkeeper position is the least affected (4.6%).

As for the girls, the position with the highest number of injuries is midfielders as in Giza, Mithöfer, Farrell, Zarins, and Gill (2005).

According to Acevedo et al (2014), in outdoor sports, as is the case of soccer, the natural grass surface presents less risk of injury than that which is artificial. This is reflected in our results, where artificial grass represents the highest number of cases in both men and women. It should be noted that in Cantabria the number of artificial grass fields is predominant.

On the other hand, attending to the type of studs, we see how the AG is the most used at the time of injury representing a high percentage of the sample. These data do not match with the results obtained by Meyers (2017), where no differences are observed in terms of the type of studs used and the injuries produced.

In soccer, the main ACL injury mechanism is non-contact (Ekstrand, Waldén and Hägglund, 2011; Waldén et al 2015; Dick, Putukian, Agel, Evans and Marshall, 2007; Teresa, 2003). Our results confirm this fact, reflecting that the highest percentage in both men and women are produced through this mechanism. Given this, we see that these types of injuries are due to inadequate movement patterns that can be modified through preventive work (Dai, Mao, Garrett, & Yu, 2014). Thus, even if we can reduce the number of injuries through this type of work, the reality is that, in both sexes, a high percentage does not perform any type of preventive training.

Regarding the dominance of the injury, there is no consensus on whether this factor is a variable to be taken into account. On the one hand, Rochcongar, Laboute, Jan, and Carling (2009) find that the right leg is injured more, regardless of dominance. On the other hand, Waldén et al (2011) observe that there is a relationship between the injured leg and the dominance of the player, being in this case the left leg the most damaged.

Finally, it is seen how in both groups the month where the highest number of ACL injuries occur is April, as in the study conducted by Schiffner et al (2018) in German professional soccer.

### *Limitations*

Due to the fact that this is a sample collected by the Cantabrian Football Federation through interviews, 15 people had to be eliminated from the initial sample because they presented all the variables in full, going from a sample of 93 to a sample of 78. Since there is no data prior to 2016, there is no possibility of comparing more seasons with each other or any specific factor. In addition, the selected sample is amateur and most studies are based on professional leagues, which may imply that some results are not similar. Finally, the sample of women with ACL injuries was very small.

### *Conclusion*

The aim of this article is to know some of the risk factors as well as mechanisms of anterior cruciate ligament injury in Cantabrian soccer players from the 2016 to 2019 seasons.

Analyzing whether the ACL injury entailed the involvement of other body parts or not, it was observed that this occurs mainly without any associated structure.

The main mechanism of injury is non-contact, with a greater number of people affected during the first part of the competition and in the month of April. In addition, this injury occurs mainly on artificial turf and with the AG type of studs.

Men are usually injured between the 23rd minute and half-time of the first half, with defenders being the most affected. On the other hand, women are injured mainly between the start of the match and the 23rd minute and the most injured position is midfielder.

Regarding the dominance of the injured leg, no significant conclusion can be drawn and preventive work is recommended to reduce the number of injuries.

In future lines of research, it would be interesting to be able to carry out an intervention in the different clubs, acting on those modifiable risk factors and analyze whether the number of ACL injuries is reduced or not.

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