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Review

Vibration as preventive therapy and treatment of delayed onset muscle soreness. A systematic review

Claudia Carrasco Legleu, Ramón Candia-Luján, Lidia Guillermina De León Fierro, Ofelia Urita Sánchez, Kevin F. Candia-Sosa

Facultad de Ciencias de la Cultura Física, Universidad Autónoma de Chihuahua, México.

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Summary

In recent years the vibration therapy has received great importance in the treatment of delayed onset muscle soreness. Pain that occurs between 12 and 24 hours after an unaccustomed exercise. So the aim of the present study was to determine the preventive and therapeutic effect of vibrations on delayed onset muscle soreness. Conducted a searching in PubMed, Web of Science, Scopus, SportDiscus, PEDro and Cochrane Library databases, for which keywords were used; delayed onset muscle soreness and vibration. 403 articles were identified in the different databases, 10 were selected that met the criteria for review. Besides before, 6 other items that were identified by the search engine Google Scholar were included, in all cases retrieved in full text. 75% of the articles have less than 5 years of have being published. Kleber Burton index, measured by the median, was 2,5 years. The average frequency applied to the participants was 37,4 ± 15 Hz, with a displacement of the platform 3,7 ± 2,3 mm and a length of 9,4 ± 8,8 min. While the average methodological quality of the studies was 4,9 ± 1,1 After analyzing the selected studies it was concluded that the topic is present and that the vibrations are effective both in the prevention and treatment of delayed onset muscle soreness.

Key words:
Delayed onset muscle soreness. Eccentric exercise. Vibration therapy. Frecuency. Displacement.

La vibración como terapia preventiva y tratamiento del dolor muscular tardío. Una revisión sistemática

Resumen

En años recientes la terapia vibratoria ha recibido gran importancia en el tratamiento del dolor muscular tardío. Dolor que se presenta entre 12 y 24 horas después de haber realizado un ejercicio desacostumbrado. Por lo que el presente estudio tuvo como objetivo determinar el efecto preventivo y terapéutico de las vibraciones sobre el dolor muscular tardío. Se llevó a cabo una búsqueda en las bases de datos Pubmed, Web of Science, Scopus, SportDiscus, PEDro y Cochrane Library, para lo cual se usaron las palabras clave; delayed onset muscular soreness y vibration. De 403 artículos identificados en las diferentes bases de datos se seleccionaron 10 que cumplieron con los criterios establecidos para la revisión. Además de los anteriores, se incluyeron otros 6 artículos que se identificaron por medio del buscador Google Académico, en todos los casos se recuperó en artículo en texto completo. El 75 % de los artículos tiene menos de 5 años de haber sido publicados. El índice de Burton Kleber, medido con la mediana, fue de 2,5 años. El promedio de la frecuencia aplicada a los sujetos de los estudios fue de 37,4 ± 15 Hz, con un desplazamiento de la plataforma de 3,7 ± 2,3 mm y una duración de 9,4 ± 8,8 min. Mientras que el promedio de la calidad metodológica de los estudios fue de 4,9 ± 1,1 Después de analizar los estudios seleccionados se concluyó que el tema es actual y que las vibraciones son efectivas tanto en la prevención como en el tratamiento del dolor muscular tardío.

Palabras clave:
Dolor muscular tardío. Ejercicio excéntrico. Terapia vibratoria. Frecuencia. Desplazamiento.

Correspondence: Ramón Candia Luján
E-mail: rcandia@uach.mx

Introduction

Delays onset muscle soreness (DOMS) is considered to be a transitory effect of intense or unaccustomed exercise[1]. Armstrong[2] defines DOMS as the feeling of discomfort or pain that occurs in the skeletal muscle after performing unaccustomed physical exercise. This pain appears between eight and twelve hours after performing unaccustomed physical exercise, with the greatest intensity appearing between 24 and 72 hours after, with a possible duration of between 5 and 7 days[3]. Pain that gets worse after performing exercises with greater eccentric content. Examples of activities that include this type of contraction are walking downhill, and opposing the pull of gravity while lowering a weight or object[4].

Over a hundred years have passed since Hough[5] first distinguished between pain that appears during exercise and pain that appears the following day, explaining the latter as a result of muscle damage produced during muscle contractions. Despite the fact that the mechanism that produces this pain is still not known, over the years diverse theories have been developed that aim to explain this phenomenon. In 1983 while reviewing the issue, Francis[6] defined four theories; lactic acid, muscle spasm, tissue tears and damage to the connective tissue. In a later review, Dierking and Bemben[7] added to these four previous theories, with that of cell inflammation. Finally, Cheung *et al.*[8] also carried out a review of the DOMS producing mechanisms. As well as the previous theories, they included the enzyme efflux theory. However, they also mention that the DOMS producing mechanism cannot be explained with just one theory, but rather by the sequence of events that combine the muscle damage, enzyme efflux and inflammation theories. Figure 1 shows the sequence of events that produces DOMS proposed by Foschini *et al*[9].

Due to the discomfort caused by DOMS, both for those that perform regular physical exercise as well as for sedentary people, studies have been done in which diverse strategies have been assessed to counteract this pain, among which include: anti-inflammatories[10], anti-oxidants[11], physical therapies[12], among which vibrational therapy has recently gathered significant importance.

In view of all the foregoing, the following question arises: is the use of vibrational therapy effective in preventing and treating delayed onset muscle soreness?

In response to the question, the following objective was proposed: carry out a systematic review of the main databases in the field of health to establish the effectiveness of vibrational therapy in both preventing and treating delayed onset muscle soreness.

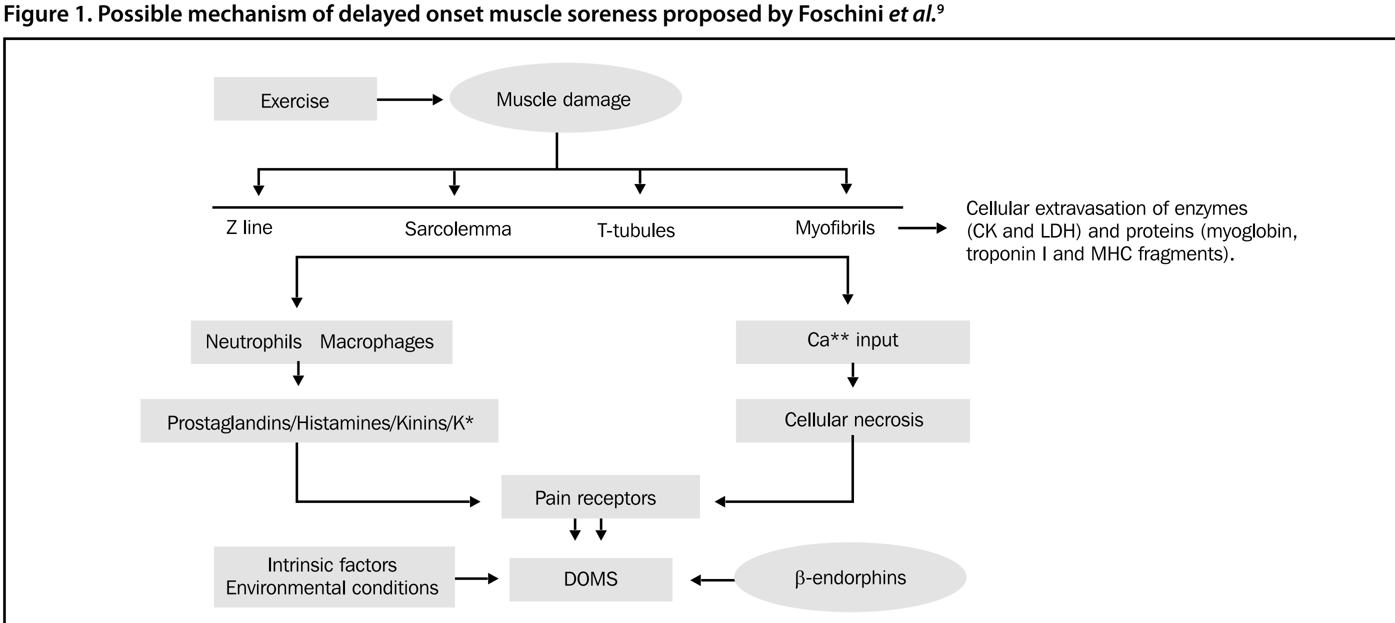
Vibrational therapy

Vibrational therapy is given using mechanised stimuli characterised by an oscillating movement determined by the extent, number and acceleration of the oscillations[13]. Some of the acute effects of the vibrations on the body are increased oxygen consumption, increased muscle temperature and blood flow[14], which may have an influence on counteracting DOMS.

In accordance with Albasini *et al.*[15], therapy using vibrations dates back to Ancient Greece. However, over recent years it has grown in popularity as an alternative way to develop strength, power and flexibility, as well as coordination. This explains why it is now commonplace to find vibrating platforms in gyms, rehabilitation and medical centres.

Although the first research carried out on the use of vibrations was done so from the perspective of their negative effects on the health[16]. Today, the focus has changed and studies are mainly conducted on the development of muscle strength on diverse populations.

Figure 1. Possible mechanism of delayed onset muscle soreness proposed by Foschini *et al.*[9]



Material and method

Article search strategy

The search for the articles was performed on the following databases: Pubmed, Web Of Science (WOS), Scopus, Physiotherapy Evidence Database (PEDro), Cochrane Library and SportDiscus. The Google Scholar search engine was used to identify studies that were found in databases other than those consulted. In terms of the search details, below are the terms used for each database PubMed; ("vibration" [MeSH Terms] OR "vibration"[All Fields]) AND "delayed" [All Fields] AND onset [All Fields] AND ("myalgia" [MeSH Terms] OR "myalgia" [All Fields] OR ("muscle" [All Fields] AND "Soreness" [All Fields] OR "Muscle Soreness" [All Fields]), WOS; "vibration delayed onset muscle soreness" (Tema), Scopus; [All Fields], PEDro; (simple search), Cochrane Library; [All Text] and SportDiscus; vibration (TX Complete text) AND delayed onset muscle soreness (TX Complete text).

The criteria for the selection of studies: one of the variables measured in the study must be DOMS, original research, published in peer review journals, in English, therapy applied to humans, no restriction on the publication date. The first search was performed in July 2015 and the second in January 2016..

Assessment of the methodological quality and study selection

The quality of the studies was determined based on the PEDro scale. Of all the studies included in this review, six were qualified in the PEDro database. The rest were all analysed by two independent researchers. In the event of discrepancy, the article was assessed by a third researcher.

Regarding the selection of the first studies, the title was read, if it included a link between delayed onset muscle soreness and vibrational therapy, the abstract was read. If it met all selection criteria, the entire text was recovered and was included in the review.

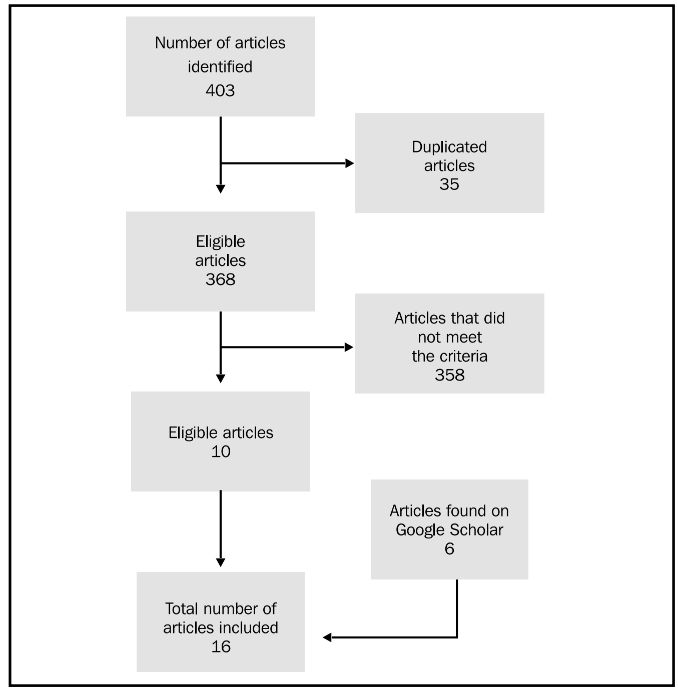
Resultados

Figure 2 displays the selection process for the studies.

Of all the studies identified, 16 met the selection criteria, of which one is a case study and the others are experimental. The methodological quality of the studies was 4.9 ± 1.1 on the PEDro scale from 1 to 10. No methodological quality assessment was performed on the case study. In terms of obsolescence, the Pierce index (percentage of studies performed less than 5 years ago) was 75%, whilst the Burton Kleber index, measured with the median, was 2.5 years. Table 1 displays the summary of the studies analysed and it can be observed that the majority were published less than five years ago.

The average frequency used in the studies in this review was 37.4 ± 15 Hz (range from 5 to 73). Regarding the movement of the platform, the average was 3.7 ± 2.3 mm (range from 0.5 to 8) and the duration was 9.4 ± 8.8 min (range from 1 to 30).

Figure 2. Flow chart for the selection of articles.



Study summary

One of the first studies dealing with DOMS with vibrational therapy was performed by Koeda *et al.*[17] in 2003, in which a comparison was carried out between the application of vibrational therapy on two separate occasions: on 8 subjects it was applied immediately and on 8 others it was applied two days after performing exercise. The DOMS reduced during the arm flex with the application of vibrations two days after the exercise. Bakhthary *et al.*[18] applied vibrations before the subjects performed the exercise; within their conclusions they reported that vibrations can prevent and control DOMS. Broadbent *et al.*[19] found that the subjects that were given vibrational therapy for five days after running downhill for forty-five minutes reduced DOMS and the interleukins-6 in great measure compared to subjects from the control group. Rhea *et al.*[20] carried out a study that aimed to analyse the effectiveness of vibrations, massage and stretching on reducing muscle pain. They reported that including whole-body vibrations in recovery is effective in reducing muscle pain.

Most of the studies performed within the past 5 years aimed to establish the effectiveness of vibrations on DOMS. In 2011, Lau and Nosaka[21] concluded that vibratory therapy was an effective intervention in reducing DOMS and in recovering the range of arm movements after undergoing a session of eccentric exercises. In the same year, Aminian-Far *et al.*[22] performed a study in which they aimed to research the acute effect of vibrational therapy applied before exercise and the prevention of DOMS. The experimental group revealed a reduction in DOMS symptoms compared to the control group. In a case report with a similar objective to the previous study, with a healthy subject and

Table 1. Summary of the studies of the effects of vibrations on DOMS.

Authors	Sample	DOMS production	Other variable measurements	Measurement of pain after exercise	Effect on DOMS	Application and duration of the vibrations
Koeda *et al*. 2003	24 subjects	Flex of the elbow until exhaustion	ROM, blood flow, arm circumference	0,2 and 7 days	The pain in the total passive flex diminished with the application of vibrations two days later	20 minutes after exercise and two days after
Bakhtiary *et al.* 2007	25 EXP 25 CONT	Treadmill sloping down at 10°	Isometric strength, CK	1 day	Greatest DOMS in the group not treated	One minute before exercise
Broadbent *et al.* 2008	15 EXP 14 CONT	40 minutes on the treadmill sloping down by 10°	Inflammatory indicators and CK	24,48,72,96 and 120 h	Less DOMS 96 hours later in the calves of the treated subjects	3 minutes during recovery
Rhea *et al.* 2009	16 subjects	4 x 8-10 squats, leg extension and curl, heel lift and dead weight. 10 40-yard sprints.		12,24,48 and 72 h	Less muscular pain in the group treated with vibrations	Two sessions of 6 minutes per day for three days
Aminian-Far *et al.* 2011	15 EXP 17 CONT	6 x 10 ECC knee extensions	Thigh circumference, muscle strength and CK	1,2,3,4,7 and 14 days	Less DOMS in the experimental group after 24 and 48h	60 seconds before exercise
Lau y Nosaka 2011	15 subjects	10 series of 6 reps. ECC elbow flexes	ROM, arm circumference, CK	0,1 h,1,2,3,4,5 and 7 days	Less muscular pain in the group treated on the second day	30 minutes after exercise on 1st, 2nd, 3rd and 4th day
Pinto *et al.* 2011	1 subject	Running	Difficulty running and limitation of movements	0 and 24	Pain reduced after applying the therapy	3 minutes after exercise and 24 h
Mohammadi y Sahebazamani 2012	15 EXP 15 CONT	5 series of 10 reps of arm flexes	Arm circumference and ROM	0,24,48 and 72 and 96 h	Less muscular pain in the subjects of the treated group	One minute after exercise
Kamandani *et al.* 2013	10 EXP 10 CONT	25 min running on a treadmill sloping down by 5°	CK	24 h	Less pain on 15 cm pressure of the knee cap in the experimental group	3 minutes before exercise
Xanthos *et al.* 2013	7 EXP 6 CONT	60 minutes walking on a treadmill sloping down by 13°	Muscular power, gait analysis and CK	0,1,2,4 and 7 days	No difference in the DOMS between the vibration and control groups	10 series of 1 minute after exercise, 1,2,3 and 4 days
Wheeler *et al.* 2013	10 EXP 10 CONT	3 x 10 strides with dumbbells	Power and flexibility	Immediately	No difference in the DOMS between groups	10 minutes between assessments
Imtiyaz *et al.* 2014	15 massage 15 EXP 15 CONT	30 reps. Arm ECC	ROM, isometric strength, maximum strength, lactate dehydrogenase and CK	0,24,48 and 72 h	Both massage and vibration reduced the DOMS	For 5 minutes before exercise
Dabbs *et al.* 2014	27 women	4 series until the split squats fail	Vertical jump, peak power strength, reaction strength upon stepping and muscle activation	0,24,48 and 72 h	Less muscular pain in the experimental group after 72 h	2 series of 30 seconds before assessments
Dabbs *et al.* 2015	16 EXP 14 CONT	4 series until the split squats fail	ROM and thigh circumference	0,24,48 and 72 h	Vibrational therapy did not help alleviate the DOMS	2 series of 30 seconds before assessments
Fuller *et al.* 2015	25 massage 25 EXP	100 maximum ECC of knee extensions	Isometric torque, CK, serum myoglobin and inflammation	0,24,48, 72 and 168 h	There was no pain difference between two treatment types	20-minute sessions twice a day for seven consecutive days
Nepocatych *et al.* 2015	8 active males	3 series of squats until fatigued	Peak power and anaerobic capacity	24,48 and 72 h	No significant benefit with the application of therapy	For 10 minutes after the test

CK Creatine Kinase: CONT Control; DOMS: Delayed Onset Muscle Soreness; ECC Eccentric actions; EXP; Experimental; ROM: Range of movement.

following a run, Pinto *et al.*[23] concluded that the inclusion of an acute treatment protocol with a low-frequency vibratory platform with the subject in different positions, reduces DOMS.

In 2012, Mohammadi and Sahebazamani[24] analysed the preventive effect of vibrations against some functional markers of DOMS in a group of young people. Among the results, they mention that training with vibrations displays the positive effects on the range of movement, DOMS and circumference of the limb treated.

In 2013, Kamandani *et al*[25] also used a treadmill to cause DOMS, but downhill. They discovered that subjects that had vibrations applied before running suffered less DOMS than the control group. Xanthos *et al.*[26] also compared vibrations with passive stretching and light exercise on a stationary bicycle as recovery methods after walking backwards on a treadmill for 60 minutes. They concluded that the vibratory therapy they performed was not recommended after DOMS producing exercise. Wheeler and Jacobson[27] compared vibrations with light exercise and the effect on DOMS, flexibility and muscle power. Their findings revealed that the two recovery types were equally as effective in treating the variables mentioned.

Imtiyaz *et al.*[28] compared the effect of vibratory therapy with massage and the effect on DOMS. They found that both therapies were equally as effective in its prevention.

Recently, in 2014, Dabbs *et al.*[29] performed a study on a group of subjects, carrying out squats on a flat surface whilst the other group did the same on a vibratory surface. They did not find a difference in the DOMS between the groups participating in the study. This same group of researchers[30] evaluated the effect of vibrations on the whole body over a short time on DOMS after performing high intensity exercises. They concluded that treatment with vibrations did not alleviate DOMS. Fuller *et al.*[31] also compared vibratory therapy with sports massage and stretching applied after performing exercises and their effects on DOMS. The application of therapy (25 subjects per group) was performed over seven days following the exercise. They found that vibratory therapy was more effective than massage in alleviating DOMS in untrained men.

In a design study, Nepocatych and Balilions[32] cross-compared the vibrational therapy with and without ice applied to the lower limbs and the effect on different performance variables. Regarding DOMS, the authors concluded that the therapy did not provide significant benefits to recovery.

Discussion

In accordance with the methodological quality scale, the studies included in the review are categorised as regular. Though due to the difficulty of administering a placebo in this type of study[33], assessing the methodological quality should be done with eight points and not ten as it is currently. Furthermore, in this respect, the comparison with passive groups is not considered valid, as the groups undergoing the vibrational therapy experience extra activation or muscle work, a factor that is absent from the control groups[34].

In terms of obsolescence, it is observed that both the issue and the articles are valid, as the majority (three quarters) of them have been published within the past five years.

Regarding the magnitude and movement, the average (37.4 ± 15 Hz and 3.7 ± 2.3 mm, respectively) coincides with values habitually used in studies seeking improvements in flexibility and proprioception, as well as relaxation and muscle strengthening[35]. This intensity promotes different metabolic responses, including an increased heart rate and blood flow to muscles[36], which would be the elements responsible for reducing DOMS. In terms of the platform movement, the average with which subjects worked allowed them to maintain contact with the platform throughout the entire training session[37]. With regards to the duration of vibration application, the average (9.4 ± 8.8 min) coincides with Rauch[14] who mentions that a typical session should last for approximately 9 minutes.

Although the average values of the studies coincide with those of the authors mentioned[35-37], which revealed positive effects in different aspects, when we look at the range we can observe that it is very wide and greatly variable, making it difficult to analyse these studies.

In this search, an update on the issue was encountered[38], which included 3 studies that aimed to review the role of vibrational therapy in the prevention of DOMS. They concluded that vibratory therapy, as well as improving physical performance, helped prevent DOMS. A review on the issue was also found[39] and just as in this study, it was revealed that vibratory therapy is effective on both a preventive and therapeutic level when treating DOMS. In their brief review, Kosar *et al.*[40] mention that research suggests that vibrations are considered to be a promising strategy in alleviating muscle pain.

Conclusions

In accordance with the analysis of the studies included in this review, it can be concluded that vibrational therapy is effective in both preventing and treating DOMS, though more studies are required in order to establish the optimum duration, frequency and movements for the therapy.

DOMS is often the reason why people that start practising physical activity give it up, and why athletes are affected on a training level, which is why aside from traditional therapies, vibrations can be included as an effective preventive method as well as a treatment to alleviate symptoms.

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Review

Caffeine and its ergogenic effect in sport (first part)

Antonio García Moreno

Universidad Pablo de Olavide. Sevilla.

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Summary

The effects of caffeine on the human body have been studied for some time and much is now known about its characteristics. In the sports world, caffeine is one of the most popular ergogenic aids and is widely used by coaches and athletes. Given its importance, in this paper we analyze the ergogenic effects of caffeine on athletic performance and related actions, through a review of the latest scientific literature. We selected studies that included well-trained subjects performing a physical activity that reflects current practices in sport. Close attention was given to the methodology used, including the dose, timing and administration method of the caffeine, with the aim of establishing an updated guide to caffeine as an ergogenic aid in sport. The results show there are a variety of studies that have investigated the effects of caffeine on exercise using different methodologies, making it impossible to reach a general assumption. Nevertheless, we are able to draw valuable conclusions including the clear trend towards the effectiveness of caffeine as an ergogenic aid in certain situations, new findings that deal with the use of caffeine on consecutive days of physical activity, the best time of day to take the substance, the strategic management of caffeine to counteract sleep deprivation, and in what direction the latest research trends in this field are moving.

Key words:
Caffeine. Ergogenic effects. Sports. Aerobic exercise.

La cafeína y su efecto ergogénico en el deporte (primera parte)

Resumen

Los efectos de la cafeína sobre el organismo humano han sido estudiados desde hace tiempo y, a día de hoy, ya conocemos gran parte de sus características. En el mundo del deporte, la cafeína es una de las ayudas ergogénicas más populares y empleadas por entrenadores y atletas. Debido a su importancia, en este trabajo nos hemos propuesto el objetivo de analizar los efectos ergogénicos de la cafeína sobre el rendimiento deportivo y todo lo que rodea a esta acción, a través de una revisión de la literatura científica más actual. Hemos seleccionado aquellos estudios que incluyeran sujetos bien entrenados realizando una actividad física que reflejara las actuales prácticas en el deporte, prestando mucha atención a la metodología empleada, esto es la dosis, el momento y la forma de administración de la cafeína, para conseguir alcanzar nuestra meta de constituir una guía actualizada sobre todo lo que rodea a la cafeína como ayuda ergogénica en el deporte. Los resultados obtenidos nos han mostrado una gran variedad de estudios que han investigado acerca de la cafeína y el ejercicio físico siguiendo diferentes metodologías, lo que provoca una imposibilidad de generalizar sobre el asunto. Sin embargo, hemos podido extraer valiosas conclusiones como la clara tendencia hacia la efectividad de la cafeína como ayuda ergogénica en situaciones determinadas, nuevos hallazgos que tienen que ver con el uso de la cafeína en días consecutivos de actividad física, el mejor momento del día para el consumo de la sustancia o la administración estratégica de cafeína para contrarrestar la falta de sueño, y hacia dónde se dirigen las últimas tendencias en investigación dentro de la materia.

Palabras clave:
Cafeína. Efectos ergogénicos. Deportes. Ejercicio aeróbico.

Correspondence: Antonio García Moreno
E-mail: antoniogm91@hotmail.com

Introduction

This review comes a decade after caffeine was struck off the World Anti-Doping Agency's (WADA) prohibited list. One of the reasons why WADA removed caffeine from the list of banned substances was that many experts considered it pervasive in a wide variety of drinks and food, meaning that athletes could be sanctioned for social consumption or dietary caffeine. Caffeine is also metabolised to varying degrees in different individuals and, therefore, the concentrations found in urine may vary considerably and not always correlate with the dose ingested[1].

The ergogenic effect of caffeine on human performance is fairly widely accepted. The most current reviews of the subject[2,3] indicate that caffeine helps to improve performance in many sporting situations, depending on a number of variables, including exercise intensity, the number of doses administered, habituation and the level of training of the subjects.

Physiologically, the action of caffeine in the body is difficult to determine to any degree of precision due to its wide distribution throughout the tissues of the body. It is largely believed that caffeine acts as a stimulant of the central nervous system; however, the glycogen-saving effect, the ability to increase fatty acid mobilization and induce the release of catecholamines, as well as direct effects on muscles, have been verified as mechanisms which contribute to the ergogenic effect of the substance[1,3].

Enhanced performance in endurance exercises can be isolated as the thread common to most of the studies which have investigated the matter. Although conflicting results do exist to a certain extent, the general conclusion would seem to be that both small doses of caffeine and moderate-to-high doses have beneficial effects on aerobic activities[2,4,5].

However, there is less consensus when it comes to anaerobic activities and exercises based on strength and power. The evidence provided in some studies suggests that caffeine can directly enhance skeletal muscle force, work and power, which may well contribute to improved overall performance in exercises of this kind[3,6,7]. Other research, however, has obtained very different results which deny this hypothesis[8,9].

The same is true, albeit on a smaller scale, of studies of real training or competition situations focusing on different sports. Although the study of the ergogenic effects of caffeine *in situ* during real events comes closest to reality, the idiosyncratic nature of these events means that they take place in extremely open and variable environments, exposing them to a wide range of outcomes which depend on whether we are dealing with a team sport or an individual sport, or on the techniques and tactics employed by the players, among other factors. Nevertheless, a large proportion of the studies conducted in the field conclude that caffeine is ergogenically effective in sport[2,10,11].

In order to understand why such disparate results are obtained, it is necessary to appreciate both the variety of methodological approaches used for studies of this kind and the difficulty involved in conducting research in this field, the sum of these two factors lying at the root of very different sets of results.

The experiments conducted have employed a very wide range of methodologies: everything from low doses of caffeine (less than 3 mg/kg) to high doses (over 9 mg/kg), with the consequent bearing on the mental and physiological response of the subject; administration of the substance by means of coffee, other drinks or capsules, and even other methods, leading to different rates of caffeine absorption in the body; and ingestion of caffeine at different times with respect to the physical exercise performed, ranging from minutes to hours before the start of the activity, or even during exertion itself, meaning that the physical activity is carried out with differing levels of caffeine in the body. Attention should also be paid to the type of protocol designed (whether it coincides with the reality of the sport or exercise, the level of training of the subjects or how familiar they are with the protocol of the activity), since this will affect the subjects' ultimate performance.

The complexity involved in conducting studies of this kind is reflected in the wide range of factors which can affect and/or compromise research results. The most important factors to bear in mind are: the degree of habituation of the participants to the substance, the side effects of caffeine, the effects of withdrawal from the substance, the intensity of the exercise performed and the different degree to which each individual metabolises caffeine[3].

So, although the effectiveness of caffeine as a performance enhancer has been widely proven, the discrepancies that have emerged make it very difficult to evaluate the specific action of caffeine precisely.

This study aims to solve this problem by reviewing the latest studies on the ergogenic effects of caffeine on sport in order to provide the members of the world of sport with a useful tool through which they can consult the characteristics of caffeine and its ergogenic effects on different sporting situations, how and when it can be administered, the factors which must be controlled and, ultimately, an updated, scientifically thorough guide on everything about caffeine as an ergogenic aid in sport.

The new trends in research on the subject[2] are also reviewed. These include:

- The administration of caffeine in alternative forms.
- The effect of caffeine on performance in adverse environmental conditions.
- The effect of caffeine on performance in sports people who are habitual consumers as opposed to those not habituated to the substance.
- The effect of caffeine on reaction time.
- The effect of caffeine on athletes' cognitive and perceptual dimensions.
- The side effects of caffeine consumption.

Finally, some of the more original results of the latest research, yet to be covered in any other review of caffeine in sport, are showcased, such as:

- The effect of caffeine on performance depending on the time of day.
- The effect of caffeine on performance in exercise carried out on consecutive days.
- The effect of caffeine on the recovery period and delayed onset muscle soreness (DOMS).
- The effect of caffeine on performance in a state of sleep deprivation.

Methodology

The databases *Medline, Scopus* and *Sport Discus* were used to search for the articles to cover in this systematic review. The search was conducted using the keywords *cafeina y deporte* in Spanish, and caffeine and sports in English, adding some other keywords like caffeine and sports performance in order to find as much information on caffeine in sport as possible. The search was also defined to the period between 2005 and 2015, the intention of the study being to compile the most recent work on the subject.

In this way, we found 361 documents on caffeine in sport, including both articles and reviews. We then screened all the articles to arrive at a list of all those addressing our chosen subject. In order to do this, and basing ourselves on our objectives, we defined a set of criteria for inclusion which the articles had to meet in order to enter the study. These criteria were:

- Articles investigating the ergogenic effects of caffeine on performance in aerobic or anaerobic sports activities.
- Articles using protocols involving well trained subjects familiar with the activity, reflecting current practices in the sport and/or simulating real events.
- Articles using methodologies specifying the dose, form and moment of administration of caffeine.

Articles which did not meet the criteria were excluded from the study. After this screening, the number of research articles for study dropped to 87.

The latest reviews were studied and compared to look into the background and current situation in our field of inquiry and, thereby, establish a starting point for our study.

Having done this, the data from all the studies were collected for their subsequent classification according to the following categories:

- The ergogenic effect of caffeine on aerobic exercise
- The ergogenic effect of caffeine on sport
- The ergogenic effect of caffeine on anaerobic exercise
- The methodology of research on caffeine and sport
- The latest trends in research on caffeine and sport
- Developments in research on caffeine and sport

Results and discussion of the studies

The ergogenic effect of caffeine on aerobic exercise

The relationship between aerobic exercise and caffeine is one of the most studied subjects within the scientific field of ergogenic aids in sport. Two studies employed a similar protocol but different methodologies to investigate the effect of caffeine on endurance in well-trained cyclists[4,5]. The trial consisted of an initial warm-up stage on a cycloergometer at 60% of maximum oxygen consumption (VO_2max) in which the subjects in the first study pedalled for 60 minutes and those in the second study pedalled for 105 minutes, followed by a second stage consisting of a 40-kilometre (km) time trial to be carried out in the shortest possible time. In the first study[4], the cyclists ingested 3 mg/kg of caffeine in capsule form 1 hour before the start of the trial, while the cyclists in the second study[5] took a solution of glucose and carbohydrates with 5.3 mg/kg of caffeine at the beginning of the trial and at 15-minute intervals during the first stage. In both studies, the cyclists improved their performance in the time trial after the intake of caffeine. Another study conducted with cyclists[12] showed that the intake of 6 mg/kg of caffeine 1 hour before exercise improved performance in a 1-hour trial, the participants covering greater distances with the administration of caffeine than they did with the placebo. In the same vein of research, Norwegian researchers[13] designed a trial for first-class cross-country skiers which consisted of covering 8 km in the shortest time possible on a ski simulator. The participants were given a concentrate sports drink containing 6 mg/kg of caffeine or placebo 75 minutes before performing the test. Caffeine significantly decreased the time it took the participants to complete the test compared to the placebo.

These studies demonstrate that low and moderate doses of caffeine administered at different times improve performance in endurance tests, thereby supporting the effectiveness of caffeine as an ergogenic supplement. This is possibly due, as suggested by the Norwegian study[13], to a drop in the exertion perceived as a result of caffeine, allowing the subject to exercise with greater intensity and a higher heart rate.

However, a 2005 study[14] with top male long-distance runners concluded that a dose of 5 mg/kg of caffeine 60 minutes before activity did not effectively improve performance in the multi-stage fitness test. The researchers did not control the level of habituation of the subjects to the substance or whether caffeine intake had produced any side effects detrimental to the athletes during the trial, so the reason for the results is unknown. Another study conducted with trained athletes[15], however, concluded that the administration of 6 mg/kg of caffeine 60 minutes before exercise led to a significant improvement in the performance of the participants in a test consisting of intermittent, high intensity, prolonged exercise which combined flat-out sprints with active recovery periods in two 36-minutes phases with 10 minutes of passive rest in between. So, contradictory results can be observed in similar subjects carrying out aerobic exercise after receiving very similar doses at the same time before starting.

Therefore, although the effectiveness of caffeine as an ergogenic aid in endurance tests can be considered fairly well proven and its use would appear to improve the performance of trained subjects, it is necessary to control the factors surrounding the administration of the substance in order to achieve the desired effect.

The ergogenic effect of caffeine on sports performance

Much of the research into the effects of caffeine on performance is carried out in laboratory conditions and although many studies try to reproduce the parameters of actually doing the sport in question, it is not possible to capture the true mood of performing the activity in real conditions. The researchers are aware of the complexity of controlling studies in the actual field, where the atmosphere and the way in which the sport is performed can vary widely, and even factors such as tactics or strategy, level of motivation, etc. can affect performance in individual and team sports alike. Even so, the number of studies *in situ* investigating athletic performance during training and competitions under the effects of caffeine has increased over recent years.

Individual sports

Athletics

One study[16] looked into the effect of ingesting 3 mg/kg of caffeine 1 hour before running 8 km on a track on well-trained competitive runners. The results showed a faster time for the 8 km after the ingestion of caffeine compared to the placebo. The same effects were observed in another study[17] on trained runners who consumed 5 mg/kg of caffeine 1 hour before running 5 km. In both studies, the athletes improved their performance when they took the caffeine supplement (of 3 and 5 mg/kg) 1 hour before testing commenced.

Shot put

A study by Bellar *et al*[18] used university shot putters to observe the effect of chewing gum with 100 mg of caffeine on 6 standard throws. 20 minutes before the round of throws, the subjects chewed the gum for 5 minutes and then removed it. The caffeine significantly increased the distances of the throws, thereby demonstrating that a low dose of 100 mg of the substance is sufficient to improve the performance of shot putters.

Swimming

Vandenbogaerde and Hopkins[19] conducted a study with 9 top swimmers which measured their performance in their specific specialities in training and competitions both in the morning and in the evening. The swimmers took 100 mg of caffeine 75 minutes before beginning and the results showed that their performance was better in the afternoon than in the morning, better in competitions than in training and better with the use of caffeine than in controls. A low dose of caffeine, such as 100 mg, can improve performance in swimmers in both competitions and training, which can prove useful when it comes to scheduling use of the substance when desired.

Cycling

A study by Bortolotti *et al*[20] selected 13 well-trained racing cyclists to do a time trial on a 20-km circuit designed for the occasion. Cyclists took capsules containing 6 mg/kg of caffeine or placebo 1 hour before the start of the test, but the results with caffeine and with the placebo were similar. The 6 mg/kg dose did not improve the performance of the cyclists, but the freedom of participants to choose their cadence and gears, together with the design of the circuit, which included areas with steep slopes which made the test harder, led the athletes to choose different strategies to confront the course. This may explain the results of this study[20], since two other studies[21,22] looked into the ergogenic effect of caffeine on trained cyclists but this time using cycloergometers. In a study by Kilding *et al*[21], cyclists did a 3-km time trial after taking 3 mg/kg of caffeine 1 hour before starting. In another study conducted by McNaughton *et al*[22], the participants pedalled to cover the greatest possible distance in 1 hour with the aid of 6 mg/kg of caffeine administered 1 hour before the test. In both studies, the caffeine improved the cyclists' performance: in the first study[21], the participants who took caffeine completed the 3 km in less time compared to those who took the placebo, whereas in the second study[22], the cyclists who took caffeine covered greater distances in one hour compared to those only taking the placebo. So it would seem that caffeine improves performance in cyclists when trials are conducted in laboratory environments, but when trials are conducted on open circuits, other variables which can affect the result come into play.

Rowing

We did not find any tests centring on rowing conducted in real conditions. However, three studies[11,23,24] did conduct research using the same protocol: well-trained rowers completed a 2,000-metre test in the shortest possible time on ergometers. In the study by Scott *et al*[11], the athletes took 100 mg of caffeine in an isotonic carbohydrate gel 10 minutes before the test and the results showed a significant improvement in their times. Carr *et al*[23] made rowers take 6 mg/kg of caffeine in capsule form 30 minutes before the test and the performance of the athletes also improved significantly over the 2,000 metres. Skinner *et al's* test[24] combined 3 different doses of caffeine: 2, 4 and 6 mg/kg of the substance were administered to the rowers 60 minutes before the test. However, no significant differences were observed in the performances of the rowers taking the different doses. This test differed from the other two in that the subjects ate a standard light meal containing 2 g/kg of carbohydrates beforehand. The concentration of caffeine in blood plasma at the start of the test was significantly lower in the subjects of Skinner et al's study[24] than they were in the other studies using the same dose[15.22], which may explain the lack of improvement in performance. Attention should, therefore, be paid to food intake when administering caffeine supplements as it may alter the levels of the substance in plasma and affect the performance of athletes. In view of these studies, we can say that both low doses (100 mg) and moderate doses (6 mg/kg) of caffeine administered before a 2,000-metre test on ergometer can improve a rower's performance.

Badminton

Two studies proved the effectiveness of caffeine on performance in competitive badminton players. In the first study[25], the players ingested 3 mg/kg of caffeine in an energy drink 60 minutes before doing the trial; this consisted of a series of tests to measure jumping power, followed by a 45-minute badminton match. After the intake of caffeine, the players jumped higher and with greater maximum power when performing counter-movement jumps and squat jumps, and the total number of impacts during the match increased. Similar results were obtained in Clarke and Duncan's study[26], in which the participants faced 3 tests simulating specific features of badminton: coincidence-anticipation timing, serve accuracy and choice reaction-time. The players took a concentrated aqueous solution containing carbohydrates and 4 mg/kg of caffeine 60 minutes before and also during the tests which substantially improved their performance in the 3 tests in comparison with the placebo. So caffeine supplements containing between 3 and 4 mg/kg taken in an energy or carbohydrate drink 1 hour before and during sessions would seem to improve competitive badminton players' patterns of activity during games.

Tennis

A study similar to that of Abian *et al*[25] was conducted with top junior tennis players. In this case[27], a set of tests consisting of measuring maximum grip strength with both hands, the speed of 3 tennis serves and speed in 8 series of 15-metre sprints one hour after ingesting an energy drink with 3 mg/kg of caffeine were designed. Following completion of the tests, the players rested for 15 minutes and then played a best-of-three-sets singles match against a similar opponent. The caffeine increased the players' maximum grip strength, their sprint speed in the test and the intensity and number of sprints they did during the match compared to the placebo. They also tended to win a higher percentage of points from serves with the intake of caffeine in comparison with the placebo. Horney *et al*[28] administered the same dose of caffeine, 3 mg/kg, in capsule form to trained tennis players 30 minutes before a simulated tennis match against a ball machine lasting 2 hours and 40 minutes. The length of the match induced significant decreases in playing capabilities due to the great physiological demands made of the players, but the caffeine supplement partially attenuated the effects of fatigue and increased serve speed towards the end of the game compared to the placebo. A small dose of caffeine, 3 mg/kg, therefore, is enough to improve aspects of performance in trained tennis players, be it administered in energy-drink form 60 minutes before exercise or in gelatine-capsule form 30 minutes beforehand.

Judo

In 2014 an experiment on six trained male judokas with competition experience was published[29]. The sportsmen had to complete a 5-day rapid weight loss course. After this period, the participants spent 4 hours recovering, eating and rehydrating, and took a 6-mg/kg caffeine capsule in the third hour. At the end of the recovery time, the judokas fought 3 Senior Judo Fitness Test matches to simulate the characteristics of a competition. There was no difference in the number of throws in the fights between athletes taking caffeine and the placebo, but a higher blood lactate level and lower rated perceived exertion were observed with caffeine compared to the placebo. So caffeine is able to reduce the sensation of fatigue and speed up lactic anaerobic metabolism without altering the performance of judokas in competition conditions after a rapid weight loss course. Analysing the results, the important role of technique and one's opponent in judo should be taken into account, because even when a judoka's physiological dimensions are improved, if the opponent is technically or physically superior, then he/she is more likely to win. However, this study has laid the foundations for cognitive and physiological improvements in competitive judokas, which can serve as a guide for future research into the relationship between caffeine and judo.

Fencing

Bottoms *et al*[30] conducted a study with 11 competition-level fencers in which the participants completed 2 rounds of tests consisting of a reaction-time test and a test of skills specific to fencing; the first tests 30 minutes before a fencing competition simulation consisting of 6 fights and lasting 60 minutes, and the second set of tests at the end of the simulation. The subjects ingested 3 mg/kg of caffeine or placebo in fruit juice after the first round of tests. There were no significant differences in reaction time between the fencers taking the caffeine and those taking the placebo, but the former tended to make fewer mistakes than the latter in the skills test. The caffeine also produced significantly lower perceived fatigue, so the findings suggest that the low dose of 3 mg/kg of caffeine maintains fencing skills while decreasing the degree of tiredness fencers perceive. This supplement does not help to improve athletes' reaction time, but can be helpful to those seeking to optimise their performance when fencing.

Team sports

In order to win in team sports, factors such as understanding between team members, the design of a good strategy and conditions favourable to the team, as well as physical and specific abilities, all play a part. The relationship between caffeine and team sports has been studied using different methodologies, but always with the same objective: to determine how to achieve better performance in these sports. To cite one example, one research group[31] designed a protocol to simulate a rugby match of 2 halves lasting 40 minutes each, in which the participants had to complete a series of circuits which included straight and sideways sprints, and combining agility tests, tackles, passes and periods of rest standing and walking. The subjects, 9 rugby players from First Division teams, took a capsule with 6 mg/kg of caffeine 70 minutes before the trial and after taking it registered improvements in sprint speed, tackling power and accuracy, as well as perceiving less fatigue. It would appear, therefore, that caffeine produces substantial improvements in several aspects of performance in team sports. We will now see what else scientific literature has published on the subject.

Volleyball

Two studies proposed a protocol which consisted of a series of volleyball-specific tests followed by a simulated match[32,33]. In both, 3 mg/kg of caffeine was administered by means of an energy drink 1 hour prior to the trial. Both Del Coso *et al's* study[32] on 15 well-trained male volleyball players and Perez-Lopez *et al's* study[33], involving 13 top female volleyball players, observed improvements in their subjects in terms of ball speed on serving, jumping height and agility in the tests, coupled with a higher percentage of successful actions during the match following the ingestion of caffeine compared to the placebo. This shows that the caffeine supplement used (3 mg/kg in energy drink) is an effective ergogenic aid for male and female volleyball players because it improves their physical performance and accuracy.

Football

The most recent study conducted on professional football players[34] indicates that the administration of 6 mg/kg of caffeine by means of capsules 65 minutes before playing does not seem to have any ergogenic effect on players' activity profile during a football match. 22 junior-team players were evaluated during a football match after ingesting caffeine or placebo; the results showed no significant differences in the total distance covered, in the number of accelerations or in sprint intensity or distance between players taking caffeine and players taking the placebo. However, as we know, the patterns of activity in football are extremely variable and depend on numerous factors, such as possession of the ball; teams with the best technique tend to play a game based on greater possession without making great physical effort. Technical parameters were not evaluated in the study and so these may explain the lack of performance in the match. A study conducted on semi-professional football players by Del Coso *et al*[10] revealed improvements in jumping ability and sprint speed measured before a football match after caffeine intake; during the match, the total distance covered was greater and run at greater speed by players who had consumed caffeine. The participants were given an energy drink with 3 mg/kg of caffeine 60 minutes before performing a trial consisting of a maximal jump test and a test of repeated 30-metre sprints, followed by a standard football match. So the results of this study contradict those of Pettersen *et al* [34], suggesting that a dose of 3 mg/kg of caffeine is sufficient to increase sprint capability and both the distance covered and the speed at which it is covered in a football match. The increase in jumping ability may also favour how well footballers play in the air.

Two other studies[35,36] evaluated trained football players during simulations of 90-minute matches in which the participants completed intermittent running trials interspersed with jumping and passing accuracy tests. In Gant *et al's* study[35], 3.7 mg/kg of caffeine was administered to the players in a concentrated carbohydrate drink 60 minutes before the simulation and every 15 minutes during the activity, while in Foskett *et al's* study[36], the players consumed capsules containing 6 mg/kg of caffeine 60 minutes beforehand. In both studies, the participants significantly improved their jumping ability with caffeine intake compared to the placebo, while their passing accuracy only improved with caffeine intake in Foskett *et al's* study[36] and average running speed increased with caffeine in Gant *et al's*[35]. In general, we can say that caffeine is an effective ergogenic supplement in football; you simply have to take into account the dose of caffeine and how and when it is administered in order to achieve the desired improvements in the different parameters of performance, as seen in the studies conducted in the field.

Rugby football

Several studies have researched the ergogenic effects of caffeine on rugby-playing performance. One of these[37] evaluated the responses of the players belonging to the women's national rugby sevens team to an energy drink with 3 mg/kg of caffeine. The players took the drink 1 hour before the start of a competition consisting of three 14-minute long rugby sevens matches with 15 minutes of rest between each game. At the end of the matches, the players performed a 15-second jumping test on a force platform. The caffeinated energy drink increased both the power produced in the leg muscles during the jumping test and running pace and speed during the games. Two other studies[38,39] designed rugby simulation protocols with trained university rugby players in which rugby-specific skills such as passing, coordination and sprinting were measured. In both studies, a solution with caffeine was administered 60 minutes before the tests, the dose in one study being 6 mg/kg[38] and the dose in the other being 4 mg/kg[39]. The results with the two doses were similar: the caffeine increased the athletes' sprint speed at the beginning of the protocol and maintained their speed at the end of the trial, improved their coordination and showed a tendency to improve their passing accuracy compared to the placebo. These findings are a valuable example of the ergogenic effects of caffeine on performance in rugby.

Hockey

Duncan *et al's* research[40] conducted on 13 competitive field hockey players concluded that the administration of 5 mg/kg of caffeine 60 minutes before playing hockey may be effective in offsetting decrements in skilled performance associated with fatigue. The study designed a protocol to fatigue the participants before performing a series of tests to measure hockey-specific skills (dribbling and ball handling). The results showed a significant increase in test scores after the intake of caffeine compared to the placebo. So the use of a caffeine supplement in hockey may be useful to enhance performance in players when fatigue sets in.

As we have seen, caffeine has proven to be an effective ergogenic aid in most sports situations. From small to moderate doses administered in different forms (gum, capsules, energy drinks and isotonic gels), it has helped improve technical, physical and cognitive performance abilities in sports people. However, studies which conclude that caffeine has no ergogenic effect on sports performance should not be overlooked: in these cases, we should draw conclusions to help us understand the behaviour of the substance better, i.e. to understand that caffeine intake does not entail an automatic improvement in the performance of the person taking it and that a number of factors determine whether its effects may prove optimal or null as far as performance is concerned.

Bibliography

The entire bibliography is provided at the end of the second part of the Review.


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Vichy Catalán y sus beneficios para la hidratación en general y en el deporte

Dr. Pedro Manonelles Marqueta

Especialista en Medicina de la Educación Física y el Deporte. Presidente de la Sociedad Española de Medicina del Deporte (SEMED-FEMEDE). Director de la Cátedra Internacional de Medicina del Deporte de la UCAM.

El hombre necesita mantenerse hidratado correctamente en su vida habitual pero donde es imprescindible un adecuado estado de hidratación es en el deporte. Sólo con una correcta hidratación se puede, por una parte, garantizar que no existirán problemas para la salud, y por otra, que el deportista no se expondrá a dos graves circunstancias. La primera, que no sufra enfermedades o lesiones relacionadas con la deshidratación, como agotamiento por calor, golpe de calor o lesiones musculares incluso más allá de los calambres musculares. La segunda, y no menos importante, evitar la disminución del rendimiento deportivo, consecuencia de un déficit hidroelectrolítico.

Las necesidades de hidratación, en relación con la actividad física y deportiva, se presentan en tres situaciones: antes, durante y después del esfuerzo. En cada una de las circunstancias se debe conseguir una correcta hidratación. Preparar el organismo para la actividad, en la primera; proporcionar el agua y electrolitos necesarios, en la segunda; y, reponer las pérdidas provocadas por el esfuerzo, en la última. En cada uno de estos momentos hay que proporcionar el agua y electrolitos que se precisan para asumir sus necesidades y evitar problemas.

Es bien sabido que existen muchos líquidos que el hombre toma en su alimentación: agua y sus diversas modalidades, zumos, leche, refrescos, infusiones, bebidas deportivas, entre otras. Una de las aguas más conocidas es el Vichy Catalán, que ofrece esta empresa en agua carbónica embotellada. Fue el médico Modest Furest quien en 1880 adquirió los manantiales de agua termal del *Puig de les Ànimes* e inició el proceso que conduciría a este producto a ser un referente actual. El compromiso de esta empresa con la hidratación en la salud y en el deporte lo demuestran varios hechos, pero el más notorio es el de la elección de Vichy Catalán y Font d'Or como las aguas de los XXV Juegos Olímpicos, celebrados en Barcelona en 1992.

Vichy Catalán es un agua mineral natural con gas carbónico y con un contenido de sales muy adecuado, especialmente en lo que supone el sodio, y que favorece los procesos digestivos. El papel de una bebida de estas características en el contexto de la actividad física, como puede ser en el ámbito laboral y doméstico, y deportivo, se centra en la hidratación en la alimentación habitual y en la que se realiza antes y después del ejercicio, y es consecuencia de sus propiedades. En primer lugar porque se trata de agua mineral de calidad como lo constata el hecho de sus certificaciones. En segundo lugar, por su contenido de electrolitos (bicarbonatos, sulfatos, cloruros, sodio, potasio y litio). En tercer lugar, por sus propiedades de palatabilidad que la convierten en una bebida muy agradable de tomar y por su digestibilidad por lo que es muy bien tolerada.

Antes de la actividad física es necesario hidratarse convenientemente para poder afrontar el esfuerzo en las mejores condiciones. Vichy Catalán proporciona la cantidad de agua y de electrolitos adecuados para los ejercicios de larga duración. Pero después de la actividad, especialmente si se ha realizado en un ambiente muy caluroso y ha sido de larga duración, es imprescindible reponer las pérdidas hidro-electrolíticas y este agua proporciona estos elementos de una forma muy adecuada. Esto es especialmente importante, si la actividad deportiva se va a repetir en breve, como puede suceder en los deportes por etapas.

En definitiva, un agua como Vichy Catalán es una opción muy útil para la hidratación y el aporte de electrolitos en la dieta habitual de cualquier persona, y de las que realizan actividad físico-deportiva, así como en la hidratación de después de la actividad física.

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XVI CONGRESO NACIONAL DE LA SOCIEDAD ESPAÑOLA DE MEDICINA DEL DEPORTE

GRANADA - HOTEL M.A. NAZARIES
23 AL 26 DE NOVIEMBRE DE 2016

Sociedad Española de Medicina del Deporte

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	Jesús Rodríguez Huertas
	Ángel Sánchez Ramos
	José Luis Terreros Blanco

ÍNDICE PREVIO DEL PROGRAMA CIENTÍFICO

SESIONES PLENARIAS

- Lesiones de partes blandas.
- Reconocimientos: controversia EEUU-Europa.
- Fisiología del ejercicio en ambientes extremos.

PONENCIAS

- Síndrome compartimental de esfuerzo en el deporte.
- La Actividad Física Beneficiosa para la Salud (AFBS-HEPA) en España y la UE, mitos y realidades.
- Actualizaciones en entrenamiento
- La salud en las redes sociales.
- Lesiones de hombro en el deportista.

CONTROVERSIAS

- Electroestimulación corporal total.
- Entrenamiento en altitud.

REMISIÓN DE COMUNICACIONES CIENTÍFICAS

El Comité Científico invita a todos los participantes a remitir comunicaciones científicas (comunicaciones orales y póster-presentación interactiva) al XVI Congreso Nacional de la Sociedad Española de Medicina del Deporte.

Temas para presentación de Comunicaciones Científicas en el Congreso:

- Medicina del deporte.
- Entrenamiento y mejora del rendimiento.
- Biomecánica.
- Cardiología del deporte.
- Fisiología del esfuerzo.
- Nutrición y ayudas ergogénicas.
- Cineantropometría.
- Lesiones deportivas: diagnóstico, prevención y tratamiento.
- Actividad física y salud.

Las Comunicaciones Orales se distribuirán en sesiones de los temas del Congreso. Por favor, escoja uno de los temas del listado como propuesta para realizar su presentación. El Comité Científico podrá reasignar el abstract en otro tema del Congreso.

Los trabajos deberán ser originales y no se habrán presentado en congresos anteriores o reuniones similares.

Las comunicaciones científicas admitidas, comunicaciones orales y pósters (presentación interactiva), serán publicadas en la revista Archivos de Medicina del Deporte.

Normas de remisión de abstracts

Por favor, preste atención a las siguientes normas de preparación del abstract de su comunicación científica (comunicación oral o póster: presentación interactiva), porque son de obligado cumplimiento:

- La fecha límite para la remisión de los trabajos científicos será el día **10 de septiembre de 2016.**
- Se remitirá la Comunicación Científica a la atención del Presidente del Comité Científico, con el formulario debidamente cumplimentado, a la siguiente dirección de correo electrónico: congresos@femede.es.
- El abstract tiene que tener una clara relación con los contenidos del XVI Congreso Nacional de la Sociedad Española de Medicina del Deporte y, en definitiva, con la Medicina y Ciencias del Deporte.
- El Comité Científico podrá destinar el trabajo presentado a la forma de presentación (comunicación oral o póster: presentación interactiva) que considere más adecuada al tipo y contenido del mismo.
- El Comité Científico se reserva el derecho de rechazar los trabajos que no cumplan los requisitos indicados anteriormente por la calidad y temática que el evento científico requiere.

Forma de preparación del abstract

- Sólo se aceptarán las comunicaciones científicas presentadas en el formato electrónico que se encuentra en la página web del Congreso: www.femede.es/congresodegranada2016 "Formato de comunicación científica".
- **Título:** El título deberá ser breve (máximo de 15 palabras) y específico. Debe reflejar el contenido de la presentación. No use abreviaturas en el título. Se escribirá en letras mayúsculas, usando el tamaño 12 del tipo de letra Arial.
- **Autores:** Se escribirá, en minúsculas, el apellido seguido, sin coma, de la inicial del nombre de cada autor, separados por comas.
- **Centro:** Indicar el centro de trabajo de los autores. Si son varios, indicar con un número superíndice.
- **Preferencia de presentación:** Seleccionar con un asterisco el tipo de presentación a la que presenta la comunicación científica.
- **Texto:** La extensión máxima del texto es de 300 palabras o 3.000 caracteres. Se escribirá en minúsculas, usando el tamaño 10 de la letra Arial. Se evitarán abreviaturas no explicadas. Se escri-

birá el contenido del resumen científico sin repetir el título de la Comunicación y ajustándose al siguiente esquema: introducción, material y métodos, resultados y conclusiones.

- Respetando la extensión máxima del texto se pueden incluir tablas, gráficos o imágenes.
- Es obligatorio indicar un máximo de **tres palabras clave**.
- Los abstracts deben incluir **información específica** sobre los resultados y las conclusiones de la investigación. No se aceptarán abstracts que establezcan que "se discutirán los resultados".

Notificación de la recepción de la comunicación científica

En el plazo de 15 días, Vd. recibirá la confirmación de recepción de la comunicación por parte de la Secretaría del Congreso. Si no la recibiera, no vuelva a remitir la comunicación y envíe un mensaje electrónico: congresos@femede.es.

Inscripción del responsable de la comunicación científica

- Cada persona puede presentar dos comunicaciones científicas como máximo (comunicación oral o póster: presentación interactiva). En caso de ser aceptadas ambas, sólo una de ellas podrá ser presentada como comunicación oral.
- Los autores (CADA UNO PUEDE PRESENTAR DOS TRABAJOS) que presenten una comunicación científica (comunicación oral o póster- presentación interactiva) y ésta haya sido aceptada, deben haberse registrado y **haber pagado los derechos de inscripción del Congreso antes del 20 de octubre de 2016**. En caso contrario su comunicación científica (comunicación oral o póster-presentación interactiva) será eliminada del programa y del libro de abstracts.
- Cada autor puede FIRMAR todos los trabajos que quiera.
- No hay limitación en el número de comunicaciones que puede aparecer una misma persona.

Presentación de la comunicación oral

- Las Comunicaciones Orales tendrán un **tiempo de presentación de 8 minutos**. Al final de cada sesión habrá un turno de preguntas.
- Todas las exposiciones orales se harán en **formato Powerpoint**, debiendo estar en posesión del responsable de las Comunicaciones de la organización el día anterior a la presentación de la misma.
- Se limita a un **máximo de 12 el número de diapositivas** de la presentación de powerpoint.

Póster (presentación interactiva)

Si su abstract se acepta pero no se puede ajustar a una presentación en forma de Comunicación Oral, se le propondrá presentarlo en forma de póster-presentación interactiva, dándole un tiempo para su preparación.

Presentación del póster (presentación interactiva)

Para la elaboración del póster (presentación interactiva) debe seguir las siguientes instrucciones que son de obligado cumplimiento:

- Formato Microsoft Powerpoint.
- Hasta 12 diapositivas, de las cuales:
  - La primera: debe contener **título, autores, centro de trabajo**.
  - La última: debe contener **título** y la palabra **FIN** o expresión similar que indique que la presentación ha concluido.
  - La penúltima o las dos penúltimas deben contener las **conclusiones**.
- Fondo de diapositivas: color neutro y uniforme.
- Texto de diapositivas: color que **contraste** con el fondo.
- En lo posible evitar incluir vídeos en las diapositivas, si se hiciera debería ser en formato **.wmv** y se deberá incluir en un subdirectorio/carpeta que enlace automáticamente con la presentación remitida. Si el video no enlazara con la presenta-

ción, no se editará por parte de la organización para corregir el error.

- La organización se reserva el derecho de ocultar diapositivas que incluyan contenidos inapropiados o inadecuadamente referenciados.
- El uso de cualquier imagen que no sea de la autoría del/los firmante/firmantes de la presentación deberá contener referencia a (y eventualmente permiso de) su autor en la misma presentación o bien podrá ser retirada de la misma y en todo caso la organización no se hará responsable en ningún caso de las consecuencias del uso inapropiado de aquellas.
- Se cuidará de igual manera de incluir las referencias bibliográficas oportunas en pequeño tamaño de letra, pero que sea legible.
- El abstract debe remitirse preparado tal como se indica anteriormente **(Forma de preparación del abstract).**
- Una vez que se le confirme que su comunicación científica ha sido aceptada para ser presentada en forma de póster (presentación interactiva) debe enviar el documento electrónico **(.Ppt)**:
  - Trabajos destinados por el autor directamente a póster (presentación interactiva): **antes del 10 de septiembre de 2016.**
  - Trabajos destinados por el autor a Comunicación Oral y que el Comité Científico destina a póster (presentación interactiva): **antes del 20 de septiembre de 2016.**
- El documento electrónico **(.Ppt)**: debe enviarse a la dirección electrónica del Congreso: congresos@femede.es.

Certificaciones

Tras la presentación de la comunicación oral o la defensa del póster en el modo en que se indique se entregará **un único certificado** al responsable de la comunicación científica.

Publicación de los trabajos científicos

Los abstracts de los trabajos científicos (comunicaciones orales y póster) **aceptados y presentados** en el XVI Congreso Nacional de la Sociedad Española de Medicina del Deporte serán publicados en la revista **Archivos de Medicina del Deporte**, publicación científica de esta especialidad y revista oficial de la Sociedad Española de Medicina del Deporte, que tiene una periodicidad de publicación bi-mensual.

Presentaciones

- Documento de consenso de la Sociedad Española de Medicina del Deporte (SEMED-FEMEDE) sobre deporte recreacional saludable.
- Pruebas de Esfuerzo en Medicina del Deporte. Documento de Consenso de la Sociedad Española de Medicina del Deporte (SEMED-FEMEDE).