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Summary / Sumario

Paradigm for the recovery in team sports

El paradigma de la recuperación en deportes de equipo

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Post-exercise recovery is a fundamental part of sporting performance[1]. During high-density competition periods, athletes often play over various days, with very short rest times between matches and/or training sessions, which is why recovery processes are a determining strategy, enabling athletes to gain a competitive advantage. In this case, players proportionally invest more time recovering than training. This is why over recent years and based on new competition systems, a greater level of relevance has been given to recovery, despite there still being little scientific evidence regarding joint sports[2]. Furthermore, the use of recovery strategies in Sports Sciences is a relatively new area of scientific research[3].

As a result of the specialisation of the different roles that make up the technical teams in joint sports, and based on the latest Position Stand "Team Physician Consensus Statement, 2013"[4], with the aim of improving recovery processes, the figure of the "Applied Sport Scientist focus on recovery" is presented as an alternative in teams and clubs, transversally organising the complex structure of player recovery processes[5].

The first step towards optimising player recovery requires a thorough customised analysis of the specific mechanisms that produce fatigue. Likewise, it requires a suitable monitoring process of the impact of the load that training and competing generates within the subject[6], as well as maintaining an appropriate health status and care for common illnesses among players[7]. In this respect, precise diagnostics are often carried out using non-invasive technology and without any kind of interference in the dynamics of the team, with the aim of later customising protocols[8].

Once the appropriate diagnostic has been developed, we must apply the suitable methods within the vast range of mediums offered to us in literature for this issue[9]. Its use will depend on the type of activity carried out, as well as the time that goes past until the next training session or competition[4].

The main methods used for the teams include: nutritional strategies (carbohydrates, proteins), ergogenic supplements such as: beta-alanine, nitrate, or creatine, active recovery, stretching, hydrotherapy, compression cuffs, massage, psychological strategies, rest and sleep[4]. However, there is a void among the scientific community[4] regarding the benefits of some of these formulas, as well as in their posterior pre, per and post-competition application. Currently, the Australian proposal is the most used, due to its level of effectiveness[10].

Finally, a new aspect is worth considering, given that teams that participate in continental leagues or in the professional American model are making increasing amounts of long-distance journeys[11]. These kinds of journeys, whether by plane, road or train, are associated with a series of phenomena described as "Travel-associated fatigue", due to the combined effects of an alternative routine resulting in physiological disturbances[12]. Among them, one of the most important is peripheral oedema[13].

As a result, the recovery process in team sports is a maximum priority concept in the current competition system. The limited time available to athletes should include a space to minimise accumulated fatigue. Therefore, its diagnosis and later customised treatment supposes an advantage to consider in the world of joint sports.

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Original article

Static balance behavior along a deep water periodization in older men

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Summary

The aim of this study was to evaluate static balance along a deep water periodization in older men. Twenty-two older men (65.2±3.8 years) completed 16 weeks of training in deep water. In the first four weeks (weeks 1-4) low intensity training was conducted twice a week, emphasizing familiarization exercises with running technique in deep water and with aquatic environment. In the following weeks (weeks 5-16) an aerobic training of high intensity was performed three times a week, using only deep water running exercise. Static balance was assessed at week 0, 5 and 17 using an accelerometer in four positions: double- and single-legged stances with eyes open and eyes closed. Statistical analysis: We performed a repeat measures ANOVA with Bonferroni post-hoc (α=0.05). Static balance improved significantly after the first four weeks of training (week 1 to 4) in both single-legged stances (~33%) and double-legged stances (~54%) ($p<0.001$).Whereas after the high intensity training period (week 5 to 16) the values remained ($p>0.05$). The results showed an improvement in static balance throughout a deep water periodization. However, improvement is found after the first four weeks that were emphasized exercises of low intensity and familiarization with deep water running technique and with aquatic environment. Following, the high-intensity aerobic training was sufficient to keep these improvements.

Key words:
Exercise. Aging.
Postural balance.

Comportamiento del equilibrio estático a lo largo de una periodización de carrera en aguas profundas en hombres mayores

Resumen

El objetivo del estudio fue evaluar el equilibrio estático a lo largo de la periodización de carrera en aguas profundas en hombres mayores. Veintidós hombres mayores (65,2 ± 3,8 años) completaron 16 semanas de entrenamiento de carrera en aguas profundas. En las primeras cuatro semanas (semanas 1-4) el entrenamiento fue de baja intensidad y se realizó dos veces por semana. Los ejercicios fueron de familiarización con la técnica de carrera en aguas profundas y con el medio acuático. En las semanas siguientes (semana 5-16) se realizó un entrenamiento aeróbico de alta intensidad tres veces a la semana, usando solamente la carrera en agua profunda. El equilibrio estático fue evaluado en la semana 0, 5 y 17 utilizando un acelerómetro en cuatro posiciones: apoyo sobre ambos pies con los ojos abiertos y vendados y apoyo sobre un pie con los ojos abiertos y vendados. Análisis Estadístico: ANOVA para medidas repetidas con post hoc de Bonferroni (α=0,05). El equilibrio estático se ha mejorado significativamente después de las primeras cuatro semanas de entrenamiento (semanas 1-4) en las posiciones en apoyo en un solo pie (~33%) y en los apoyos en los dos pies (~54%) ($p<0,001$). Mientras después del período de entrenamiento de alta intensidad (semanas 5-16) los valores se mantuvieron ($p>0,05$). Los resultados mostraron una mejora en el equilibrio estático durante todas la periodización en aguas profundas. Sin embargo, la mejora se encuentra después de las primeras cuatro semanas de entrenamiento, en los que fueron realizados ejercicios de baja intensidad y la familiarización con la técnica de la carrera en agua profunda y con el medio acuático. Después, el entrenamiento aeróbico de alta intensidad fue suficiente para mantener estas mejoras.

Palabras clave:
Ejercicio. Envejecimiento.
Equilibrio postural.

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Introduction

Worldwide population aging is becoming increasingly important due to longer life expectancies and better health conditions of the population. According to projections by the World Health Organization[1], in 2050, older adults population will include 1.9 billion people and will represent one-fifth of world population. This aging trend raises an important issue for society because aging process involves significant structural and functional changes in the individual, thus increasing susceptibility to chronic degenerative diseases, falls and injuries[2].

Postural control system integrates sensory information from somatosensory, vestibular and visual systems. In addition, central nervous system uses mechanical components (strength and support base), cognitive processes (attention and learning), sensory and motion strategies, dynamic controls and orientation in space to maintain stable postural balance[3]. With aging, there is a decrease in function of motor, nervous, sensory and vestibular systems, and a decrease in reaction time, vision and proprioception[4,5]; all factors that directly interfere with balance.

Previous studies has shown that physical activity is significantly associated with static and dynamic balance in older adults and that a sedentary lifestyle negatively affects postural stability in older adults[6,7]. Biological factors associated with aging that impair physical abilities of older adults cannot be avoided. However, many studies have been conducted in this population to evaluate the magnitude of the effect that physical activity has on a lower decline and even a possible improvement in such components. A recent meta-analysis, including 54 randomized controlled trials, concluded that exercise is an important intervention that can prevent falls[8].

In this context, exercise in an aquatic environment has been strongly recommended for older adults[9-14] because it provides low impact on joints of lower limbs and spine[15] and reduced cardiovascular overload[16,17]. Among aquatic exercises, deep water running has gained attention in scientific literature. Deep water running is performed with aid of a float vest, which serves to keep the body in an upright position and to avoid contact of the feet with the bottom of the pool, thus eliminating any impact[18].

Moreover, these characteristics combined with the fact that deep water running is an exercise in an open kinetic chain makes it necessary to have a period of familiarization with the modality. In this period the participants are performed familiarization with aquatic environment, with use of float vest and deep water running technique. These exercises produce greater instability in postural control and a large variety of proprioceptor stimuli that may provide improvements in balance. After this period, it may be initiate a more intensive training period, because the technique is already mastered and will not influence the intensity of training.

Only one study that evaluated deep water training for 12 weeks was found. This study showed a significant improvement in balance in older women[13]. However, this study did not show a period of training at low intensity to familiarize participants with deep water running technique and did not show a progression of training. Thus, arises the question of how is the balance of the improvements along a 16-week linear periodization training in deep water, which is divided into an initial part of a four-week low intensity using exercises that emphasize familiarization with technical and to aquatic environment; and a second part of longer duration (12 weeks) divided into three mesocycles high intensity emphasizing only deep water running execution. Furthermore, another aspect which appears to be important, in contrast to abovementioned study, it is carrying out a study evaluating older men balance. Thus, the aim of the present study was to evaluate the effect of 16 week to deep water running training on the static balance of older men. The hypothesis of the present study is that throughout periodization will occurs an improvement of static balance and that improvements will be observed both after the familiarization period and after aerobic training period of high intensity.

Material and method

Experimental design and approach to the problem

To understand the effects of deep water exercises on static balance in healthy older men, one group performed 16 weeks of deep water training. The first four weeks (weeks 0-4) was performed a low intensity training twice a week, emphasizing familiarization exercises with the aquatic environment and deep water running. In the following weeks (weeks 5-16) was performed a high-intensity training, three times a week, using only deep water running. It was decided to non-inclusion of a control group, since it is already documented in the literature that physical exercise can provide significant improvements in balance[6,11,19,20] and the aging worsens this aspect[4,21]. Thus, does not appear to appropriate, from an ethical point of view, maintaining a group of older people for 16 weeks without the possibility of performing physical exercise. Static balance was evaluated at three time: week 0, 5 and 17; in four out of water position: double- and single-legged stances with eyes open and eyes closed. All assessments were conducted by the same research investigator and were conducted on the same equipment with identical subject/equipment positioning and at the same time of day.

Participants

Participants for this study included 22 healthy older men, aged between 60 and 75 years, who were not engaged in any regular systematic training program in previous three months. Characteristics of the participants are presented in Table 1. Only men were prioritized so that sample was more homogeneous avoiding physiological differences between genders interfering with the results. The participants volunteered for the present investigation following announcements in a widely read local newspaper. Exclusion criteria included any history of neuromuscular, metabolic, hormonal and cardiovascular diseases. Participants were not taking any medication that affected hormonal or neuromuscular metabolism. Medical evaluations were performed using clinical anamnesis and an effort electrocardiograph test. The study was conducted according to the Declaration of Helsinki and was approved by the Ethics Committee of Federal University of Rio Grande do Sul, Brazil. Based on the variances of prior studies performed in our research group, the calculation of the sample "n" was carried out using the G POWER software (version 3.0.1.) with a statistical power of 80%.

Table 1. Participants characteristics.

n= 22	Mean	±SD
Age (years)	65.2	3.8
Body mass (kg)	82.0	22.6
Height (m)	1.78	0.1
Percent fat (%)	16.3	8.1

Assessements

Physical Characteristics

Body mass and height were measured using an Asimed analog scale (resolution of 0.1 kg) and Asimed stadiometer (resolution of 1 mm), respectively. Body composition was assessed using the skinfold technique. A seven-site skinfold equation was used to estimate body density[22] and body fat was subsequently calculated using the Siri equation[23].

Balance evaluation

Performance tests were conducted before training period (week 0), after familiarization period (week 5) and after high intensity training (week 17). Balance was measured using a triaxial accelerometer (MicroStrain, 3DM-GX2 model, Williston, VT, USA) at the hip of participants using a neoprene belt. Care was taken to position the instrument over L5 region.

All participants wore comfortable clothing and shoes of their choice to perform the tests. For assessments were necessary two researchers, one responsible for timing, start and end the test and another to support the participant in the event of imbalance. Static balance was measured for 20 s in four positions on land environment: double-legged stance with eyes open, double-legged stance with eyes closed, single-legged stance with eyes open and single-legged stance with eyes closed. The order of these tests was randomized and there was a 5 min interval between each position change. In the tests with eyes open, the participants stood silently on the meter staring at a point marked on the wall (distance was 3 m forward and height was 1.5 m). In the double-legged stance tests, the participants were instructed to maintain spacing between their feet that did not cross the shoulder lines. For the data analysis, we excluded the first and last 5 s to avoid variations of position changes, resulting in 10 s of data for each task. The accelerometer had six A / D converters to ensure that all sensors presented simultaneously and was calibrated for sensor misalignment. The sampling frequency used was 100 Hz. Following signal acquisition, the data were exported to the Matlab software which calculated acceleration Root Mean Square (RMS) values according to O´Sullivan et al.[24]. For the RMS values, we used the resultant acceleration of the three axes that were evaluated (medio-lateral, anterior-posterior and vertical).

Training program

The training program was divided into four four-week mesocycles, totaling 16 weeks of intervention. The first mesocycle (weeks 0-4) was conducted twice weekly, on nonconsecutive days; thus, totaling 8 sessions of 45 minutes each. The exercises were performed using a flotation device, without feet touching the bottom of the pool. All sessions were conducted as follows: (1) warm-up exercise; (2) fluctuation in the supine position, lateral and ventral; (3) alternating decubitus positions; (4) displacements across the pool using only upper limbs; (5) exercises to perfect the technique of deep water running; and (6) stretching. Some of the exercises used can be observed in Figure 1. The intensity of the exercise was Borg category scale [9] (very light) as measured by the Rating of Perceived Exertion (RPE). The exercise program was conducted at an indoor swimming pool that had a water depth of 1.98 m and a water temperature of 30-32 ºC.

Figure 1. Illustration of some of the exercises used during familiarization period.

In the following mesocycles, the participants trained on nonconsecutive days, three times per week for 12 weeks (weeks 5 to 16); totaling 36 sessions. The training sessions lasted 45 min; the first part was used to warm up, and the end of the session was used to stretch the main active muscle groups used in the session. The main part of the session had lasted 30 minutes in which there has been aerobic interval training in deep water running. The training intensity was controlled using individual heart rate corresponding to anaerobic threshold (HR_{AT}), determined in a maximal deep water running test and controlled by a HR monitor (Polar, FS1)[25]. During the first 4 weeks, participants performed 6 bouts of 4 min at 85-90% of HR_{AT} (weeks 5-8), with 1 min of active recovery between bouts at below 85% of HR_{AT}; in the weeks 9-12, participants performed 6 bouts of 4 min at 90-95% of HR_{AT}, with 1 min of active recovery between bouts at below 85% of HR_{AT}; and in the last 4 weeks (weeks 13-16), the participants performed 6 bouts of 4 min at 95-100% of HR_{AT}, also with 1 min of active recovery between bouts at below 85% of HR_{AT}.

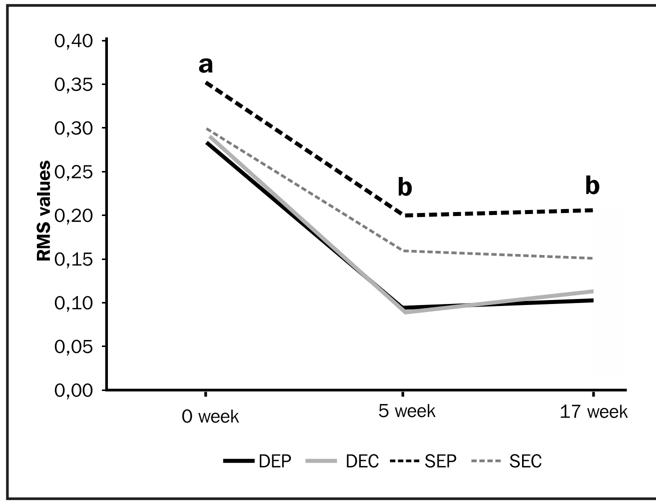
Statistical analysis

Results are reported as mean and standard deviation. Normal distribution and homogeneity parameters were checked with Shapiro-Wilk and Levene test's respectively. ANOVA and Bonferroni were used to comparisons over time. Retrospective statistical power provided by SPSS after analysis was equal or greater than 0.873 in all variables. Significance was defined as α=0.05. The SPSS statistical software package (version 20.0) was used to analyze all data.

Results

Static balance evaluated in different stances showed significant differences over time ($p<0.05$). From the post-hoc test was observed that week 1 to week 4 there was a decrease in the RMS value in all positions, which represents an improvement in static balance. The percentage of improved in double-legged stance eyes open was 34% and in eyes closed was 32%, furthermore, in single-legged stance eyes open was 56% and in eyes closed was 53%. Moreover, week 5 to week 16 (corresponding to high intensity training) there was a maintenance of these values, in all stances evaluated (Figure 2).

Figure 2. Static balance response over time in the double-legged stance, eyes open (DEP) and eyes closed (DEC), and in the single-legged stance, eyes open (SEP) and eyes closed (SEC) positions. Different letters represent significant differences on balance over time in all cases evaluated (p<0.05).



Discussion

The results confirm in part the hypothesis of this study, since it was observed an improvement in the balance of participants in the intervention. However, this improvement was only observed after the first four weeks for familiarization with the aquatic environment and technique of deep water running. The following period, corresponding to aerobic training of high intensity only with deep water running, was effective for the maintenance of improvements.

The decrease in RMS values in all evaluated positions after the first period of the training, corresponding to low intensity training, showing a significant improvement in balance for all participants. The pattern of oscillation of the body is still not clearly understood, but it is believed that most proprioceptors adapt to variations and reduce their responses[26]. This behavior can also affect sensorimotor mechanisms involved in balance control during unstable positions. Thus, low frequency oscillations during static postural positions can allow the system to receive updated information on movements and positions at an appropriate pace[27]. Furthermore, RMS values in all stances evaluated remained similar after the high intensity training.

In the literature, there are no studies evaluating balance throughout an aquatic periodization and few studies have evaluated balance after an intervention in an aquatic environment and findings have been widely varied[11,13,19,28-31]. In a study of older people by Simmons & Hansen[28], the authors found that two sessions per week in an aquatic environment, for a five week intervention period, may be sufficient to improve parameters related to balance that were evaluated by functional tests. Training was performed in shallow water and used different exercises that aimed to cause instability. Thus, results of the present study and the above study show that the balance can be improved after a short period of intervention in water. Furthermore, in each session of the present study, the emphasis was on exercises that familiarized the subject with the aquatic environment, the use of the float vest and the technique of deep water running. To this end, exercises were performed in different decubitus positions, with changing positions and with displacements without the use of the lower limbs. Moreover, execution of these exercises in deep water further optimized instability because of the open kinetic chain nature of the exercises, as previously described. In a similar context, a recent systematic review indicated that exercises that include progressively difficult postures, with a reduced support base, and dynamic movements that perturb the center of gravity and provide a stress to postural muscle groups are the most likely to provide improvements in the balance of older adults[32]. Therefore, the exercise characteristics may have been fundamental in explaining the significant improvements in balance.

Longer studies evaluating balance in older adults were also found in the literature. However, only one of them involved exercise training in deep water. In a 12 week intervention period, with twice weekly frequency, Kaneda *et al.*[13] compared the effects on balance in older adults of two aquatic exercise programs, deep water running and water aerobics. The training sessions consisted of 10 minutes of warm-up on land and 20 minutes of walking exercises (walking forward, backward, sideways, with kicking, torso twisting and knee-ups, etc.) in shallow water for both groups. Following this, one group moved to deep water to perform basic movements of walking and running and the other group remained in the shallow water to perform basic movements of walking, plus some resistance exercises. Lastly, both groups had a 10 minute rest, followed by 10 minutes of recreation and relaxation in the water. Both groups showed an improvement in balance in a double-legged stance with eyes open and eyes closed, as assessed by a posturographic meter from the decreased range of postural sway (cm) and area of postural sway (cm^2). Furthermore, the group that had trained in deep water showed a decrease in time for performing the Tandem-walking test. Thus, based on these results, the authors concluded that both training approaches seemed to be effective in improving static balance. However, it is difficult to know whether the improved balance resulted from the main part of the training session, performed by one group in shallow water and the other group in deep water, or from the exercise portions that were the same for both groups (for example, walking at different offsets, which produces greater instability) because the static balance responses were similar for both training groups.

Also using a longer intervention period and older adults participants, Lee et al.[31] compared 12 weeks of balance training in an aquatic and a land environment. Evaluation was performed using the *Good Balance System* (Finland), which is similar to that of a force platform system. The results showed a decrease in mean velocities (mm/s) in both groups, both in a medio-lateral and an antero-posterior direction, in a double-legged stance with eyes open and closed. Regarding dynamic balance, both groups showed improvement, however, the group that conducted the training in water showed more significant improvements compared to the group that trained on land. Therefore, the authors believe that water stimulates proprioceptors that help in the development of balance. According to the authors, the interaction of gravity and buoyancy during movements in water, especially in situations of postural sway, actively stimulates proprioceptive mechanoreceptors to decrease this postural sway.

In the present study, the high intensity training in deep water did not improve the balance diverging results found in studies previously cited. However, were efficient to keep what had been improved in the first period. Moreover, the different methods employed, both in relation to the duration of training and with regard to the different assessment techniques to measure balance, hinder the comparison between studies. However, the results found in the literature and in this study demonstrate that exercises that involve greater instability and challenges to posture maintenance seem to be the most useful for improving balance, with an aquatic environment being an interesting tool to optimize these responses in dynamic and static balance. Furthermore, the different assessment instruments also make comparisons difficult. In the present study, balance was assessed using an accelerometer, which is a relatively new tool for such evaluations. According to the literature review by Groot *et al*.[33], up until their publication date, no studies assessing balance with an accelerometer had been found. However, this same study recommended the use of an accelerometer because of its easy application and lightweight and compact design that allows it to be used in static and dynamic situations. Complementing this information, Moe-Nilssen&Helbostad[26] claim that the high sampling frequencies of accelerometers help distinguish differences in postural control during static positions, for example, between the double-legged position with eyes open and eyes closed.

One of potential limitations of this study was not using a control group that could give greater methodological quality at the same. Moreover, it could have been inserted an assessment of dynamic balance that possibly could also respond significantly the second part of the training and could even increase the practical applicability of the study. For future studies it is suggested to compare different training strategies in deep water in balance responses, such as using different intensities and different exercises.

Despite the above limitations, the study showed significant results to support the prescription of training in deep water that aims at improving balance in older men. To the present date this seems to be the first study to assess the balance over a periodization in the aquatic environment, demonstrating the effectiveness of the realization of the familiarization period in improving balance. We also highlight that according to our results and the literature, exercises with greater instability that generate a greater postural control are more efficient in the improvement of this variable. In this context, the aquatic environment is a safe environment for their realization, as it allows the execution of postures that on land become more susceptible to falls. Finally, the period of high intensity aerobic training, showed a maintenance effect is also an important result since aging is accompanied by a significant loss of balance[4,21].

In conclusion, the results of the present study demonstrate that a short-term, four week of familiarization exercises to both the aquatic environment and deep water running technique were able to induce significant improvements in the static balance of older men. In addition, aerobic deep water running training was sufficient to maintain these gains. This result is important because it demonstrates that the practice of exercises in deep water helps not only to familiarize individuals with the modality but also to provide improvement in balance, which may reflect an improvement in postural control, thus preventing possible falls and functional dependence.

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Physiological Response of a Paratrooper Unit in Urban Combat

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Summary

Background and objectives: Specific research in military field has traditionally been focused on the effect of combat stress and the development of diseases such as post-traumatic stress disorder. Paratroopers units are considered as elite corps as one of the most operative and due to their special way of deployment, making the foray into the area of operations by mean of a parachute jump. Current war theatres are characterized by their asymmetry and for taking place in urban areas. The organic military response in urban combats has been little studied in specific literature despite its importance for training and specific instruction, for this reason, the objective of the present study was to analyze the physiological response of a paratrooper unit during a simulation urban combat.
Material and Methods: Heart Rate, Blood Lactate and rated of perceived exertion, were analyzed before and after a simulated urban combat in 12 paratroopers of the Spanish Army. The simulated action was preceded by an automatic parachute jump from a training platform.
Results: After the simulation, subjects showed a significant increase ($p <0.05$) in the values of lactate (1.26 ± 0.20 mmol/l vs. 2.56±0.45 mmol/l) and heart rate (38.79±3.13% vs. 75.80±7.08 FC max.).
Conclusions: The paratrooper unit conducted a simulation of combat and an aerobic threshold at 75% of maximum heart rate and blood lactate concentration of 2.6mmol/l were reached. The increase in the lactate and heart rate values after the simulation may be due to the activation of the body defense mechanisms´ (sympathetic nervous system).

Key words:
Lactate. Combat. Military. Rated of perceived exertion. Heart rate.

Respuesta fisiológica de una unidad paracaidista en combate urbano

Resumen

Antecedentes y objetivos: La investigación específica en el ámbito militar se ha centrado tradicionalmente en el efecto del estrés de combate y el desarrollo de patologías como el desorden de estrés postraumático. Las unidades paracaidistas son considerados cuerpos de élite por ser una de las más operativas y por su forma especial de despliegue, realizando la incursión en la zona de operaciones mediante un salto paracaidista. Los actuales escenarios bélicos, se caracterizan por su asimetría y por producirse en entornos urbanos. La respuesta orgánica en situaciones de combate urbano ha sido poco estudiada en la literatura específica a pesar de su importancia para el entrenamiento e instrucción específica, por lo que se planteó como objetivo de la presente investigación analizar la respuesta fisiológica de una unidad paracaidista durante una simulación de combate en población.
Material y métodos: Se analizó la frecuencia cardiaca, lactato sanguíneo y percepción subjetiva de esfuerzo en 12 hombres (29,9±5,5 años) paracaidistas del Ejército de Tierra Español antes y después de realizar una simulación de combate urbano. La simulación venía precedida de un salto automático en paracaídas desde una torre de entrenamiento.
Resultados: Después de la simulación, los sujetos mostraron un aumento significativo ($p<0,05$) en los valores de lactato (1,26±0,20 mmol/l vs. 2,56±0,45mmol/l) y de frecuencia cardiaca (38,79±3,13 % vs 75,8±7,08% FC max.).
Conclusiones: El análisis de los datos muestra como una simulación de combate provoca un incremento de los valores de lactato sanguíneo con respecto al valor basal, situándolo en valores de umbral aeróbico. La unidad paracaidista realizó esta simulación a una intensidad del 75% de la frecuencia cardiaca máxima y con una concentración de lactato sanguíneo de 2.6 mmol/l. El aumento de los valores de lactato y frecuencia cardiaca durante la simulación puede ser debido a la activación de mecanismos de defensa del cuerpo humano (sistema nervioso simpático).

Palabras clave:
Lactato. Combate. Soldado. Percepción subjetiva de esfuerzo. Frecuencia cardiaca.

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Introduction

Specific research in the military field has traditionally focused on the effect of stress in combat in the development of pathologies such as Post-Traumatic Stress Disorder (PTSD)[1], with a large proportion of war veterans exposed to combat or war zones having developed PTSD. The rate of PTSD is one of the highest among the psychological disorders, estimated to be 30% among veterans from the Vietnam war and 10% among those from the Persian Gulf[2,3]. More recent studies on active troops establish a prevalence estimated at 16.7%, and even 24.5% among military reservists[4]. A direct link is therefore revealed between the exposure to combat situations and the risk of developing PTSD[1]. Combat operations are also some of the most stressful situations for the human body, comprising a risk for the physical integrity and the very life of the combatant. The study of the organic response of this demographic has been very limited and practically exclusively centred on the analysis of different organic parameters before and after carrying out different missions[5-7]. In this respect, Lester *et al*[8] demonstrated how after 13 months on a mission to Iraq, an increase in the upper and lower body strength occurred (7% and 8% respectively), an increase in muscle power (9%) and of fat mass (9%) as well as of aerobic performance by 13%. On the other hand, Rintamäki *et al*.[9] observed how after 12 days of military manoeuvres in winter, accumulated fatigue did not occur, nor negative effects on the maximum strength and the maximum oxygen consumption, but it did cause a reduction of the heart rate of combatants, due to the exertion carried out in these manoeuvres. Currently, various studies have highlighted the psycho-physiological response of combatants due to the stress involved in the combat situations they face[1,10,11]. Along the same lines, Clemente *et al*.[12] discovered that in combat situations, combatants achieve a high activation of the sympathetic nervous system, which triggers an increase in muscle strength, heart rate and blood lactate concentration, despite the rating of perceived exertion of the combatants being lower than that obtained physiologically. The acute effects of administrating caffeine in combat were also analysed, as caffeine is an anxiogenic substance that can even be damaging given the stress and anxiety to which soldiers in combat situations are subjected[10].

Within the combat units of contemporary armies, paratrooper units are considered to be elite, as they are one of the most operative units and as a result of their special deployment technique, as not only do they have to face the same combat situations as the rest of the infantry, but they also have to enter the operation zone via a parachute jump. Specific research in these units has been reduced to case studies of the HALO (High Altitude Low Opening) and HAHO (High Altitude High Opening) jumping tactics[10,13]. In both studies, in which the paratrooper must be equipped with an oxygen mask and heavy equipment to endure the environmental conditions of the jump, an increase in the sympathetic modulation was obtained, as well as a reduction of cortical activation, of muscle strength, an increase of the creatine-phosphokinase blood concentration, and a rating of perceived exertion below that of the established organic response. Within these paratrooper units, just as other units deployed in current operation settings, there is a precedence of urban combat situations, close combat and hand-to-hand combat, in which personal defence and cuffing skills are fundamental[14]. Despite these previous studies, the organic response in urban combat situations among paratrooper units has not been studied, despite its importance for training and specific instruction, for which this research study has been proposed with the aim of studying the physiological response through the analysis of the heart rate, blood lactate concentration and the rating of perceived exertion of the combatants of a paratrooper unit during an urban combat simulation.

Material and method

Subjects

Twelve male soldiers were analysed from the Spanish Territorial Army Paratrooper Brigade (29.8 ± 5.4 years; 174.84 ± 4.1 cm; 74.63 ± 9.05 Kg; 15.8 ± 17.8 years of experience in their unit), many of them with experience on current international missions to areas of armed conflict. The soldiers were equipped with a simulated parachute for the jump and with the standard combat uniform and boots, as well as tactical and technical apparatus, simulated handgun, simulated rifle, simulated knife, cuffs and a 14 kg backpack, simulating the real equivalent weight for this kind of manoeuvre. All the procedures carried out in this research complied with the principles of the Helsinki Declaration, were approved by the General Army Headquarters of the Unit and also all participants signed a consent form.

Combat simulation

The combat simulation entailed a combat intervention in a village, preceded by a simulated automatic parachute jump from a jumping training tower. Once on the ground, they removed their jumping gear and moved on foot to the simulated urban area. The mission objective consisted in rescuing a prisoner, in this case an isolated allied combatant that they had to evacuate to a safe zone. During the simulation, the combatants, organised into intervention groups of four combatants, had to respond in accordance with international combat legislation and regulations in diverse situations: unarmed and armed civilians, enemy combatants with hidden weapons, enemy combatants with firearms, Improvised Explosion Devices (IED). After identifying the prisoner, he/she had to be taken to a safe zone, thus completing the mission.

Procedure

Before and immediately after the combat simulation, the following measurements were taken:

- Rating of perceived exertion (RPE) with the scale 6-20 (Borg, 1970).
- Blood lactate taking a 5µl of capillary blood sample from the finger of the subjects and analysing it with a lactate system, Lactate Pro (Akagui, Tokyo, Japan)

Table 1. Results of the physiological parameters measured pre and post manoeuvres (Average ± TD).

	Unit	PRE	POST (p)	% Change	d Cohen
RPE	-	6.00 ± 0.00	10.20±1.88 (0.003)	70.00	-
Lactate	mmol/l	1.26 ± 0.20	2.56 ± 0.45 (0.002)	103.17	6.50
HR	bpm	73.58 ± 5.16	143.83 ± 13.48 (0.002)	95.47	13.61
% HR	%	38.79 ± 3.13	75.80 ± 7.08	95.41	11.82

RPE: Rating of perceived exertion; HR: Heart rate.

– Heart rate via a Polar S610 heart rate monitor (POLAR, Finland). Once the results were collected, the percentage of the maximum heart rate (MHR) was calculated using the 220-age formula.

Statistical analysis

The statistical analysis was carried out using the SPSS 21.0 programme. The descriptive statistics used to display the results were the Average ± Typical Deviation (TD). Next, the normality of the sample was established with the Shapiro-Wilk test. After this, a comparative analysis was carried out of t Student averages of related measurements, as the study variables complied with the parametric assumptions. For all the comparisons, the significance index of $p < 0.05$ was accepted. The size of effect was calculated using the d Cohen [SE = Average Post-test - Average Pre-test)/ TD Pre-test].

Results

Upon studying the data obtained (Table 1), we can see how the rated perceived exertion values were 10.20 ± 1.88 ($t(11) = 7.60$; $p < 0.001$). The blood lactate concentration increased significantly from 1.26 ± 0.20 mmol/l up to 2.56 ± 0.45 mmol/l ($t(11) = 10.73$; $p < 0.001$) upon finishing the combat simulation.

The average heart rate during the manoeuvre was 143.83 ± 13.48 ppm ($t(11)=18.14$; $p < 0.001$) (75.80 ± 7.08% of the max. HR).

Discussion

The physical status and the reaction of the combatants is highly relevant both for their physical integrity as well as for the success of their actions[15]. The data analysis reveals how this combat simulation provokes an increase in the blood lactate values compared to base values, placing it within the aerobic value threshold[16]. The blood lactate concentration following an activity provides an excellent means of controlling the physiological changes that take place in organic exertion. Opposed to that found in similar studies with other military units[12, 17], where values of blood lactate were reached that exceeded those of the anaerobic threshold, paratroopers presented lower values, leading us consider that the higher the level of training, occurring particularly with the paratrooper brigade, the lower the blood lactate concentration for the same kind of exertion[18].

In the cases of previous studies, fundamentally noteworthy is the high psychological load of the tests carried out, in which soldiers face each other and they have to control a large number of uncertainties (such as windows, doors, holes, light changes or civilians mixed with potential terrorists), requiring a quick interpretation-assessment, and which are the focus of hostile situations, thus supposing a threat to them. This kind of situation can take the soldier to a state of psychological over-stimulation, generating anxiety or panic[12, 19], and symptoms of fatigue of the central nervous system[17]. This high degree of activation and muscle tension is reflected in the significant increase of blood lactate concentrations among the combatants.

The increase of lactate values and of the heart rate during the simulation may be due to the activation of the human body's innate defence mechanisms, such as the fight-flight reaction, in which the sympathetic nervous system is activated and prepares the body for any dangerous situation[12,17,20]. This leads us to propose the importance of psychological training and the ability to manage situations of tension and stress, opening up the possibility of quantifying the organic fatigue load induced by stress and contrasting it with the performance of the combatants, as indicated in recent studies[17]. The average heart rate obtained from the subjects during the test (143.83 ± 13.48 bpm) is very similar to that obtained for subjects in an ultra-resistance trial of 24 hours that was 150.5 ± 20.60 bpm[21] which was above that obtained in an ultra-resistance cycling trial of 525 km, which produced 126.00 bpm[22]; and it is also above the values obtained for a subject that covered 172 km in 24h at a HR intensity of 119 ± 80 bpm[23]. The intensity of the load that the combatants carried according to the average heart rate, would be in the aerobic-anaerobic transition zone, and within that at aerobic level 2[24,25]. The authors indicate the blood lactate concentration for this zone to be at around 3 mmol/l, a slightly higher value than that reached by the subjects; once again highlighting the preparation and training of the military subjects used in this study.

The rating of perceived exertion values were between very light and moderate, which can be explained thanks to the accumulated experience and adaptation achieved by these paratroopers following years of practice, manoeuvres and deployments in the current international operations areas. These results are similar to those reported in other kinds of extreme situations for the body, such as ultra-resistance trials[26,27], where the organism is also subject to extreme situations. In these trials the fatigue mechanisms are established by blood markers of muscle damage, an accumulation of metabolites or a reduction in the electrolyte concentration, taking the runners to their physiological limits, which directly affects their psychological response, obtaining elevated rating of perceived exertion values (RPE) and a very elevated sensation of fatigue, despite lactate levels being low. However, in combat, psychological stress is at its maximum, with these psychological factors (stress, anxiety, panic, uncertainty) having a direct effect on the physiological response.

The response of the combatants analysed differs from specific trials and tests carried out on other bodies, such as fire-fighters[28], also subject to huge stress and extreme situations for the body during their missions and training sessions, and whose intervention equipment is also considerably heavy, between 10 and 14 Kg[29]. Various studies have revealed the high demands of oxygen consumption, heart rate and blood lactate in laboratory tests and in real and simulated situations among fire-fighters[30-32]. These high values have traditionally been attributed to the muscular metabolic activity, thermo-regulatory pressure and fatigue resulting from protective equipment and the specific exertions, highlighting the importance of a good level of cardiovascular resistance and of muscle strength[33]. As such, following a brief simulation of patient rescue in a hospital, Von Heinburg *et al*[28] observed lactate concentration values of 13 ± 3 mmol/L in operations of 5-9 minutes, compared to those lasting 15 minutes, and 2.56 ± 0.45 mmol/L of lactate following the combat situation of the paratrooper group. We reiterate the importance of training and experience when it comes to facing these situations, such as that revealed by the paratrooper brigade, being one of the most operative and prepared elite units in the Spanish Territorial Army.

Practical application

The results obtained have highlighted the organic response of the paratroopers in a simulated combat situation. With these results, specific training sessions could be proposed, applied to military operative interventions in situations of urban combat, possibly using traditional training methods such as extensive continuous methods, or long and/or methodological current intervals, such as high-intensity interval training (HIIT)[34].

Conclusion

The combatants of a paratrooper unit carried out an urban combat simulation at an aerobic intensity range of 75% of the maximum heart rate and a blood lactate concentration of 2.6 mmol/l.

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Original article

Occurrence and type of sports injuries in elite young Brazilian soccer players

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Summary

Introduction: The aim of this study was to analyze the injuries affected in young soccer athletes of high performance categories, under (U) -11, U-13, U-15, U-17 and U-20 years and the associations between the variables related the injuries.
Material and method: Data were collected from medical records of the medical department of 143 injured athletes belonging to a club in the first division of the Brazilian Championship. The young athletes were evaluated in the following categories: under (U) -11, n = 30 (10.45 ± 0.5 years), U-13, n = 34 (12.15 ± 0.3 years) U-15, n = 23 (14.56 ± 0.4 years), U-17, n = 24 (16.52 ± 0.5 years), U-20, n = 32 (18.24 ± 0.6 years). Data collection was conducted from January 2014 to November 2014 (11 months). The data were analyzed and classified according to the categories and the lesions identified as per the recommendations of the study group in injury FIFA Medical Assessment and Research Centre.
Results: The results showed that there was a total of 200 lesions in all categories, the teams U-15, U-17, U-20 stood out with the greatest occurrences of injuries ($p<0.05$) and index of injuries ($p<0.05$). The Pearson correlation test showed a positive and significant coefficient of correlation ($r = 0.879$; $p < 0.05$) between index of injuries and hours of game.
Conclusions: It was observed that the occurrence and characteristics of lesions of young soccer players in different categories are higher according to the increasing number of games and that the older groups demonstrate a greater number of lesions more similar to those in adults.

Key words:
Soccer. Occurrence. Injury.

Ocurrencia y el tipo de lesiones deportivas en los jóvenes jugadores de fútbol brasileños de élite

Resumen

Introducción: El objetivo del estudio fue analizar las lesiones en los jóvenes futbolistas en categorías de alto rendimiento barro (SUB) -11, SUB -13, SUB-15, SUB-17 and SUB-20 años y las asociaciones entre las variables relacionadas con las lesiones.
Material y métodos: Se recogieron datos de los registros médicos del departamento médico de 143 jóvenes futbolistas pertenecientes a un club de la primera división del Campeonato Brasileño. Los jóvenes futbolistas fueron evaluados en las siguientes categorías: SUB -11, n = 30 (10,45 ± 0,5 años), SUB-13, n = 34 (12,15 ± 0,3 años), SUB-15, n = 23 (14,56 ± 0,4 años), SUB-17, n = 24 (16,52 ± 0,5 años) y SUB-20, n = 32 (18,24 ± 0,6 años). La recolección de datos se llevó a cabo a partir de enero 2014 a noviembre 2014 (11 meses). Los datos fueron analizados y clasificados por las categorías y las lesiones identificadas de acuerdo con las recomendaciones del grupo de estudio en la lesión de Evaluación Médica de la FIFA y el Centro de Investigación.
Resultados: Los resultados mostraron que hubo un total de 200 lesiones en todas las categorías. Los equipos B-15, B-17 y B-20 se destacaron con las mayores ocurrencias de lesiones ($p<0,05$) y el índice de lesiones ($p<0,05$). La prueba de correlación de Pearson mostró un coeficiente de correlación positivo y significativo ($r = 0,879$; $p <0,05$) entre el índice de lesiones y horas de juego.
Conclusiones: Se observó que la incidencia y características de las lesiones de los jóvenes futbolistas en diferentes categorías son más altos de acuerdo con el aumento del número de juegos y que los grupos de mayor edad demuestran un mayor número de lesiones más similares a las de los adultos.

Palabras clave:
Fútbol. Ocurrencia. Lesión.

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Introduction

Soccer is a high performance sport which is practiced young athletes. Soccer has undergone changes in recent years, mainly due to high training loads that require athletes to work near their maximum which leads to a higher predisposition to muscle fatigue[1]. This causes players to have greater demands regarding physical performance leading them to early maturation[2], and being more susceptible to injury[3].

It is estimated that for every 1000 hours of game play, the number of injuries is, on average, four to six times higher than the number of lesions that occur during training[4]. In professional athletes it is estimated that three out of four soccer players suffer for years, a performance limiting lesion[5].

Fédération Internationale de Football Association (FIFA), according to the Medical Assessment and Research Centre, defined as any injury occurring suffered by a player in competition or in training, which requires him or her to interrupt their activity and prevents them from participating in at least one practice or game[6]. Thus, it is important that there is a correct application of the training load to avoid muscular imbalances[3], with a recovery period sufficient to allow recovery from muscular fatigue[7].

The practice of physical activity for children and adolescents is encouraged throughout the world[8], however, another aspect that must be considered is the increase in numbers of weekly training and games in all categories, regardless of age, which puts the athlete potentially beyond their physiological limits of age[5]. So it is plausible to believe that the occurrence of injuries tends to be higher in younger practitioners who have a high volume of sports.

Sporting consequences of these injuries can be numerous, ranging from a pre disposition to injury in adulthood, through technical limitation to the early end of career[9]. Thus, identifying the occurrence of injuries in young athletes and verify possible relations with a time of sports practice, the coach can add information to prevent these injuries. The reduction of these sports injuries is important to the health of young athletes and could have a long-term economic impact on health care[10].

The incidence of injuries and their risk factors in adult soccer players are objects of many studies[11-13]. However, while approximately 45% of players aged under 15 have suffered at least one injury[14], few studies have investigated the injuries in young athletes and their relations with the training time and game according to their age. Thus, the present study has the hypothesis that the occurrence of injuries is greater in the categories of soccer players approaching the professional category and that there is a positive association between injuries and hours game. Therefore, the aim of this study was to analyze the injuries affected in young soccer athletes of high performance categories, under (U) -11, U-13, U-15, U-17 and U-20 years and the associations between the variables related the injuries.

Material and method

This research is a descriptive cross-sectional and correlational study. Data were collected from the 143 medical records of a club in the first division of the Brazilian Championship. The sample was chosen intentionally because it was composed of all the athletes who attended the medical department (MD). Medical records were evaluated in the following categories: Under (U) -11, n = 30 (10.45 ± 0.5 years), U-13, n = 34 (12.15 ± 0.3 years) U-15, n = 23 (14.56 ± 0.4 years), U-17, n = 24 (16.52 ± 0.5 years), U-20, n = 32 (18.24 ± 0.6 years). To be included in the study, medical records had to meet the following criteria: (a) lesion caused and (b) received care in the medical department of the club.

The study was based on data from the medical records medical department (MD), from January 2014 to November 2014, totaling 11 months. The data were analyzed and classified according to the age categories and the injuries identified. During the season, athletes with confirmed or suspected lesions were referred to the MD, where the doctor collected the following information: description of the injury (e.g. muscle, tendonitis, bruises, sprains, fractures or dislocations), anatomic site of the lesion (e.g. trunk, head, arm or leg), type of treatment (e.g. curative, anti-inflammatory drugs, surgeries, rehabilitation including ice, heat, ultrasound, shortwave and transcutaneous electrical stimulation), and date of admission to the initiation of treatment. When analyzing the data, it was ranked according to the type of acute traumatic injury and anatomic location from data originally collected in the patient chart, according to the recommendations of the study group in injury FIFA Medical Assessment and Research Centre[6].

To protect the identity of the club and the player, each player was given a unique coded identification number, which was known only by the club's medical staff and researchers. The data were analyzed in IBM® SPSS® Statistics Version 21 and presented descriptively. In addition, the index of injuries (IOI) was calculated by formula:

$$IOI = \frac{i \times 1000}{TH}$$

Onde:
IOI = Index of injury;
i = Injuries for each athlete
TH = Total hours (Training Hours of training + hours of game)

The Chi-square test was applied to compare the occurrence of injuries among categories. Shapiro-Wilk test was performed to confirm proximity of the sample data with a normal distribution. The one way ANOVA was carried out in groups and Bonferroni post-hoc test was performed for multiple differences of variables among categories. The Pearson correlation test was used to analyze the associations between the study variables. The study adopted the value of $p < 0.05$ for statistical significance.

Results

During the data collection period there was a total of 200 injuries (Table 1). There were a greater number and variety of injuries in older compared to younger age groups with 66 injuries in the U-17 team and 61 injuries U-20 compared to 12 injuries in the U-11 and 15 injuries in the U-13 teams. The commonest injuries were muscle stretch injuries (n=33) and contusions (n=32). Ankle injuries (N=26) were more common than knee injuries (n=15).

Table 1. Descriptive values of the types of lesions in the affected category Under (U) -11, U-13, U-15, U-17 and U-20.

Types of Injuries	U-11	U-13	U-15	U-17	U-20	Total
Muscle Stretch	3 (25%)	1 (6%)	10 (22%)	9 (14%)	10 (16%)	33 (16%)
Myalgia	0	5 (33%)	7 (15%)	15 (23%)	4 (6%)	31 (15%)
Low Back Pain	0	2 (13%)	3 (7%)	1 (1%)	3 (5%)	9 (4%)
Trauma	2 (17%)	0	2 (5%)	12 (18%)	14 (23%)	30 (15%)
Contusion	5 (42%)	4 (27%)	13 (28%)	7 (11%)	3 (5%)	32 (16%)
Tendonitis	0	1 (6%)	2 (4%)	3 (4%)	4 (7%)	10 (5%)
Sprain No Diagnosis	1 (8%)	1 (6%)	1 (2%)	4 (6%)	6 (10%)	13 (7%)
Knee Sprain	1 (8%)	0 (6%)	2 (4%)	3 (5%)	3 (5%)	9 (5%)
Ankle Sprain	0	1 (6%)	6 (13%)	11 (17%)	8 (13%)	26 (13%)
Anterior Cruciate Ligament	0	0	0	0	4 (7%)	4 (2%)
Posterior Cruciate Ligament	0	0	0	0	2 (3%)	2 (1%)
Herniated Disc	0	0	0	1 (1%)	0	1 (1%)
Total	12 (100%)	15 (100%)	46 (100%)	66 (100%)	61 (100%)	200 (100%)

† U-11 until U-20, category aged 10 up to 20 years

Table 2. Exposure and occurrence of injuries by category.

	U-11	U-13	U-15	U-17	U-20	Total
N	30	34	23	24	32	143
Amount Injuries	12	15	46*	66*	61*	200
Injuries for each athlete	0.40±0.02	0.44±0.01	2.00±0.12*	2.75±0.11*	1.91±0.24*	1.40
Hours of game season	10.00±0.12	23.33±0.21	53.60±1.31*	64.60±3.45*	75.00±3.89*	226.53
Hours of training	371.25	371.25	371.25	371.25	371.25	371.25

* p<0.05; significant differences for U-11 and U-13.

Table 3. Analysis of correlation between amounts of injuries and hours of training and game.

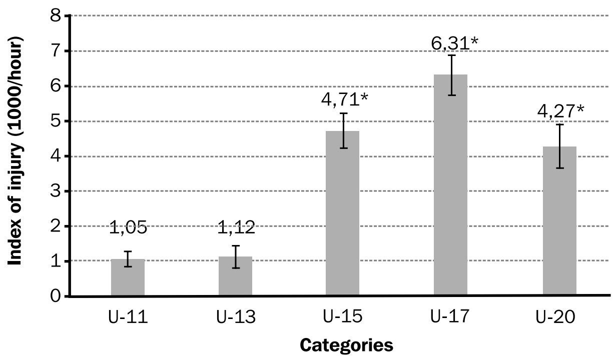
		Amount of injuries	Hours of game	Injuries per athlete	Hours of traning + game
Hours of game	r	0.970*			
	p-value	0.006			
Injuries per athlete	r	0.965*	0.894*		
	p-value	0.008	0.041		
Hours of traning + game	r	0.970*	0.999*	0.894*	
	p-value	0.006	0.000	0.041	
Index of injury 1000/h	r	0.954*	0.879*	0.999*	0.879*
	p-value	0.012	0.049	0.000	0.049

* p < 0.05

Table 2 displays the number of injuries and number of hours of exposure to game and training. All age categories had the same training pattern, with an average of five workouts per week lasting approximately 1.5 hours, totaling 371.25 hours of training. The U15, U17 and U20 categories had greater occurrence of injuries and greater number of hours of gaming sessions (p <0.05) when compared to the U-11 and U-13 categories. The same result was found in the index of injuries (p <0.05) in Figure 1.

Table 3 shows data correlating the training and game hours with the number of injuries. The results suggest that the practice time the activity is directly related to the incidence of injuries, because the correlation shows that the longer the athletes train or play the more likely to injure.

Figure 1. Analysis of index of injuries in the categories.



* p<0.05; significant differences for U-11 and U-13

Discussion

A total of 200 injuries were documented during the season of 2011, resulting in 1.4 injuries for each athlete / year on average, a rate close to the studies of Walden *et al*.[15], Chamari *et al*.[16] and Ekstrand *et al*.[17]. Results of recent studies suggest most soccer injuries are caused by direct trauma resulting in contusions and muscle injuries, leading to strains and sprains in the lower extremities[18-20]. In our study, we see a similar pattern in our results compared to the results of these authors. Furthermore, the location of lesions recorded in our study was similar to that reported in other studies[15,19,21] affecting predominantly the knee and ankle joints and muscles of the thigh and leg. The disproportion of injuries among body segments, upper and lower limbs, can be attributed to the higher demand of the lower extremity in soccer[7].

There was a gradual increase in the number of games according to the increasing age group of players, i.e. the higher the age group the higher the number of games. This finding is corroborated by Bengtsson *et al*.[22] who observed with great concern that the time spent in match play massively increases for soccer athletes as their level of professionalism rises and age advances.

The studies by Ribeiro *et al*.[23] and Junge *et al*.[24] also refer to the same amount of training 90 minutes a week. This situation seems to demonstrate a standardized duration for training in soccer players. However, the teams U-15, U-17 and U-20 had an average incidence, a fact different to that shown with the average of the whole group. When we observe the prevalence of these three categories with the literature we noted similar rates found in other studies with young soccers[17,24,25], however, these injury rates were higher than those found in studies with adults[21,26]. These results corroborate the hypothesis highlighted by this study. Besides the large number of games this higher incidence may be explained by a weakness in technique and tactics, as well as a possible lower muscle strength, endurance, coordination and experience of young athletes. Changes in the system of training young athletes, focusing on technique and ability beyond the physical component, may help to minimize the incidence of sports injuries[27].

Some studies have shown large differences in incidence rates of injuries recorded in soccer[17,24,28]. attributed these differences to conceptual contradictions, study design, methods of data collection, observation schedules, and characteristics of the samples studied. The system for data collection has also been the subject of numerous discussions. Fuller *et al*.[6] argue that a proper injury record should include components such as location, type and circumstances of the injury. Junge and Dvorak[28] recommend that for the exact calculation of the incidence of injuries the number of games and practice sessions should be documented for each individual athlete. Moreover, they claim that the registration of sports injuries should be done prospectively because retrospective data have limited value, and prospective studies as well as evaluating the incidence of injury can also identify groups and risk factors.

In additional, this study found a high association with uptime with the occurrence of injuries. The results corroborate the findings by Keller *et al*.[29] and Weber[30]. The high number of games and the time devoted to training sessions become more frequent occurrence of muscle and osteoarticular injuries in athletes[30].

The present study examined the occurrence of lesions in base class athletes, however, it is not stuck to check the mechanisms of these lesions and or the severity thereof, which may somehow be considered limitations of the study.

Conclusions

As was expected the hypotheses, the present study observed that the occurrence of characteristics of the injuries of young soccer players in different age categories are larger in older age groups and that the larger the number of games played the greater the number of injuries sustained. Thus, the soccer coaches can avoid injury by overtraining in young athletes. For further studies, it is recommended to analyze the different types of training in basic categories in soccer.

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Original article

Blood lactate concentration and strength performance between agonist-antagonist paired set, superset and traditional set training

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Summary

Objective: To investigate acute effect of agonist-antagonist paired set (PS), superset (SS) and traditional set (TS) training on maximal repetition performance, ratings of perceived exertion (RPE) and blood lactate (BL).
Material and method: Ten recreationally trained men (27.5 ± 3.8 years; 75.0 ± 5.6 kg; 176.4 ± 4.8 cm) participated in the current study. Firstly, the 8 repetition maximum (RM) loads were determined for the seated row (SR) and bench-press (BP) exercises. Then, three experimental protocols were applied: TS - 3 SR sets were performed followed by 3 BP sets; PS - 3 paired sets were performed between SR and BP exercises in alternate manner; SS - 3 paired sets were performed between SR and BP exercises without rest interval between each set paired set. Blood lactate sampling was measured prior to session (PRE); immediately post-exercise (POST); 3 min (P3), and 5 min (P5) post-exercise.
Results: Greater repetition performance was noted under PS compared to SS and TS protocols for SR and BP exercises, respectively. No differences were noted between SS and TS protocols. Higher blood lactate concentrations were also noted under SS protocol compared to PS and TS, respectively, for POST, P3 e P5 measures. RPE was significantly higher under SS than PS and TS, respectively.
Conclusion: Therefore, the PS may be an interesting method to be adopted in order to increase the repetition performance in acute manner for multi-joint exercises for upper body muscles, as well as, the SS method might be an alternative to increase the metabolic stress and muscle fatigue.

Key words:
Paired set. Strength. Lactate. Coactivation. Performance.

La concentración de lactato en sangre y rendimiento de fuerza entre series emparejadas agonista-antagonista, super series y entrenamiento tradicional

Resumen

Objetivo: Investigar el efecto del entrenamiento con series emparejadas agonista-antagonista (SE), súper series (SS) y series tradicionales (ST), en el rendimiento de repeticiones máximas, la percepción subjetiva del esfuerzo (RPE) y lactato sanguíneo (L).
Material y método: Diez deportistas de recreación (27.5 ± 3.8 años; 75.0 ± 5.6 kg; 176.4 ± 4.8 cm), hombres, fueron voluntariamente sometidos a este estudio. En primer lugar han sido determinadas las cargas de 8 repeticiones máximas para los ejercicios de remo sentado (RS) y press de banca (PB). Posteriormente, se aplicaron 3 protocolos: ST - 3 series de RS seguidas por 3 series de PB; SE – 3 series emparejadas entre los ejercicios RS y PB alternadamente; SS – 3 series emparejadas entre los ejercicios RS y PB sin intervalo de recuperación entre cada serie emparejadas. Muestras de L han sido medidas antes de la sesión (PRE); y inmediatamente después de la sesión (POS); 3 min (P3), y 5 min (P5) después.
Resultado: Se encontró un mayor rendimiento de repeticiones en SE en comparación con SS y ST para los ejercicios RS y PB. No se observaron diferencias entre los protocolos SS y ST. Se observó una mayor concentración de lactato en el protocolo SS en comparación con SE y ST respectivamente, para las mediciones POS, P3 y P5. La RPE fue significativamente mayor en SS, en comparación con PS y TS respectivamente.
Conclusión: Por consiguiente, el SE puede ser un método interesante para ser adoptado con el fin de aumentar el rendimiento de repeticiones en forma aguda para los ejercicios multi-articulares para los músculos superiores del cuerpo, como también, el método SS podría ser una alternativa para aumentar la tensión metabólica y la fatiga muscular.

Palabras clave:
Series emparejadas. Fuerza. Lactato. Coactivación. Rendimiento.

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Introduction

Resistance training promotes several adaptations in musculoskeletal such as the increases in maximal strength, hypertrophy, power output, and muscular endurance for fitness and sports practitioners[1]. In order to optimize these adaptations, a few methodological prescription variables are often manipulated: exercise order, rest interval between sets and exercises, number of sets and exercises, muscle actions, training load and frequency[2].

Several training methods are used adopted by coaches and practitioners of resistance training to manipulate the methodological prescription variables with the goal to increase the outcomes[3]. In this sense, agonist-antagonist paired set (PS) training proposes to trigger the muscles with agonist-antagonist role (*i.e.* biceps and triceps brachii) in alternate manner, with or without rest interval between sets and exercises with the goal to increasing the strength performance in a time-efficient manner[4]. Similarly, the superset (SS) method aims to trigger the same or different muscle group or limbs, without rest interval between sets and exercises, with the goal to induce an augmentation in muscle fatigue and metabolic responses, and consequently providing an augmentation in muscle hypertrophy potential[5]. The PS and SS are often associated to greater training efficiency (training volume/time) when compared to traditional set (TS) training, due to the shorter rest between sets and exercises and the short recovery period between like sets[4,6-8].

Recently, a few studies have been observed the acute effects of PS and SS compared to TS on training volume, power output, electromyographic (EMG) activity and training efficiency (loads/min)[4,6,9-15]. Robbins *et al.*[12] found similar training volume and EMG activity of pectoralis major, triceps brachial and anterior deltoid muscles between TS training and PS performing 3 sets in bench pull and bench press exercises, with 4 repetition maximum (RM) loads. The authors adopted 4-minute rest interval between sets and exercises in TS, and 2-minute between sets and exercises in PS. Recently, Maia *et al.*[4] noted higher repetition performance and muscle activation of rectus femoris and vastus lateralis performing PS and SS (*i.e.* lying leg curl and leg extension), adopting shorter rest intervals (without recovery, 30 s and 1-minute) compared to longer intervals (3 and 5 minutes), as well as, compared to the leg extension performed without antagonist preloading (*i.e.* TS condition).

However, there is still a lack of evidence about the effects of PS and SS on metabolic markers, such as, blood lactate concentration pre and post exercise , and also strength performance among training methods. Carregaro *et al.*[13] compared the effect of three methods of antagonist prealoading: multiple sets (MS), SS and reciprocal actions (RA) investigating the effects on EMG activity (*i.e.* vastus lateralis, vastus medialis and rectus femoris), fatigue index, total work and blood lactate concentration performing isokinect knee flexion and knee extension. The authors observed which SS generated higher fatigue index when compared to RA and MS protocols, respectively, as well as, SS promotes significant greater blood lactate concentration after SS when comparing to RA and MS, respectively.

Furthermore, there are still limited evidences about the metabolic, effort, and repetition outcomes performing PS and SS compared to TS method. These evidences may help coaches, athletes and resistance training practitioners during the prescription of training programs, with the goal to increase the outcomes without compromising strength performance. Therefore, the purpose of the current study was to investigate acute effect of PS, SS and TS on maximal repetition performance, ratings of perceived exertion (RPE) and blood lactate concentration.

Material and method

Participants

Ten recreationally trained men (27.5 ± 3.8 years; 75.0 ± 5.6 kg; 176.4 ± 4.8 cm) participated as voluntary in the current study selected by convenience, adopting a non-probabilistic procedure. The inclusion criteria were: with a) to have at least 1 year of resistance training (RT) experience; b) to perform RT ≥ 3 times a week with an average of 1 hour per session); c) to have experience in the execution of selected exercises. The exclusion criteria were: a) to show any medical conditions which could affect the outcomes this study; b) to use nutritional supplements or other ergogenic which could induce alterations in strength and metabolic responses.

The participants were instructed to do not performer any type of exercise 48h before the test or training sessions. All participants answered the *Physical Activity Readiness Questionnaire* and signed an informed consent form in accordance with the Declaration of Helsinki. The study was approved by the ethics committee of the institution with the protocol: 28037114.2.0000.5257.

Procedures

Eight repetition maximum loads determination.

In the week before the experiment, the 8 repetition maximum (RM) loads was determined for each participant for the wide-grip seated row (and bench-press exercises (Life Fitness, Rosemont, IL, USA). The 8RM load was defined as the maximum weight that could be lifted for 8 consecutive repetitions until concentric failure. The executions of both exercises were standardized, and pauses were not permitted between the concentric and eccentric phases. This procedure was controlled by a experienced researcher. If an 8RM was not accomplished on the first attempt, the weight was adjusted by 4–10 kg and a minimum 5-minute rest was given before the next attempt. Only 3 trials were allowed per testing session. The test and retest trials were conducted on different days with a minimum of 48 hours between trials[4]. To reduce the margin of error in testing, the following strategies were adopted[16]: (a) standardized instructions were provided before the test, so the subject was aware of the entire routine involved with the data collection; (b) the subject was instructed on the technical execution of the exercises; (c) the researcher carefully monitored the position adopted during the exercises; (d) consistent verbal encouragement was given to motivate subjects for maximal repetition performance; (e) the additional loads used in the study were previously measured with a precision scale.

Experimental Sessions

After determining the 8RM loads, three experimental protocols were applied in a randomized design, adopting 72h of recovery interval between the test sessions. Before testing, each participant performed a specific warm-up of 12 repetitions with 40% of 8RM loads for both exercises, adopting 2-minute rest interval among exercises, and the beginning of the testing session[14]:

- *Traditional set training*. Three sets were performed in seated row exercise followed by three sets of bench-press exercise, adopting 2-minute rest interval between sets and exercises. The session duration was approximately 10 minutes.
- *Agonit-antagonist paired set*. Three paired sets were performed between seated row and bench-press exercises in alternate manner, adopting 2-minute rest intervals between sets and exercises. The session duration was approximately 10 minutes.
- *Supersets*. Three paired sets were performed between seated row and bench-press exercises without rest interval between each set paired set (*i.e.* SR-BP). Then, a 150 seconds – rest interval was adopted before the next paired set. The session duration was approximately 5 minutes. The OMNI-Res[17] scale was adopted to record the RPE after each set and exercise for all protocols. All sets and exercises was performed until concentric failure with 8RM loads. The fatigue index, commonly defined as the drop in strength and power during a training session, was estimated for each exercise in both orders using the formula proposed by Dipla *et al*[18]: FI = (third set/first set) × 100; where a higher percentage value (%) indicates a superior fatigue resistance.

Blood lactate

After cleansing the site with 70% alcohol, the ear lobe was punctured using a disposable lancet (Accu-check Safe-T-Pro Uno®). The first drop of blood was discarded to avoid contamination with sweat and then a small blood sample was collected (25 ll) before exercise (rest for at least 15 min). Blood sampling was performed after each protocol, at the following times: (a) immediately upon completion (PRE), (b) 3 min (P3), and (c) 5 min (P5) after completion. The samples were placed in labeled microtubules (Eppendorf) containing 50 ll of sodium fluoride solution [1%], and stored at approximately 4°C for 30 min and subsequently placed in a refrigerator. All samples were analyzed using the Accutrend® (Roche)[19].

Statistical analysis

Statistical analysis was performed using SPSS software version 20.0 (Chicago, IL, USA). The statistical analysis was initially performed using the normal Shapiro-Wilk test and homocedasticity test (Bartlett criterion). All variables were normally distributed and homocedasticity. The intraclass correlation coefficient ($ICC = (MS_b - MS_w)/[MS_b + (k-1) MS_w)$ was calculated to verify the test and retest reproducibility of 8 RM loads determination. Two-way ANOVA for repeated measures followed by post hoc Bonferroni test was applied to determine whether there was a significant difference or interaction between the type of training (TS, PS and SS) and sets[1-3] for repetition performance during seated row and bench press exercises. One-way ANOVA for repeated measures followed by post hoc Bonferroni was applied to verify if there was significant difference between lactate levels and fatigue index between protocols over the time points recorded. Friedman non-parametric test was applied to compare the rating of perceived exertion between protocols and sets for each exercise. The value of p <0.05 was adopted for all inferential analyzes.

Results

The ICC for 8 RM loads was bench press: 0.91 and seated row: 0.92, respectively. The 8 RM loads were bench press: 76 ± 13,2 kg and seated row: 66,8 ± 8,8 kg. Significant differences were noted in repetition performance between the protocols (F = 183.558; p = 0.0001) and sets (F = 48.957; p = 0.0001) for seated row exercise, as well as, there was also a significant interaction between sets and protocols (F = 19.333 p = 0.0001) (Table 1). Greater repetition performance was noted under PS condition for sets 2 (p = 0.001; p = 0.002) and 3 (p = 0.0001; p = 0.0001) when compared to SS and TS protocols, respectively. No differences were noted between SS and TS protocols for all sets performed in SR exercise. Considering bench-press exercise, significant differences were noted between the protocols (F = 85.398; p = 0.0001) and sets (F = 24.868; p = 0.0001), as well as, significant interaction between sets and protocols (F = 12.641; p = 0.0001). Higher repetition performance was observed under PS protocols for sets 2 (p = 0.01; p = 0.0001) e 3

Table 1. Maximum repetition performance (Mean and SD) for seated row and bench press exercises under each set and protocol.

	Set 1	Set 2	Set 3	*p* value	Fatigue Index (%)	*p* value
Seated Row						
Traditional	8 ± 0	6.8 ± 0.4*	5.9 ± 0.7*	-	73.7 §	-
Superset	8 ± 0	6.2 ± 0.4*	5.3 ± 0.4*	0.0001	66.2	0.001
Paired set	8 ± 0	7.6 ± 0.5§¥	6.9 ± 0.3*§¥	0.001	86.2§¥	0.03
Bench Press						
Traditional	8 ± 0	6.8 ± 0.4*	5.9 ± 0.7* Ť	-	73.7 §	-
Superset	7.9 ± 0.3	6.5 ± 0.7*	5.2 ± 1*Ť	0.001	65.8	0.001
Paired set	8 ± 0	7.8 ± 0.4§¥	7 ± 0*Ť§¥	0.001	87.5 §¥	0.001

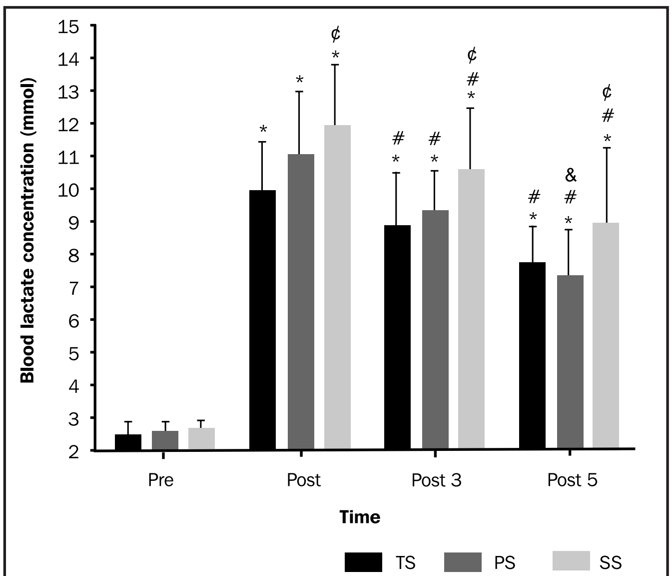
* Significant difference for set 1 ($p \leq 0.05$); Ť significant difference for set 2 ($p \leq 0.05$); § significant difference for superset protocol ($p \leq 0.05$). ¥ Significant difference for traditional protocol ($p \leq 0.05$); *p values refer to traditional set protocol.

($p = 0.001$; $p = 0.001$) when compared to SS and TS protocols, respectively. Moreover, there was no significant difference in repetition performance between TS and SS protocols for bench-press exercise.

Significant decreases in repetition performance was noted between set 2 to 1 and set 3 to 1, for seated row exercise in SS and TS. This reduction was only observed in set 3 compared to 1 for SR under PS condition. However, significant decreases in repetition performance was observed between set 2 to 1, set 3 to 2, and set 3 to 1 for all exercises and protocols for bench-press exercise. Higher fatigue index was noted under PS compared to SS ($p = 0.0001$); ($p = 0.001$) and TS ($p = 0.0001$); ($p = 0.002$) for seated row and bench-press exercises, respectively. Significant differences were also noted between TS compared to SS for seated row ($p = 0.0001$) and bench-press ($p = 0.002$) exercises.

Significant difference in blood lactate concentration was found between the measurements ($F = 10.704$; $p = 0.001$) and protocols ($F = 240\ 977$; $p = 0.0001$), as well as, significant interaction between the measurements and protocols ($F = 2.793$; $p = 0.019$). There was a significant increase in blood lactate concentrations in POST measure for all protocols compared to PRE condition, respectively (Figure 1). Higher blood lactate concentrations were also noted between P3 and P5 measures, when compared to POST measure under TS ($p = 0.0001$; $p = 0.001$), PS ($p = 0.002$; $p = 0.001$), and SS ($p = 0.0001$; $p = 0.0001$). The PS protocol showed significant difference between the P3 ($p = 0.0001$) and P5 ($p = 0.0001$) measures. In addition, SS protocol showed blood lactate concentrations significantly higher than PS and TS protocols for POST ($p = 0.001$; p 0.0001), P3 ($p = 0.001$; p 0.0001) and P5 ($p = 0.0001$; p 0.002) measures, respectively.

Figure 1. Blood lactate concentration prior to exercise (PRE), post-exercise (POST), 3-minutes post-exercise (P3) and 5-minute post-exercise (P5).



*Significant difference for PRE measure ($p \leq 0.05$); #: Significant difference for POST measure ($p \leq 0.05$); &: Significant difference for P3 measure ($p \leq 0.05$); ₵: Significant difference for TS and PS protocols ($p \leq 0.05$); SS: superset protocol; PS: agonist-antagonist paired set; TS: traditional set protocol.

Table 2. Ratings of perception exertion (OMNI-Res) of each set, exercise and protocol (Values are presented as median).

	Seated Row		
Traditional	3	4.5*§	6* Ť§
Supersets	3	6*	7.5* Ť
Paired sets	2	5.5*	6.5*
	Bench Press		
Traditional	5,5	7*	8*
Supersets	5.5	8*	9*
Paired sets	4	6*§	7*§

* Significant difference for set 1 ($p \leq 0.05$); Ť: significant difference for set 2 ($p \leq 0.05$); §: significant difference for supersets protocol ($p \leq 0.05$).

The RPE was significantly higher for sets 2 and 3 compared to set 1, for all protocols and exercises (Table 2). However, during exercise seated row exercise, the SS protocol showed higher RPE values for sets 2 and 3, compared to TS and PS conditions, respectively. Similar results were observed for the bench press exercise (Table 2).

Discussion

The main findings of the current study were the greater repetition performance found under PS method when compared to TS and SS protocols for both exercises. In addition, similar repetition performance was noted between SS and TS methods, however, SS showed higher levels of blood lactate concentration post-exercise, when compared to TS and PS, respectively. These results corroborate previous studies that found significant differences in strength performance and fatigue index comparing SS, TS and PS training methods[4,8,13,20].

Resistance training is the axis of several sports which requires muscle strength, power, and endurance performance[2]. The repetition performance for a given load intensity is important parameter to monitoring the efficiency of the training programs[3]. In the current study, higher repetition performance was observed under PS compared SS and TS for both exercises. These augmentations in strength performance due to the implementation of PS method have been also reported in the scientific literature. Baker e Newton[9] found significant increase power output performing bench press throws (with 40% of 1-RM) 3-minute after conducting a set of 8 repetitions in bench pull exercise compared to control condition without antagonistic preloading. Paz *et al.*[14] also observed significant increases in repetition performance under a PS protocol performing bench-press and seated row exercises without rest interval in alternate manner with 10RM loads, when compared to a TS of seated row exercise. However, Robbins *et al.*[10] observed similar training volume between PS and TS methods performing three sets of bench pull and bench-press exercises, with 4RM loads. Moreover, the PS protocol was performed in approximately half the time (adopting 2-minute rest interval) compared to TS (*i.e.* 4-minute rest interval). These evidences are in agreement with the current study which showed greater efficiency and fatigue resistance under PS compared to TS and SS methods, respectively.

These potential effects of PS method in strength performance are often associated with some factors such as changes in triphasic neural pathway of activation, increased elastic energy storage, and peripheral fatigue due to the longer rest provide among like sets for each exercise, respectively[4,8,13]. However, the hypothesis associated with changes in the triphasic neural pathway suggests that after antagonist preloading, a braking phase of antagonistic burst may occur and, consequently, increasing the agonist recruitment[9]. Moreover, the results of the current study may not be associated with the above condition, considering that this breaking phase has been reported only during high-speed movements[5]. Additionally, the hypothesis associated with the elastic energy storage is limited, due to the lack of appropriate instruments for evaluating such condition, as observed in previous studies[6,21,22]. Despite the above hypotheses, Maia *et al.*[4] observed significant increases in repetition performance adopting SS and PS methods, with shorter rest intervals (30 s and 1-minute) performing lying leg curl and knee extension exercises with 10-RM loads, as well as, higher muscles activity of rectus femoris and vastus medialis when compared to TS protocol. However, the increases in repetition performance found in the current study are in agreement with the mechanisms proposed by Roy *et al.*[23]. They suggested that the preloading characteristic of APS training has a positive effect on agonist muscles because of the facilitatory stimulation of Golgi tendon organs of knee flexor muscles and muscle spindles of extensor muscles, in this study, the activation of shoulder abductor muscles. On the other hand, in the current study the resistance training session was composed by multi-joint exercises, for this reason the higher recovery period between like sets during PS method may have decreased the peripheral fatigue over the sets due to the muscle mass involved in both exercises.

However, similar repetition performance was noted between SS and TS methods for both seated row and bench-press exercises. These results may be associated to the limited rest between sets and exercises adopted under SS, when compared to TS method. The fatigue index was significantly lower under SS than TS, which corroborate the RPE and blood lactate concentrations data found in SS method when compared to TS and PS, respectively. On the other hand, session duration of SS method was approximately the half in relation to TS condition, which suggested that SS may be more time-efficient than TS method. Carregaro *et al.*[24] also observed higher levels of blood lactate concentrations after a SS protocol, performing three sets of 10 repetitions of knee isokinetic flexion and extension, when compared to a MS and RA protocols, respectively. The authors suggested that these higher fatigue index and blood lactate concentrations in the SS were due to the protocol format where subjects had a lower degree of muscle recovery. However, they observed that considering the total work, fatigue index, and load range the SS method was less efficient when compared to RA and MS.

In the current study, significant augmentation in blood lactate concentration was found between POST and PRE measures for all experimental protocols. Additionally, SS method showed higher lactate values under POST, P3 and P5 measures when compared to TS and PS methods, respectively. These data are in agreement with the study of Carregaro *et al.*[13], who noted higher blood lactate concentration under SS protocol compared to RA and MS. Additionally, only the PS method showed significant decreases in blood lactate concentration comparing P5 to P3 measures. It has been postulated that lactate concentrations can be considered an important indirect marker of metabolic stress during resistance training. According to Gentil *et al.*[25], disturbances in K^+ concentration are associated with increased blood lactate concentration and, consequently, a decrease in excitability caused by muscle fatigue. Under conditions of metabolic stress, the gradual increase of K^+ could lead to inactivation of Na^+ channels which, probably, would reduce the release of Ca^+ by the sarcoplasmic reticulum via decreased amplitude of the action potential[26]. This event leads to failure of action potentials to affect the excitation–contraction coupling of the fiber and reduced strength performance[27].

In the current study, the RPE was significantly higher for sets 2 and 3 compared to set 1 for all exercises and protocols. These results are in agreement with the study of Spreuwenberg *et al.*[28] which shows higher RPE for sets and exercises performed at the end of the resistance training sequence. However, the SS protocol showed higher RPE values for sets 2 and 3, when compared to PS and TS methods for both exercises. However, there was no difference between TS and PS methods. The results of this study demonstrated a positive correlation between blood lactate concentration and RPE. Additionally, there was significant reduction in repetition performance of repetitions over the three sets performed in SR and BP exercises for all experimental protocols. These results may be associated to the shorter rest interval (120 s and 150 s) adopted between sets and exercises, which was not sufficient to maintain the repetition performance over the sets. De Salles *et al.*[29] claim that prolonged rest intervals are needed between sets and exercises to allow a complete resynthesis of adenosine triphosphate (ATP), allowing better muscle recovery and strength performance maintenance.

This study has a few limitations such as, the assessment of only two resistance exercises for upper body muscle, considering that a traditional set training session are often composed by multiple exercises and sets. The small size of the sample is also limitation, which compromising the data reproducibility. On the other hand, the methodology adopted in the current study may be easily applied by coaches and practitioners in RT fields.

Conclusions

In conclusion, the PS promoted greater repetition performance, when compared to TS and SS methods, respectively. However, the SS method showed similar repetition performance than TS protocols, but higher levels of blood lactate and RPE than TS and PS methods, respectively. Therefore, the PS may be an interesting method to be adopted in order to increase the repetition performance (e.g., strength gains) in acute manner for multi-joint exercises for upper body muscles reducing the RPE and metabolic stress, as well as, the SS method might be an alternative to increase the metabolic stress without compromising the strength performance (e.g., hypertrophy stimulus).

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Sports medicine vs occupational medicine: two divergent specialties with a common past

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Summary

Sports & Physical Education Medicine and Occupational Medicine are two medical specialties with a common past, the "school regime ", which have evolved divergently. The purpose of this article is to review the regulations and documents to help understand the current situation of both specialties. To this, basic legislation has been revised, the related specialized training ones and other documents. The results show differences in the format of the training program, the existence/nonexistence of a regulation to develop the relevant law, the requirement or not mandatory to practice as a specialist in his professional field, the presence or not of an employment category associated, calls for public jobs and/or the presence/absence of public jobs in all the State Autonomous Communities. Basically we can say that while one of them (Occupational) has been consolidated in the system of specialized medical training; the other one (Sport) has disappeared in the latest calls. The fact that one of them has a legal support forcing hire doctors work in its scope (prevention services) has favored in the author's opinion, not only to stay in the internal specialist residence system but also its best employment both in the public health sector and private. Still, the present and the immediate future provide job opportunities for both specialties, with a common jurisdictional area in which to promote the health of the general population, workers and sports people. In this sense, would be essential to develop the Sports Act in the form of regulations, with the support of the Medical Societies reference to clarify the roles of the various professions and the realization of the specialty as competent to conduct medical examinations of fitness in sports activities and competitions.

Key words:
Sports Medicine.
Occupational Medicine.
Medical Speciality.

Medicina del deporte *versus* del trabajo: caminos divergentes de dos especialidades con un pasado común

Resumen

La Medicina de la Educación Física y el Deporte, y la Medicina del Trabajo son dos especialidades con un pasado común, el régimen de "escuela", que han evolucionado de forma divergente. El motivo de este artículo es revisar la normativa y otros documentos para ayudar a comprender la situación actual. Para ello se ha consultado legislación básica, la relacionada con la formación especializada y aquella otra relativa a puestos de trabajo asociados. La revisión muestra diferencias respecto: al formato del programa formativo, la existencia o inexistencia de un reglamento que desarrolle la Ley pertinente, la exigencia o no de la obligatoriedad para ejercer como especialista en su ámbito profesional, la correlación o no de una categoría laboral asociada, las convocatorias de ofertas públicas de empleo y/o la presencia/ausencia de puestos de trabajo públicos en todas las Comunidades Autónomas. Básicamente se concluye que, mientras una de ellas (la del Trabajo) se ha consolidado en el sistema de formación médica especializada; la otra (del Deporte) ha desaparecido en la oferta de las últimas convocatorias. El hecho de que una de ellas tenga un soporte legal que obliga a contratar especialistas en su ámbito de actuación (los servicios de prevención) ha favorecido tanto su permanencia en el sistema para la formación de especialistas médicos como la inserción laboral en el sector de la sanidad pública y privada. Aun así, el presente y el futuro inmediato brindan oportunidades de trabajo para ambas especialidades, con un ámbito competencial común en lo que a la prevención y promoción de la salud de la población general, laboral y deportista se refiere. En este sentido, sería fundamental el desarrollo de la Ley del Deporte en forma de Reglamento, con el apoyo de las Sociedades Médicas de referencia, para clarificar las funciones de las diversas profesiones y concretar la especialidad competente para realizar los reconocimientos médicos de aptitud del deportista.

Palabras clave:
Medicina del Deporte.
Medicina del Trabajo.
Especialidad médica.

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Introduction

The specialities of Physical Education and Sports Medicine (SM), and Occupational Medicine (OM) have a shared past, with both having been specialities in the student system[1]. However, whilst the first is not currently offered in the new calls for access to positions within the training system specialised in Health Sciences, the second is[2,3]. This article offers a comparative perspective between both specialities, observing the evolution in regulatory development as a factor that has influenced the current situation, making suggestions for the future. In this respect, the aim is to review regulations and documents that are directly related to the issue, so as to reflect upon the current situation.

Background

The Spanish Constitution of 1978[4] protects the right to work, to health and to its promotion through physical exercise. In fact, Article 43.3 establishes the promotion of physical education and sport, indicating in 148.19 the exclusive competency that the Autonomous Communities have in promoting sport and the appropriate use of leisure time[4].

The General Health Act 14/1986[5] cited the improvement and specialisation of healthcare staff. In turn, Act 44/2003 governing the Organisation of Healthcare Professionals[6] (OHPA) indicated the right to the free exercising of healthcare professionals, including those with official qualifications in health sciences, by recognising specialised Health Science training as regulated and official training. Specialised training serves to fill specific work positions in public and private centres and establishments. The OHPA mentioned the suppression, modification or adaptation of healthcare specialities whose training system was not that of the residency[6], a training system that emerged from a now removed legislation from 1984[1].

Current legislative situation

Article 21.2 of the Public Health Act 33/2011[7] states that *"health examinations can be carried out prior to sporting practice only when stipulated so by the sectoral regulation in force",* leaving regulatory development open.

Recently, the seventh additional provision of the Royal Decree (RD) 639/2014[8] established that *"From the calling of selective trials 2015, for access in 2016 to specialised healthcare training positions, positions will not be offered in training for students in Medical Hydrology, Physical Education and Sport Medicine, Legal and Forensic Medicine, and Industrial and Galenical Pharmacy specialities".* This was upheld, and despite the Supreme Court declaring the Royal Decree of core training to be invalid, the callings for the 2016 and 2017 exams have not offered any positions for access to the SM speciality[2,3].

Why has this situation arisen? The comparative analysis of legislation related to both specialities can provide us with some keys, apart from other factors that have not been included within this review.

Analysing the Health Sciences Specialities training programmes on the Ministry of Health[9] website, we can see the first difference. And whilst the speciality of SM has maintained an unaltered programme, in the form of a 5-page supplement to a single-column supplement, which dates from 1996, entitled the *"Specialists training guide"*[9]; the other speciality, of OM, changes this via the Order SCO/1526/2005 published in the Official State Gazette[10] (OSG), to which it dedicates 10 pages in double column[10].

The existence of an Act that pin points the necessity of speciality: a key factor

The existence of an act that supports and justifies the working category is the fundamental factor that differentiates both specialities. Article 22 of the Occupational Risk Prevention Act11 (ORPA) from 1995 establishes that *"the monitoring and control measures for worker health should be performed by healthcare staff with technical competency, training and accredited capacity".* Development regulations of the ORPA have specified which specialists have this competency, training and capacity. On the one hand, Article 37 of the Regulation of the Prevention Services[12] clearly mentions that: *"The prevention services that perform worker health monitoring and control duties should have a doctor specialising in Occupational Medicine...".* Explicitly revealing the legal requirement to have a speciality in OM to occupy work positions in the certified working category. On the other hand, RD 843/2011[13] in Article 4 indicates that *"healthcare personnel must have the healthcare qualifications to perform their professional competencies: doctors must be specialists in Occupational Medicine",* adding that this must be the speciality of the technical director. This said, the medical director of the prevention service must be a specialist in OM.

The clarifying situation with regards to OM contrasts with that of the speciality of SM, with one legislation - Act 10/1990 of sport[14] - in which the Superior Board of Sports (SBS) already indicated that "Spanish sporting federations may be required that to grant licences or participate in sporting competitions in the state field, an essential requisite is for the athlete to undergo a medical aptitude examination" under specific conditions. It also indicates that *"the conditions for undertaking medical aptitude examinations, as well as the sports modalities and competitions in which they may be necessary, shall be established in the provisions developed in this Act".* Note, that these conditions have not materialised to date. Aside from the other considerations regarding the protection of the health of athletes and about the prevention and fight against doping in athletes. Without specifying which medical specialist should carry out these tasks. Common sense rules that, at least prevention, should be the exclusive competency of the SM, with reference guides about the prevention of doping currently existing, drafted by experts in the speciality[15].

In the latest update of this Act, published in May 2015, the competency or the training of the doctors with the capacity to perform these aptitude examinations have not yet been specified. Nor have they been specified by the Autonomous Communities, apart from the attempt of the Catalan Act of the Exercise of Sporting Professionals[16], which established the compulsory nature of examinations for sporting aptitude.

By means of an example, similar legislation, such as the recently published *Sports Act of Andalusia*[17], does not specify which medical specialist should carry out the health examinations of athletes; whereas it does develop other professions that intervene in sporting practice, such as: *"Teacher or physical education teacher, director or sports director, trainer or sports trainer, and instructor or sports instructor"*[17].

The availability of a specific legislation in this field of activity is an opportunity that other specialities in the so-called "school system" have not had. For example, that of Hydrology, also "disappeared" in the offer of positions in the latest callings for specialised healthcare training[2,3]. Legal and Forensic Medicine[2,3] has also ceased to be offered, a speciality that could well follow other directions as its work positions depend on the Ministry of Justice. However, it does not appear to have influenced the speciality of SM as this depended on other Administrations other than that of healthcare. A situation that has occurred in at least some Autonomous Communities.

Correlation of the title of specialist with the corresponding working category in the public sphere

Another difference between both specialities is the existence or not of an unequivocal associated working category, an issue that, evidently, favours the employability of any medical specialist in the public healthcare sector. This peculiar fact of specialities without associated work positions also occurs with the majority of those in nursing[18], apart from in midwifery and occupational nursing.

There are currently doctors with a speciality of OM occupying work positions both in primary (healthcare districts) and specialised healthcare spheres (basically hospitals) in all Spanish Autonomous Communities. However, SM specialists are limited to occasional initiatives in Sports Medicine Units. This is the case of the "Sant Joan de Reus" University Hospital in Tarragona. There are also positions in those known as "High-Performance Centres" (HPC), such as those in Granada and Seville in Andalusia, or that of "Sant Cugat Del Vallés" in Catalonia, and those of the Sports Medicine Centres in Autonomous Communities such as those of the Government of Aragon, or that of the Junta of Andalusia (SMC), where despite doctors working there with a speciality in SM, it is not the officially required speciality. Furthermore, they appear as *"Sports Medicine Consultants",* being able to work in those medical positions without a speciality or with other specialities, with a long time having passed since vacancies were offered in the cited SMC.

Other options for carrying out the speciality are the so-called "Sports Technification Centres", such as that of "Illes Balears" in Palma de Mallorca, as well as the Sports Medicine Centre of the Higher Board of Sports in Madrid.

However, and differently to the speciality of OM, today there are no work positions associated with the speciality of SM in any of the Autonomous Communities, with a structural situation for the OM compared to the circumstantial situation of SM in which there are positions for the working category in the public healthcare sphere. The existence or not of Public Employment Offers (PEO) for the corresponding category in each of them is the proof of this. As far as is known, a PEO is an ideal way to consolidate a job position as statutory personnel, aside from the open-ended nature of some of the vacancies, such as "labour" ones (such as in the SMC, for example). Comparing the two specialities, whilst there have been PEOs for the speciality of OM, with new imminent positions, it is difficult to find any offers in the OSG or in the Official Gazette of the Autonomous Communities of the State with a speciality in SM.

Another labour opportunity is teaching in degree and post-graduate university studies for healthcare qualifications (medicine, nursing, physiotherapy, occupational therapy, podiatry, nutrition), and non-healthcare qualifications (Physical Activity Sciences and Sport). However, these options are usually part time and in optional subjects, apart from exceptions of professionals with acknowledged prestige in SM. For example, at the University of Oviedo, through the Regional Unit of Sports Medicine of the Principality of Asturias, and in private universities such as the "San Antonio Catholic University" in Murcia, and the "European University" in Madrid.

Correlation of the title of specialist with the corresponding labour category in the private sphere and opportunities in the sector

The lack of this correlation with the speciality of SM has left a labour gap which is being taken advantage of by other medical specialities, such as Rehabilitation, Traumatology, Cardiology, Family Medicine and even OM.

Whilst it is clear for the OM who should work as a specialist in their own Prevention Service or as a Prevention Service employee within the private sector, it is not so clear in terms of SM. For example, with regards to sports centres that have arrangements with sports federations, sports clubs, city councils, associations or other bodies where physical activities and/or sports are carried out. Even in the field of professional athletes, where, despite also being workers, it should be made clear that the entire team of healthcare professionals should be led and/or coordinated by the specialist in SM. The sphere of professional athletes is a crossroads between both specialities, and an example that, despite that stipulated by the Law, medical examinations are sometimes carried out by other specialists. This converging setting generates reciprocal working opportunities. In this respect, and by means of an example, the RD 843/2011[13] offers the opportunity for those in SM to work in Prevention Services, with the literal mention that: *"Other specialist doctors or nurses in possession of the official title will be able to participate in the healthcare* *service, depending on the capacities associated to their speciality or subject”,* under the responsibility and management of a doctor specialising in OM. The Mutual Funds for Accidents in the Workplace that collaborate with the Social Security also constitute an employment niche for SM, as they are the most asked for after traumatology, rehabilitation and family medicine specialists.

Other employment opportunities in the private sector are Emergency services and units, both general and specialised, including the provision of first aid in the diverse modalities and sporting events with mass participation (the case of popular races such as half marathons and marathons, which have increased exponentially in recent years). Specialised units and centres also offer employment to SM in multi-disciplinary teams, which is the case of the Donostia Hospital Sports Medicine Unit, or the Sports Medicine and Traumatology Services available in various clinics in the other major cities, as well as the Medical Services of healthcare companies and of professional and amateur sports clubs.

The survey about the professional situation of SM specialists[19,] performed by the Spanish Sports Medicine Society (SEMED)[19], indicates that the majority of its associates work in the private sector, mainly in consultations or their own medical centres, and in specialised centres or diverse consultancies. Many of them interact with diverse professionals: specialised doctors, physiotherapists, nurses, podiatrists, nutritionists, licensed individuals or graduates in Physical Activity and Sports Sciences (PASS) or others[19].

Trespassing in the sector

The ideal situation in any working setting is to work as a team, having previously clarified the roles. A consequence of the lack of clarity about which these are and to whom certain professional competencies correspond is trespassing. It is something that may be occurring, for example, with laboratory exertion tests, when they are carried out by non-medical professionals. A situation to which SEMED has demonstrated its clear opposition[20]. Regarding this, all Medical Societies affected should clarify the role of each professional in the areas of competency that come into conflict with the SM, differentiating performance tests from exertion tests. This trespassing does not occur when legislation backs up the speciality, which is the case of the speciality of OM, where it is unusual to find a situation of non-healthcare professionals carrying out tests that correspond to the speciality: spirometry, vision control, audiometry or the electrocardiogram, tests that are performed by Occupational Medicine specialists.

Emission of aptitude in medical examinations

A key issue for both specialities is to establish to whom the act of issuing the aptitude corresponds for the work or physical activity and sport, respectively. Firstly, because it is a medical act, with the responsibility that this implies. Secondly, because it constitutes one of the essential tasks that define both specialities. Issuing aptitude for sporting or labour practice is, for both specialities, the same as issuing it to an ophthalmology specialist to operate on a cataract. Would anyone question the latter? Let us, then, reflect on *“who”* is today issuing aptitude for federated athletes: general doctors and/or family doctors, or other doctors from any other speciality. We should also reflect upon *“how”* (complacently by some colleagues) and even upon *“where”* these examinations are taking place. Regulation on the registration and records of healthcare centres is clear about this issue[21].

If we differentiate between healthcare and preventive activity, at least the latter should be the exclusive competency of SM specialists, referred to medical examinations for sporting and pre-sporting competitive practice. The issuing of aptitude is the end result of these examinations, a reason why it should be the exclusive competency of SM, just as with health examinations with OM[22].

Table 1 summarises the main differences between both specialities.

Table 1. Summary of the main difference between both specialities.

	SM	OM
Training programme	1996 supplement	Order SCO/1526/2005, 5th May
Specific legislation	Sport Act	ORP Act
Regulation that develops it	No	Yes, the RPS and the RD 843/2011
Mentions the enforceability of the speciality to exercise	No	Yes
Associated working category	No	Yes
PEOs for the category	No	Yes
Specific public work positions in all the AC	No	Yes

ORP: Occupational Risk Prevention; RPS: Regulation of the Prevention Services. RD: Royal Decree; CA: Autonomous Communities; PEO: Public Employment Offer.

Future of the speciality: challenges and opportunities

The future poses challenges to the speciality of SM. The main one is the development, in the form of Regulation, of the Sport Act[14], a Regulation that, just as with OM[12], could pin point the need and its role with regards to medical examinations, at least for federated athletes. As a result, SM must face the returning challenge of Appendix I of the relationship of medical specialities in Health Sciences through the residency system[8], as the potential specific work positions for specialists will not be of any use unless there are qualified professionals that can cover this demand.

Another challenge that the speciality faces is the certification of the specialist qualification for the free transit between the countries of the European Community, a challenge that is also faced by nursing specialities[18]. In this respect, a study is required that specifies in which countries, such as Italy, there is an official speciality and the procedure to certify these qualifications, due to the uncertainty that arises from the lack of positions in the latest callings for specialised healthcare training.

On the other hand, the speciality of SM has a promising immediate future for those that have detected the needs arising from contemporary physical inactivity. The regulation[17] mentions *"physical education and sport as an overriding principle of social and economic policy"*, with a potential impact on the economy and on employability. Both specialities have great possibilities on the common ground that is prevention and the promotions of health, in both labour and sporting spheres, and among the general population. The current problem faced by the Spanish population regarding obesity and excess weight is well-known. The same Public Health Act[7] dedicates an entire chapter - II - to the promotion of health, and III to the prevention of health problems and their causes. As an example, the person that wrote this article is in charge of the consultancy for hospital personnel to quit smoking, being aware of the importance of the appropriate prescription of physical exercise on the prevention of weight-gain, a consequence of quitting smoking, as well as on overcoming active smoking. As well as the implementation and development of Programmes to Promote Health in the Workplace (PHWP)[23], in which a specific prescription of physical exercise is necessary. PHWP is increasingly required in corporate settings[24].

To cover this demand, specialised training is required. In this respect, a course of Master university studies could be offered in this subject. It should be recalled that in terms of enforceability, under no circumstances should the title of these Masters be confused with that of the corresponding medical speciality[6].

Finally, following the simile of the two rivers that emerge from the same source, that temporarily converged in the same channel in their past in the School system, and that have evolved divergently, SM and OM both face the challenge of converging once again in the future via a common core in the system of specialised medical training. The future offers open doors to those that have been able to spot opportunities in the promotion of health among the general public, the working and sporting demographics in diverse disciplines and related pathways, whether in the competitive sphere, in the leisure-recreational setting, or in the generation of health benefits, with possibilities in the preventive field (as "Health Monitoring for athletes") and in the healthcare setting (in the Working Mutual Funds or other centres). Facts that will depend on the work carried out by the respective National Committees of Specialities, by the corresponding Medical Societies, and in how the need to specialists in Physical Education and Sports Medicine to be kept in the labour market is explained to society.

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Review

Approach to syncope related to the sport

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Summary

The safety of physical activity in athletes who have presented a syncope is not well established. It differs in some aspects from the management of syncope in the general population. Although syncope in athletes is generally benign, inadequate assessment can have dire consequences. Syncope may be the prelude to episodes of sudden death. It is a frequent phenomenon in the general population, it is estimated that up to 50% of the population may present a syncopal episode throughout life, as well as relatively infrequent in the sports population. It is estimated that around 6% of athletes may experience syncope at 5 years of follow-up. An adequate differential diagnosis is essential. The etiology of these episodes can be very diverse, although in most cases, we are faced with benign cause syncopes that appear right after exercise. However, it is necessary to be systematic and rational when considering other diagnostic studies that allow us to rule out malignant cardiological pathologies such as cardiomyopathies, channelopathies, etc. Likewise, many doubts arise among professionals when it comes to establishing the best recommendations in relation to continuing physical activity at the professional level. It is really important to establish an algorithm of decisions about proper management of them. Particular caution should be taken when suspending physical activity in athletes who present syncopal episodes of benign etiology or treatable causes. Current research focuses mainly on the safety of sports activity in athletes with syncopal episodes and the fear that the persistence of the practice of physical activity at a competitive level can significantly increase the risk of adverse events, especially arrhythmic events and sudden death. In this review, we will analyze numerous studies and guidelines of clinical practice, in order to establish the recommendations for an adequate assessment of syncope of the athlete, as well as the restriction of sports activity in pathologies that can be potentially lethal.

Key words:
Syncope. Exercise. Athlete. Sporting activity. Competition.

Abordaje del síncope relacionado con el deporte

Resumen

La seguridad de la actividad física en deportistas que han presentado un cuadro sincopal no está claramente establecida y difiere en algunos aspectos del manejo del síncope en la población general. Aunque el síncope en deportistas es un cuadro por lo general benigno, un evaluación inadecuada puede tener consecuencias nefastas, ya que el síncope puede ser la antesala de episodios de muerte súbita. El síncope es un fenómeno frecuente en la población general, se estima que hasta un 50% de la población puede presentar un episodio sincopal a lo largo de la vida, así como relativamente poco frecuente en la población deportista. Se estima que en torno a un 6% de los atletas pueden experimentar un síncope a los 5 años de seguimiento. Es fundamental la realización de un adecuado diagnóstico diferencial. La etiología de estos episodios puede ser muy diversa; aunque en la mayoría de los casos, nos encontramos ante síncopes de causa benigna que aparecen justo después del ejercicio. Sin embargo, es necesario ser sistemáticos y racionales a la hora de plantear otros estudios diagnósticos que nos permita descartar con seguridad aquellas patologías cardiológicas malignas (miocardiopatías, canalopatías, etc.) Asimismo, surgen numerosas dudas entre los profesionales a la hora de establecer las mejores recomendaciones en relación a continuar la actividad física a nivel profesional y en el algoritmo de decisiones para establecer el manejo adecuado de los mismos. Se debe tener especial precaución a la hora de suspender la actividad física en deportistas que presentan cuadros sincopales de etiología benigna o de causas tratables. Las investigaciones actuales se centran principalmente en la seguridad de la actividad deportiva en deportistas con episodios sincopales, y el temor a que la persistencia de la práctica de actividad física a nivel competitivo pueda aumentar de forma significativa el riesgo de eventos adversos, especialmente de eventos arrítmicos y muerte súbita. En esta revisión, analizaremos numerosos estudios y guías de práctica clínica, con el fin de establecer las recomendaciones a la hora de realizar una adecuada valoración en el síncope del deportista, así como la restricción de la actividad deportiva en patologías que pueden resultar potencialmente letales.

Palabras clave:
Síncope. Ejercicio físico. Deportista. Actividad deportiva. Competición.

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Introduction

Syncope is a common phenomenon in all age groups, however, its assessment in competition-level athletes is little known to date.

These episodes predominantly occur after having performed intense exertions and are generally benign. However, syncope during exertion may be a symptom of structural heart disease or channelopathies that may trigger sudden death. To focus the diagnosis, it is key to carry out a detailed anamnesis, a thorough physical exploration as well as, occasionally, multiple diagnostic techniques (electrocardiographic monitoring, image techniques, etc.).

Despite the majority of syncopes in athletes being reflective and considered benign, such as, for example, neurologically mediated syncopes, if this occurs when the athlete is performing a high-risk sport (diving, motorcycling, etc.), it could potentially be lethal. It is estimated that in around 50% of cases, no definitive ethology is found for the syncope[1].

Recommendations for treatment and a potential restriction of physical activity constitute an important challenge for the clinic. We should consider that the long-term suspension of sporting activities may cause serious emotional and psychological problems in the athlete.

For these reasons, today it is considered essential to carry out a complete study of syncope in athletes so as to avoid unfavourable outcomes and to avoid undue sporting restrictions in healthy individual athletes. By means of this review, the assessment and handling of syncope in competition-level athletes will be discussed.

Definition

Syncope is defined as the transitory loss of conscience due to global cerebral hypoperfusion, with posterior spontaneous and complete recovery. In contrast, pre-syncope is defined as the presence of torpor or weakness without arriving at a loss of consciousness[2].

The differential diagnosis of the syncope is wide, though the majority present a benign aetiology. Only a small percentage is attributable to the presence of underlying structural heart disease[3].

Demographic

This clinical framework presents a prevalence of around 40% in the general population[4]. Athletes represent an exceptional population in the context of handling syncope, given the great controversy in the need to carry out screening tests in athletes, in both the elite and in those that carry out recreational physical activity.

Cases of syncope are more frequently due to vasovagal or orthostatic aetiology (at around 30%) with the presence of cardiogenic causes in around 9.5% of cases. A broad study describes that in 37% of cases, a definitive cause of the syncopal framework is not described[5].

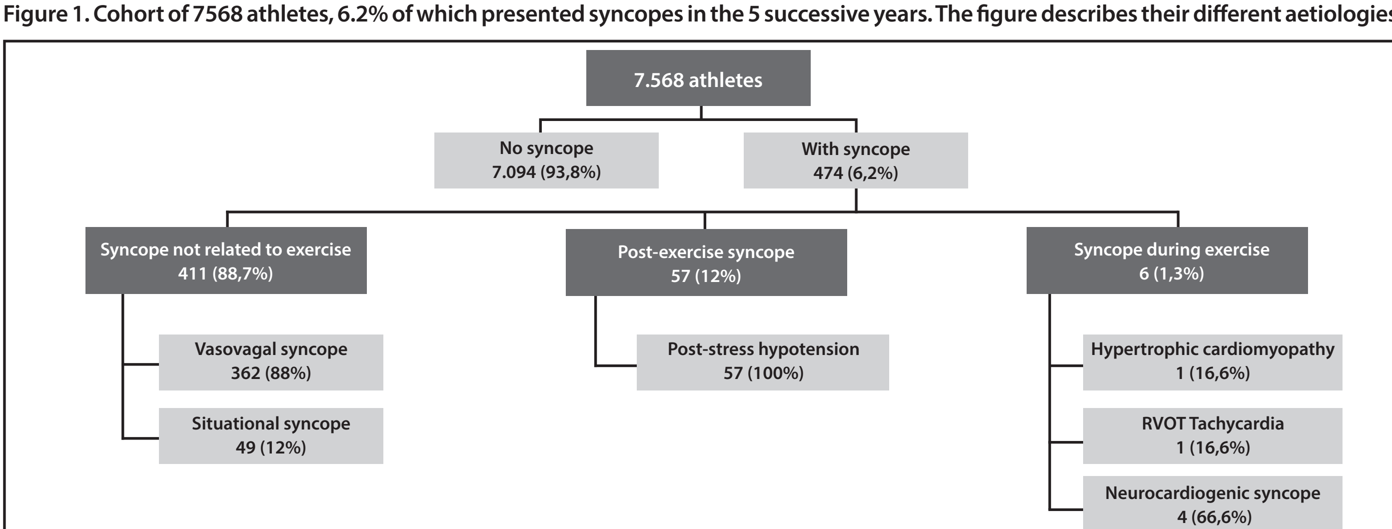
It is estimated in different publications that around 5-6% of athletes may experience a syncope in 5 years of follow-up[6]. In a cohort of 7,568 athletes[7], 474 (6.2%) of athletes presented syncopes in the 5 successive years. Of these, the vast majority of the cases were not related to exercise, 12% were post-exercise, and just 1.3% of cases were triggered during the exertion, with these latter being diagnosed as hypertrophic cardiomyopathy, right ventricle outflow tract tachycardia and neurologically mediated syncope (Figure 1). As such, the majority of the syncopes were neurologically mediated, also called reflex or vasovagal syncopes.

The syncope is currently much less frequent in athletes than in the general population[8]. Furthermore, according to diverse publications, the majority of syncopal episodes are not related to exercise[9].

Classification

We should take into account that in the study of syncope in athletes, we may find different situations, trying to clearly limit the time

Figure 1. Cohort of 7568 athletes, 6.2% of which presented syncopes in the 5 successive years. The figure describes their different aetiologies.



relationship with this clinical picture. In many cases, the syncope is clearly related to exercise (during or just after it), and on certain occasions it may be an individual that regularly practises sport, and that has presented a syncopal episode with no relationship at all to physical activity. In these cases, the characteristics of the clinical picture must also be thoroughly researched via a detailed anamnesis.

We can therefore classify athletes with syncope into two main groups depending on chronology of it:

Syncope related to exercise

On numerous occasions they may have a vasovagal or situational aetiology, etc. Dehydration and the reduction of the intravascular volume can induce a state of orthostatic hypotension and induce a pre-syncopal episode[10].

However, exercise-related syncopes are more worrying, and have been classically related to cardiovascular diseases[11]. For this reason, the athletes that lose consciousness during exercise require an exhaustive study to rule out underlying heart disease. Furthermore, we should assess whether the athlete should restrict his/her physical exercise until potentially malignant pathologies have been ruled out. In certain occasions, some carefully supervised training can be continued (monitored using a Holter, training vests, etc.), especially if we have immediate access to an automatic external defibrillator.

These kinds of syncopes may be the only symptom to precede sudden cardiac death[12]. The differential diagnosis should include numerous cardiological causes, such as: hypertrophic cardiomyopathy (HCM), congenital coronary abnormalities, right ventricle arrhythmogenic dysplasia (RVAD), channelopathies such as long QT syndrome (LQTS), or Brugada syndrome[13], myocarditis, *conmotio cordis,* etc. We should also take into account heat stroke or hydro-electrolytic alterations as aetiology of the exercise-related syncope.

Post-exercise syncope

We should distinguish this from the collapse framework associated with exercise, in which the athlete falls to the ground with no real loss of consciousness or cerebral hypoperfusion. In these cases, preferably non-cardiogenic causes should be ruled out, such as dehydration, hyponatremia, heat stroke, etc. When the syncope occurs immediately after exercise and is triggered whilst the athlete is standing, generally it is less worrying and usually has a benign aetiology.

Collapse associated with exercise can also be a symptom of exhaustion or may more commonly be a neuromediated syncope that has occurred after stopping quickly after exercise. Exercise leads to an increase in the heart rate (suppression of the para-sympathetic system and increase of sympathetic activity), an increase of contractibility and systolic volume, as well as the balance between sympathetic vasoconstriction in the inactive vascular beds and the increase of muscular-skeletal vasodilation of metabolic origin.

These physiological responses result in a marked increase of cardiac output, which is re-distributed to the active muscles. During exercise, the maintenance of the cardiac output increase will be pre-load-dependent and requires the peripheral muscle activity to return the venous blood to the heart. When exercise is stopped quickly, the pump stops working and the venous blood return to the heart is reduced, with the consequent decrease of end diastolic volume of the left ventricle, systolic volume, and therefore the cardiac output[14].

As such, neuromediated syncope is also frequent in these situations, though its mechanism is still little known today. One of these mechanisms described is the cardiac depressor reflex, also known as the Bezold-Jarisch reflex[15]. During the acute reduction of the pre-load and filling of the heart with the sustained elevation of the catecholamines, the increase of the myocardial contractility can lead to the activation of chemoreceptors and mechanoreceptors, and induce paradoxical bradycardia and hypotension.

In a study published several years ago regarding ultra-marathon races[16], it was estimated that 85% of athletes collapsed after the competition. Only a third of these runners had a medical condition behind this collapse (predominantly hydroelectrolytic disorders, heat stroke, etc.), whilst the rest quickly regained stability after being placed in the Trendelemburg position. On the other hand, all the runners that collapsed during the race had an unidentified medical condition.

Differential diagnosis

The differential diagnosis of syncope in athletes is vast, though currently we can divide them into two main categories: neurocardiogenic or cardiological syncope. Less frequent causes of syncope include eating disorders, substance abuse, chronic fatigue syndrome, psychiatric, neurological and metabolic disorders.

Neurocardiogenic syncope

This kind of syndrome consists in neurologically mediated events due to our body's sudden incapacity to maintain the blood pressure at the levels needed to maintain the brain flow. This term of neurocardiogenic syncope has been widely discussed by experts, including numerous aetiologies such as vasodepressor syncope, orthostatic syncope, cardioinhibitor syndrome, situational syndrome and carotid sinus syndrome[17]. Situational syncopes include episodes associated with urination, defecation, coughing, etc.

Although the exact mechanism of these clinical pictures is unknown, literature suggests that syncopal episodes are due to the fact that the organism is incapable of increasing the systematic vascular resistances efficiently in response to the significant reduction of the venous return.

Cardiogenic profile syncope

It is important to rule these kinds of pathologies out, given that to a large extend they determine whether the syncopal picture could be an important risk marker of sudden death. In turn we could divide this kind of syncope into two subgroups, depending on if they are arrhythmic episodes or circulation disorders, or structural heart disease episodes.

Arrhythmic episodes or circulation disorders

Multiple arrhythmogenic pathologies are described that can cause syncopal events, and, in turn, that are potentially lethal: Brugada syndrome, long QT syndrome, Wolf Parkinson White[18], polymorphic ventricular tachycardia, idiopathic ventricular tachycardia, etc. As such, especially in athletes over 35 years, we must consider that ischemic heart disease may be a common cause of sudden death in athletes, also presenting a high arrhythmogenic load whilst physical exercise is being carried out. Likewise, we should take into account that we will frequently find athletes with different degrees of atrioventricular block (AV block), with the majority of them considered within the physiological alterations in the context of the heart of an athlete. Given the increase of vagal tone that they present, we frequently encounter findings such as sinus bradycardia, migratory pacemakers, 1st degree AV block, type I Mobitz 2nd degree AV block, pacing of the union, etc. As such, asymptomatic patients present pauses of less than 4 seconds, not requiring additional studies. However, we should rule out advanced circulatory disorders, such as significant pauses (greater than 4 seconds), type II 2nd Mobitz degree AV block or complete AV block, which could lead to a picture of dizziness or syncopal episodes.

Structural heart disease

The cardiogenic profile syncope can be related to those athletes that have structural cardiological pathologies, especially cardiomyopathies, coronary abnormalities and atherosclerosis. With suspected cardiological aetiology syncope, we should use image techniques to rule out the presence of myocardial disease, such as hypertrophic cardiomyopathy (most frequent cause of sudden death in the under 35s), right ventricle arrhythmogenic dysplasia, dilated cardiomyopathy, non-compacted cardiomyopathy, etc. In the event of this kind of pathology, a genetic study and family advice is recommended[19]. We should also rule out both coronary atherosclerosis and congenital coronary abnormalities. Other causes of structural heart disease, that may on rare occasions cause syncopal episodes or sudden death in athletes are: myocarditis, valvular heart disease, Marfan syndrome, etc.

The assessment of an athlete with syncope

Clinical history and anamnesis

In the assessment of an athlete that has revealed a syncopal picture, it is considered fundamental to carry out a clinical history and complete anamnesis, as they can identify the aetiology of the syncope. It is fundamental to distinguish if the syncope is related to exercise or immediately after performing exercise. It is also important to rule out the presence of relevant family antecedents. In the event that there is a significant family history of unexplained deaths or known genetic mutations, thorough research should be performed regarding the possible presence in family members of hypertrophic or dilated cardiomyopathy, long QT syndrome, right ventricle arrhythmogenic dysplasia, etc. On occasions it could be helpful for the athlete to provide a complete genealogy tree during the assessment to obtain a detailed and complete family history. Research should also establish if these athletes have consumed alcohol, pharmaceutical drugs, certain illegal drugs or substances that improve their physical performance and interfere in syncopal pictures.

It is important to assess the state of hydration and nutrition at the time of the event, environmental conditions, the activity of the patient immediately before the syncopal episode, the presence of auras or warning signs, etc. It should also be researched if the patient has presented prior symptomatology on any occasions: dizziness, nausea, pre-syncopal episodes, chest pain, palpitations or dyspnoea. As such, it is recommended to investigate the presence of cardiovascular risk factors that may suggest the existence of ischemic heart disease as a main diagnosis: smoking, arterial hypertension, dyslipidemia, *mellitus* diabetes, etc. We should take into account that athletes, occasionally, may mask or minimise symptoms so they are not excluded from carrying out professional physical activity.

On numerous occasions, athletes are not able to remember the events that occurred during the syncopal episodes, which is why it is very useful to question witnesses that saw the episode. If cardiopulmonary resuscitation has been carried out and an automatic defibrillator used, efforts should be made to obtain the records. It is recommendable to insist on the time frame of the clinical picture, reinforcing the clinical picture of the patient before, during and immediately after the syncopal episode. For example, certain pre-syncopal events may guide us to a differential diagnosis: a febrile condition in the days prior to the episode enables us to rule out the presence of Brugada syndrome, myocarditis, etc. The presence of a stress stimulus (including loud noises or getting into cold water) that precedes the syncope may suggest the diagnosis of a catecholaminergic tachycardia, long QT syndrome[20], etc.; whilst chest trauma could indicate a commotio cordis. Myoclonic tremors or the relaxing of sphincters could suggest certain convulsive activity, though patients with neuromediated syncopes often develop certain myoclonic movements that are confused with convulsive activity.

Physical exploration

It is essential to carry out a suitable physical exploration in the study of the syncope: neurological examination, cardiopulmonary auscultation (special manoeuvres can be carried out with the aim of ruling out specific pathologies, such as in the case of HCM or mitral valve prolapse), the presence of peripheral pulses (Table 1). This will help us to rule out predominantly different types of valvular heart diseases or aorta diseases[21].

The physical examination should also include an assessment of the vital signs, which predominantly includes heart rate and blood pressure.

Table 1. Suggestive findings in physical exploration with associated suspected diagnostics.

Findings in the physical examination	Suspected diagnosis
Episode triggered immediately after standing up	Orthostatic hypotension or orthostatic postural tachycardia
Heart murmur	Significant heart valve diseases
Dynamic abnormal heart exploration	Structural heart disease
Weak pulse in lower extremities Difference in pressure between upper and lower limbs	Coarctation of the aorta
Pulse in slow ascent	Aortic stenosis
Bisferious pulse Increase in the intensity of the murmur following the Valsalva manoeuvre	Hypertrophic cardiomyopathy
Chest deformity Joint hypermobility Kyphoscoliosis Palate with pronounced arch	Marfan Syndrome
Wheezing	Asthma, anaphylaxis

These measurements should be performed after 3-5 minutes of rest, both standing and in the supine position. Likewise, we should measure the blood pressure both in the upper extremities as well as the lower limbs so as to rule out coarctation of the aorta. It is important to carry out an appropriate inspection of the athlete, as well as, for example, phenotypical characteristics that could suggest the existence of Marfan syndrome: *pectus excavatum,* scoliosis, joint hyper-flexibility, etc.[22].

Resting electrocardiogram

It is key to perform a 12-lead electrocardiogram (ECG) on athletes that have presented a syncopal condition[23]. The majority of disorders associated with a greater risk of sudden cardiac death, such as cardiomyopathies and channelopathies, present abnormal findings in a basal electrocardiogram.

However, the interpretation of the ECG in athletes requires a careful analysis to properly distinguish the physical changes related to athletic training with suggestive findings of an underlying pathological condition.

The prevalence and significance of electrocardiographic alterations in the heart of athletes have been the motivation behind numerous studies and discussions. There are currently criteria that help discern whether or not these changes are related to physiological adaptations or are suggestive of structural heart disease. Some of these criteria often fall into a grey area, in which discerning the pathological from the normal can be complicated, which is why on occasions a strict follow-up is required as well as a certain degree of "un-training" so as to perform a suitable assessment. Both the Seattle criteria and current guidelines from the European Cardiology Society in the interpretation of electrocardiographic alterations of athletes classify these findings as those that are common among athletes and related to the adaptation to exercise, and findings that do not appear to be related to training and that require a more thorough study to exclude underlying heart pathologies. Recently, refined criteria have been developed, which integrate and improve both previous classifications; presenting even greater sensitivity and specificity; with a significantly lower rate of false positives[24].

We frequently encounter physiological adaptations in athletes that align with the vagal hypertonia that athletes usually present: sinus bradycardia, 1st degree AV block, Mobitz I 2nd degree AV block. However, these findings alone do not justify the presence of the syncopal condition, which is why other causes must be ruled out[25].

As we have previously commented, in the electrocardiographic assessment, we are going to encounter findings within normality or those that suggest physiological alterations. However, these findings should not give the doctor a false sense of security, as multiple potentially lethal pathologies (atherosclerosis, coronary abnormalities, non-compacted cardiomyopathy, etc.) can be clinically silent in the resting ECG. Likewise, the ECG in athletes may orientate us towards a diagnosis upon revealing data compatible with Wolff-Parkinson White Syndrome (WPW), supraventricular arrhythmias (atrial fibrillation, etc.), myocardiac ischemia, or channelopathies such as the Brugada syndrome or long QT syndrome.

Despite the sensitivity being very variable, various studies suggest that approximately half of cardiovascular diseases can be detected in asymptomatic athletes following an ECG.

Laboratory

Laboratory trials can prove highly useful, especially if there is a certain previous focus on the possible aetiology of the syncopal condition. It is convenient to carry out a haemogram if there is suspected anaemia, frequently in older patients with suspected active bleeding, or women during menstruation.

If the syncope has been triggered in a possible context of arrhythmia or extreme dehydration, the electrolyte levels or those of other metabolic alterations should be assessed, especially alterations of sodium, potassium and other ionic disorders. Myocardial damage markers should be required (creatine kinase, troponine, etc.) when faced with a suspected condition of acute myocarditis, acute coronary syndrome, etc. As such, it is important to consider that on multiple occasions we can encounter normal laboratory findings in the study of syncope, which is why it should merely be considered a tool to complement the diagnosis, and not useful in excluding primary cardiac disorders.

Transthoracic echocardiogram

Today, the echocardiogram is a fundamental test that largely helps us to establish the definitive diagnosis or to rule out the presence of structural heart disease.

This result is highly useful in confirming the findings suggested in the electrocardiogram, as well as in studying the dimensions of the heart cavities and the parietal thickness, ventricular function, dilation of aortic root, etc.[26]. Furthermore, it is currently considered to be the gold standard in establishing the diagnosis of different cardiomyopathies (hypertrophic cardiomyopathy, dilated cardiomyopathy, etc.) or significant heart valve diseases.

As such, if the syncopal condition is highly suggestive of neurological or vasovagal aetiology and the electrocardiogram is completely normal, performing an echocardiogram may not be strictly necessary.

Advanced imaging techniques (Cardiac magnetic resonance/Computerised tomography)

Advanced imaging techniques help us to study different types of structural heart disease more precisely. These non-invasive tests can be highly useful when defining the myocardium and coronary anatomy, especially if they cannot be correctly assessed in the echocardiogram.

A cardiac CT should be performed when faced with a suspected presence of congenital coronary abnormalities or the presence of ischemic heart disease with a low pre-test probability[27]. We should consider that this study exposes the athlete to high levels of radiation, which is why it is recommended to exercise precaution during follow-up.

Magnetic resonance is currently the gold standard in performing a definitive diagnosis of right ventricle arrhythmogenic dysplasia[28]. Via this technique, the myocardium and right cavities can be studied with better image resolution. As such, the different late enhancement models with gadolinium and the oedema sequences may help to establish the presence of myocardial fibrosis, myocarditis, non-compacted cardiomyopathy, etc.

Exertion test

The cardiac stress test may be a very useful tool in handling the syncope, with the carrying out of an echocardiogram prior to use with the aim of ruling out structural heart disease also being recommendable. It is important to carry out an exertion test in athletes that present recurring syncopes during exercise; given that monitoring during the exertion will help us to discern between different aetiologies, such as arrhythmic episodes, reflex syncopes, etc.

The habitual protocols used in clinical practice (Bruce, Naughton, etc.) are short-duration exercise protocols of low-intermediate intensity, for which on occasions they may not provoke the symptoms in the athlete. Currently, the performance of an exertion test is recommended, which simulates physical activity during which the syncopal episode occurs[29]; i.e. individualised protocols should be performed based on the sporting activity carried out or on the setting in which it develops. For example, athletes with a high aerobic component, such as long-distance runners or triathletes, should keep a constant or lightly ascending rhythm over a long period of time. Conversely; athletes with anaerobic predominance should carry out interval training with high-speed races and intermittent resting periods.

Therefore, the cardiac stress test may be highly useful, especially if we suspect arrhythmic aetiology of the syncopal event. The exertion test also helps us rule out ischemic heart disease, to assess the functional capacity of the athlete and the induction of arrhythmic events, whether during the exertion phase or the recovery phase.

Holter

The Holter test provides us with an electrocardiographic record for 24 hours, helping us rule out the presence of significant pauses as well as paroxysmal arrhythmic events.

It is recommendable to position this device when the athlete is going to perform his/her habitual sporting activity. In the event that competitive physical activity has been restricted, the performance of recreational physical activity could be recommended during the time that the electrocardiographic monitoring is being carried out[30].

However, the Holter has low sensitivity, and on most occasions we will find certain limitations when it comes to achieving significant findings during monitoring. For this reason, in cases in which there is still a high suspicion of cardiogenic syncope due to the presence of arrhythmias or circulatory alterations, it could be useful to position a more prolonged recording device or an implantable Holter. Furthermore, once the athlete returns to his/her habitual sporting activity after having ruled out underlying heart disease, it is recommended that eventual electrocardiographic monitoring continues during high intensity training sessions.

Tilt - test

The tilt test is a non-invasive study method which studies the changes that take place in the blood pressure and heart rate depending on the postural angles, predominantly during the prolonged standing position. It is mainly indicated in the study of athletes with suspected pre-syncopes, repeated syncopes of vasovagal aetiology, and in the study of other alterations to the autonomous nervous system.

In different studies, it has been demonstrated that this test has low sensitivity, and a high rate of false positives in athletes[31]; which is why it should not be used as the main tool in establishing the diagnosis of the syncope in the athlete.

Electro-physiological study

The electro-physiological study (EPS) is a useful tool, though uncommon in the study of syncope; though today it is estimated that only 2% of patients with syncopes of unknown aetiology undergo an EPS[32].

This test is highly effective when it comes to inducing supraventricular arrhythmias and ventricular tachycardias. For this reason, the EPS may be used in athletes to confirm and treat arrhythmias targeted during the diagnostic study. This test is highly useful in patients with suspected Wolff-Parkinson White Syndrome, intranodal tachycardia, etc.; in which the excision of anatomical substrate is also attempted.

With regards to ventricular tachycardias (VT), the recovery rate after excision with radio-frequency is very high in idiopathic tachycardias in the absence of structural heart disease. However, in cases of VT in patients with structural heart disease[33], such as coronary disease and established myocardial scarring, excision may not be considered curative, given that they present a very high risk of recurrence and of presenting sudden death during follow-up.

Therapeutic attitude

Managing the syncope should fundamentally focus on establishing the safety of the athlete. These athletes should be remitted following the clinical picture, to doctors with experience in the diagnosis and treatment of syncope in athletes. These athletes should suspend sporting practice until the study has been completed. There are some centres that promote an organisation model of managing the syncope, via multidisciplinary approach units, as well as the importance of risk assessment scales following a syncopal condition[34].

The objectives of this assessment are fundamentally based on excluding underlying structural heart disease that could lead to sudden death, therefore enabling the athlete to return safely to physical activity. Patients with benign syncope aetiologies (orthostatic, vasovagal, etc.) may continue with sporting activity after establishing the suitable guidelines. However, in those that are still undiagnosed after the complete study is over, strict follow-up should be performed when it comes to assessing re-incorporation into habitual physical activity[35]. Patients that present a high risk of sudden death, unchangeable with treatment or therapeutic intervention, should restrain from competitive sport and limit physical activity to merely the recreational kind.

In athletes with neurocardiogenic profile syncope, it is important to avoid triggering factors. A suitable intravascular volume should be maintained, which is why good hydration is recommended, preferably with isotonic drinks. Certain simple manoeuvres may help avoid this kind of condition; usually involving the exercising of the lower extremity muscles: isometric contractions, crossing legs, Trendelemburg position, squatting position, etc. (Figure 2). However, these manoeuvres will only be useful in the event that athletes present warning signs or symptomatology prior to the syncopal episode to have time to perform them[36].

Although certain medications can be used (alpha-agonists, disopyramide, beta-blockers, etc.) in this kind of syncope, pharmacological treatment is not clearly recommended at the current time, given that it has not given significantly favourable results[32]. As such, high-risk sports should be avoided (motorcycling, cycling, etc.) in athletes that present recurring syncopal episodes, despite the aetiology being benign.

According to the 36th Bethseda Conference[37], the suspension of sporting activity is recommended in athletes that have presented potentially malignant aetiology syncopal episodes, especially with cardiological causes. In the case of athletes with an implantable automatic defibrillator (IAD), the clinical practice guidelines and current recommendations are quite restrictive regarding physical activity. However, recent data affirms that even competitive activity may be safe in those athletes, as long as a customised assessment is carried out of the patient and of the base pathology, and an activity level is adjusted to the programming of the device[38].

Conclusion

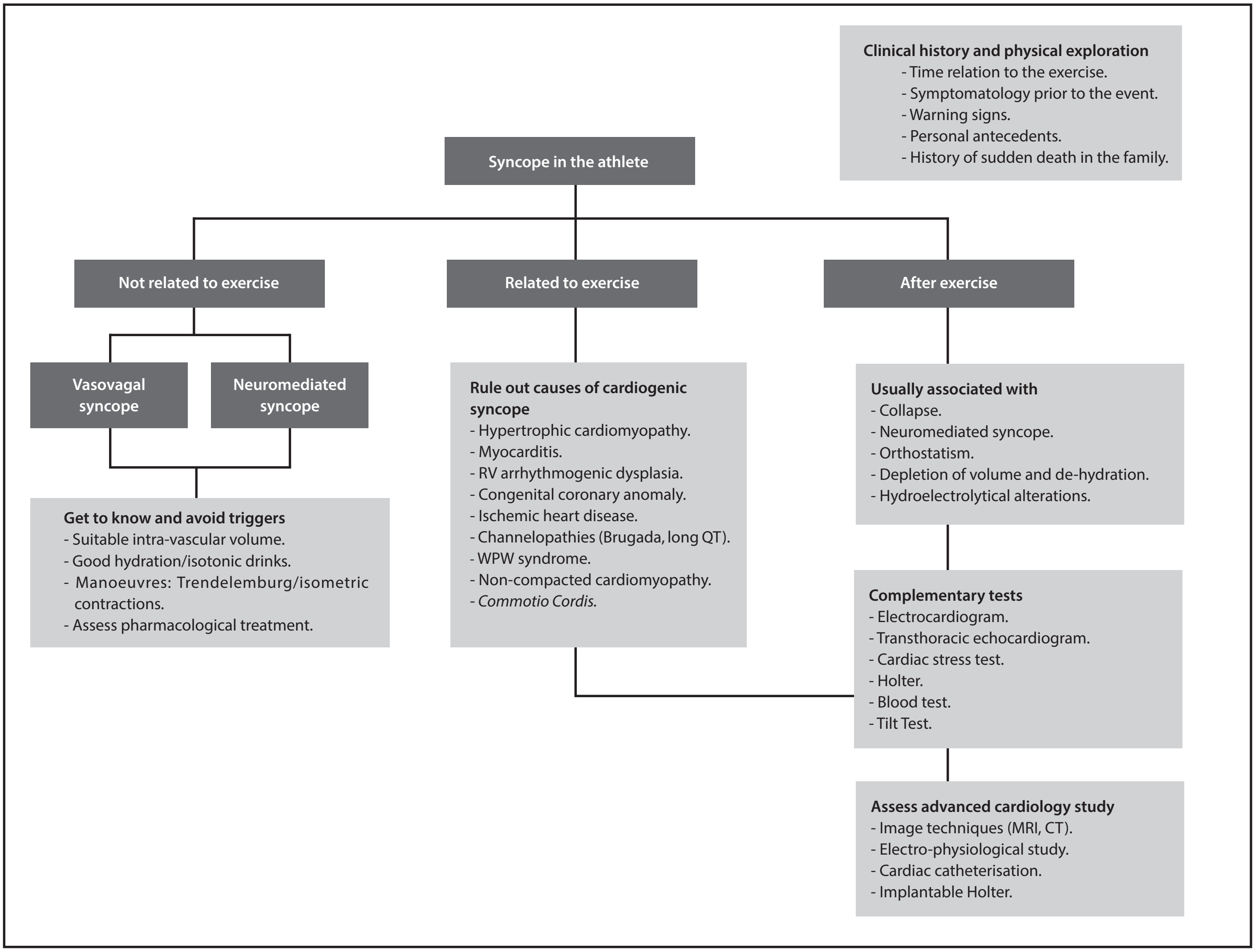
The appropriate assessment of the syncope continues to be a subject of debate, given the wide spectrum of circumstances, both benign and potentially dangerous, whose first revelation may be this symptom. The assessment of the symptomatology in the demographic of athletes also implies an added difficulty, as well as the conditions in which the syncope occurs, and the implications that ceasing sporting activity at competitive level entails. Today we frequently face the challenge of carrying out a suitable assessment in athletes that have presented syncopes. Cardiovascular adaptations through sport often overlap with initial states of heart diseases, whose cardinal symptom is the syncope, thus increasing the diagnostic difficulty. The amount of evidence currently available is wide; aside from a detailed clinical history, physical exploration and an electrocardiogram, it is not uncommon to require further tests to help establish a differential diagnosis. Carrying out these tests may follow a rational and phased sense, depending on the findings discovered during the study of the syncope. On occasions, despite having an exhaustive assessment, doubts may persist regarding the benign nature of the syncope, which is why follow-up and often ceasing physical activity may form part of the diagnosis.

Based on this, the main objective of the assessment of the athlete with syncope is to establish whether or not there is a potential risk of sudden death and to establish the safety of physical activity.

An error in the diagnosis may have devastating consequences, but on the other hand, the cost of diagnosing a benign condition as dangerous or potentially lethal can lead to the unnecessary restriction of physical activity, with negative consequences for the athlete.

To conclude, the assessment of syncope in athletes has certain characteristics that distinguish it from the general population. A careful and phased assessment can help us to not make errors in the diagnosis

Figure 2. Algorithmic assessment focus of an athlete with a syncopal picture.



and to not increase the anxiety linked to a pathology that in the large majority of cases is benign.

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ASPECTOS PSICOLÓGICOS DEL DEPORTISTA LESIONADO

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Todo aquel que se embarque en cualquiera de las múltiples variedades de actividad físico-deportiva, ya sea de ocio o de alta competición, debe aceptar que ésta comporta un cierto riesgo de lesión. Según la gravedad y circunstancias específicas que cobre la lesión, la misma puede modificar uno o varios de los aspectos fundamentales del estatus psicológico y comportamental del deportista lesionado.

El libro trata sobre tales aspectos, entre los que cabe destacar: el impacto y las consecuencias psíquicas que provoca la lesión deportiva; los mecanismos por los que el daño de los tejidos afecta a la conducta del deportista; las reacciones emocionales que provoca la lesión en el competidor; las diferentes intervenciones de afrontamiento y soporte frente a la lesión; el sobreentrenamiento como causa de lesión; las secuelas postlesionales del deportista; y los modos psicológicos de actuación que favorecen la recuperación del lesionado. Además, el autor dedica un capítulo a la descripción de la técnica de relajación profunda que ha aplicado con éxito a deportistas lesionados durante su dilatada praxis médico-deportiva.

MANUAL COMPLETO DE KRAV MAGA

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El agua constituye el 50-60% del peso corporal del adulto y llega a más del 80% del peso de órganos como los riñones, pulmones y tejido muscular. Cumple diferentes funciones en nuestro organismo: es un componente presente en todas las células y tejidos; actúa como solvente y medio de suspensión, como reactivo o como un producto de reacción en las reacciones de hidrólisis y como transportador de nutrientes y/o moléculas de desecho; permite intercambios entre células, líquido intersticial y capilares, mantiene el volumen vascular y permite la circulación de la sangre; participa en la termorregulación y sirve de base de líquidos lubricantes para las articulaciones, la saliva y las secreciones mucosas. Además, manteniendo la forma celular, actúa como amortiguador (cerebro, médula espinal y feto).

En nuestro organismo el agua se distribuye en dos compartimentos: extracelular e intracelular. El líquido extracelular se subdivide a su vez en líquido intersticial, plasma, y líquido transcelular (líquido sinovial, peritoneal, pericárdico, cerebroespinal e intraocular).

Los compartimentos intracelular y extracelular tienen la misma osmolaridad total. El intercambio de agua entre ellos es continuo y se realiza de forma pasiva, buscando igualar las diferencias en las concentraciones de aniones y cationes en los dos compartimentos. Un aumento en la osmolaridad sanguínea estimula la secreción de vasopresina, que induce la sed provocando el deseo de beber. Además, la hipófisis también segrega hormona antidiurética que provoca una mayor concentración de la orina y una menor diuresis.

El balance de agua corporal depende de la diferencia entre las ganancias y las pérdidas. Las ganancias provienen de la ingesta (consumo de líquidos y del agua contenida en alimentos sólidos) y de la producción de agua (a partir de la oxidación de hidratos de carbono, grasas y proteínas). Las pérdidas de agua se producen en el riñón, la sudoración, las pérdidas insensibles (a través de la piel y los pulmones) y por las heces.

Las pérdidas de agua por la orina son las más importantes (más del 40% del total). Una parte de ellas son obligatorias, necesarias para excretar las sustancias hidrosolubles que se eliminan por vía renal (urea, ácido úrico y minerales). Otras son pérdidas facultativas, que dependen de la carga renal de solutos y la capacidad de concentración renal.

Por otro lado, y en contraste con la pérdida hídrica insensible cutánea y pulmonar que es continua y obligatoria, la pérdida por sudoración es un mecanismo opcional que interviene en la termorregulación: a temperatura ambiente mayor de 30º C se activa la sudoración con objeto de mantener el equilibrio calórico.

El sudor es hipotónico, comparado con el plasma o el líquido extracelular, por lo que la sudoración intensa causa más pérdida de agua que de electrolitos. Esto aumenta la osmolaridad extracelular induciendo el paso de agua desde las células hacia el líquido extracelular y causando deshidratación hipertónica.

Un adulto consume de 2.000 a 2.500 ml de líquido diario, pero debemos tener en cuenta que nuestro requerimiento diario de líquidos, dependerá de nuestro metabolismo, de las condiciones ambientales y del grado de actividad física, pudiendo variar de un día a otro.

La escasez de agua corporal puede alterar la capacidad del cuerpo para mantener la homeostasis en determinadas situaciones (enfermedad, ejercicio físico o estrés térmico) afectando a las funciones y la salud. Por ello, especialmente en estas ocasiones, es necesario insistir en la hidratación. El agua mineral Font d´Or, de baja mineralización, ayuda a contribuir al mantenimiento de nuestra homeostasis mejorando el control de las funciones de nuestro organismo.

Así, aunque con frecuencia se excluye el agua de las listas de nutrientes, debemos considerarlo un componente esencial para el mantenimiento de la vida, que debe ser aportado por la dieta en cantidad suficiente.

Bibliografía

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VII JORNADAS NACIONALES DE MEDICINA DEL DEPORTE

EL EJERCICIO FÍSICO: DE LA PREVENCIÓN AL TRATAMIENTO

24-25 de noviembre de 2017

Zaragoza

Aula Luis Giménez - Pedro Asirón

ASOCIACIÓN ARAGONESA DE MEDICINA DEL DEPORTE (ARAMEDE)

SOCIEDAD ESPAÑOLA DE MEDICINA DEL DEPORTE (SEMED)

PROGRAMA PRELIMINAR

PONENCIAS

DÍA 24 DE NOVIEMBRE, VIERNES

09.00-09.30 **Recogida documentación**

09.30-11.00 **PONENCIA: Reconocimientos médicos de despistaje**
Moderador: ***José Manuel González de Suso Janariz***

El programa de reconocimientos médicos en populares
Juan Miguel Morillas Martínez

El papel del electrocardiograma de reposo

El papel de la prueba de esfuerzo
Gonzalo María Correa González

11.00-11.30 **Café/Descanso**

11.30-13.00 **PONENCIA: Componentes de las bebidas para el deporte**
Moderador: ***Juan José Lacleta Almolda***

El agua
Nieves Palacios Gil de Antuñano

El sodio
José Antonio Villegas García

Los carbohidratos
Raquel Blasco Redondo

13.00-13.45 **CONFERENCIA INAUGURAL**
Presentador
Pedro Manonelles Marqueta
José Luis Terreros Blanco

13.45-14.15 **Inauguración oficial**

16.00-17.30 **PONENCIA: El ejercicio en poblaciones específicas**
Moderador

Personas con discapacidad física
Josep Oriol Martínez Ferrer

Personas con discapacidad psíquica
Francisco Javier Ordóñez Muñoz

Personas de edad avanzada
Jovanka Manojlovic Rakocevic

17.30-18.00 **Café/Descanso**

18.00-19.30 **PONENCIA: El deporte en la mujer**
Moderador: ***Carlos Moreno Pascual***

Embarazo y puerperio
Juan Carlos De la Cruz Márquez

La triada de la mujer deportista
Mª. Josep Martí Utset

Trastornos de la conducta alimentaria
Helena Palacín Fornons

DÍA 25 DE NOVIEMBRE, SÁBADO

09.00-10.00 **Comunicaciones libres**

10.00-11.30 **PONENCIA: Prescripción y programación de ejercicio**
Moderador: ***Ángel Durántez Prados***

Evidencia científica
Zigor Montalvo Zenarruzabeitia

La prescripción de ejercicio
Carmen Porcar Rivero

La programación del ejercicio
Javier Álvarez Medina

11.30-12.00 **Café/Descanso**

12.00-13.30 **PONENCIA: La prescripción en la enfermedad**
Moderador: ***Carlos Melero Romero***

Enfermedad cardiovascular
Luis Serratosa Fernández

Enfermedades respiratorias
Franchek Drobnic Martínez

Enfermedades metabólicas
Fernando Salom Portella

13.30 **Clausura de las Jornadas**

COMUNICACIONES CIENTÍFICAS

El Comité Científico invita a todos los participantes a remitir comunicaciones científicas a las **VII Jornadas Nacionales de Medicina del Deporte**.

Los temas de las Jornadas Nacionales para presentación de Comunicaciones Científicas se describen en el siguiente listado:

- Actividad física y salud
- Programación de ejercicio para la salud
- Lesiones deportivas: diagnóstico, prevención y tratamiento
- Medicina del deporte
- Cardiología del deporte
- Nutrición y ayudas ergogénicas
- Cineantropometría
- Fisiología del esfuerzo
- Entrenamiento y mejora del rendimiento

Las Comunicaciones Orales se distribuirán en sesiones de los temas de las Jornadas Nacionales. 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 de las Jornadas.

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

Los abstracts de las comunicaciones científicas admitidas, comunicaciones orales y pósters (presentación interactiva), serán publicados en la revista Archivos de Medicina del Deporte.

Información complementaria en: **www.femede.es**

PREMIOS

Los inscritos en las VII Jornadas Nacionales de Medicina del Deporte que presenten comunicaciones **podrán optar al Premio a la Mejor Comunicación oral de las Jornadas.**

Para optar al premio **SE DEBE HACER CONSTAR EXPLÍCITAMENTE QUE SE OPTA A PREMIO** en carta dirigida al presidente del Comité Científico y adjuntar al Resumen remitido. En este caso, además de enviar el Formato del Resumen de Comunicación Científica, se debe de mandar el **trabajo completo en el plazo de presentación de las Comunicaciones Científicas.**

Los trabajos que se presentan en formato de póster (presentación interactiva) no optan a premio.

El trabajo que obtenga la segunda mejor puntuación, y supere en nivel de calidad exigible, será dotado con un accésit a la Mejor Comunicación de las Jornadas.

Dotación de los premios

Premio a la Mejor Comunicación Oral de las Jornadas:

- Dotación económica: **1.000 euros.**
- Certificado acreditativo.
- Publicación en la revista Archivos de Medicina del Deporte con indicación del premio obtenido.

Accésit a la Mejor Comunicación Oral de las Jornadas:

- Dotación económica: **500 euros.**
- Certificado acreditativo.
- Publicación en la revista Archivos de Medicina del Deporte con indicación del premio obtenido.

El premio será entregado en la clausura de las Jornadas.

Los trabajos premiados serán publicados en la revista Archivos de Medicina del Deporte (para lo que deberán ser adaptados a las normas de publicación) y se aceptará la revisión efectuada por el Comité Científico.

Los premios podrán ser declarados desiertos si no alcanzan el nivel de calidad exigible.

Información complementaria en **www.femede.es**

INFORMACIÓN GENERAL

Sede de las Jornadas

Hotel Silken Reino de Aragón
Vía Ibérica, 1
Calle Coso nº 80. 50001 Zaragoza
Teléfono: +34 976 468 200

Secretaría Técnica

Asociación Aragonesa de Medicina del Deporte
Paseo de Teruel nº 23, 3º-3ª. 50004 Zaragoza
Teléfono: 976 237 129
Correo electrónico: aramede@telefonica.net
Página web: http://www.femede.es

Agencia de viajes

Viajes El Corte Inglés S.A.
IATA 78211733. División Eventos Deportivos
Teniente Borges, nº 5. 41002 Sevilla
Teléfono: 954 506 603/04
Fax: 954 222 479
Correo electrónico: areaeventos@viajeseci.es
Horario: Lunes a viernes de 9.00-14.00 y de 16.00-19.00

Derechos de inscripción	Antes del 9-7-17	10-7-17 al 15-9-17	Desde el 16-9-17 y en sede Jornadas
Cuota general	125 euros	150 euros	200 euros
Miembros ARAMEDE/ FEMEDE	100 euros	125 euros	175 euros
Médicos MIR*	60 euros	75 euros	125 euros
Estudiantes**	30 euros	40 euros	50 euros

*Es necesaria acreditación
**Grados, Licenciaturas y Diplomaturas: Medicina, CC Actividad Física y Deporte, CC de la Salud...). Es necesaria acreditación. No se considera estudiantes los profesionales que cursen estudios, ni a graduados, licenciados y/o diplomados.

Forma de pago

Efectivo
Asociación Aragonesa de Medicina del Deporte.
Paseo de Teruel nº 23, 4º-3ª. 50004 Zaragoza (17-20 horas).

Transferencia
IBERCAJA-CAJA DE AHORROS DE LA INMACULADA:
C.C. ES78 2085 5261 6703 3007 8328
En ambos casos hay que aportar el boletín de inscripción adecuadamente cumplimentado.

2017		
38 Juegos Mundiales de la Medicina y la Salud: Simposio de Medicina del Deporte	1-8 Julio Marsella (Francia)	E-mail: info@medigames.com/ symposium@medigames.com web: http://www.medigames.com/
Congreso Mundial de Fisioterapia (WCPT)	2-4 Julio Cape Town (Rep. Sudáfrica)	web: www.wcpt.org/congress
23 European Society of Biomechanics Congress	2-5 Julio Sevilla	web: https://esbiomech.org/newsletter/esbiomech-newsletter-april-2015/save-the-date-esb-2017-seville/
22nd annual Congress of the European College of Sport Science	5-8 Julio Ruhr Bochum (Alemania)	E-mail: congress@ecss.de web: www.ecss-congress.eu/2017
Movement 2017	9-11 Julio Oxford (Reino Unido)	web: www.movementis.com
XIV Congreso Mundial de Psicología del Deporte	10-14 Julio Sevilla	web: www.issp2017.com/
International conference of sport science Asian Exercise and Sport Science Association (AESA)	20 Julio Mahmud Abada (Irán)	web. www.2017.aesasport.com/en/
13th Annual International Conference on Kinesiology and Exercise Sciences	24-27 Julio Atenas (Grecia)	web: www.atiner.gr/fitness
Paediatric Sport and Exercise Medicine	21-27 Agosto Utrech (Países Bajos)	web: www.utrechtsummerschool.nl/courses/life-sciences/paediatric-sport-and-exercise-medicine
27º Congress European Society for surgery of the shoulder and the elbow (SECEC-ESSSE)	13-16 Septiembre Berlín (Alemania)	web: www.secec2017.com
12th European Congress Fédération Internationale d'Education Physique	13-16 Septiembre Luxemburgo (Luxemburgo)	web: https://fiep2017luxembourg.uni.lu/
La dosis correcta para el tratamiento del dolor y la recuperación del atleta	15 Septiembre Bari (Italia)	web: http://www.fmsi.it/
Medical and Training Aspects in Handball	16 Septiembre Differdange (Luxemburgo)	web: www.handball-congress.lu
VISTA Conference	20-23 Septiembre Toronto-Ontario (Canadá)	web: http://sirc.ca/www.vista2017.com
Congreso Internacional de Ciencias de la Actividad Física, el Deporte y la Salud	21-23 Septiembre San Miguel de Tucumán (Argentina)	E-mail: guillermorubeno@blanquerna.url.edu
4th Saúde Atlântica & ISAKOS & ESSKA International Meeting	22-23 Septiembre Porto (Portugal)	web: http://jornadassaudeatlantica.com

I Congreso Internacional en Prevención y Readaptación Física Interdisciplinar	22-24 Septiembre Granada	web: http://en-forma.es/inscripcion-congreso-en-forma/
54º Congreso Nacional de la Sociedad Española de Cirugía Ortopédica y Traumatología (SECOT)	27-29 Septiembre Barcelona	web: www.secot.es
VII Congreso Iberoamericano de Nutrición	28-30 Septiembre Cuzco (Perú)	web: http://www.iberonutricion2017.com/
VIII Congreso de la World Federation of Athletic Trainer and Therapy: Patologías de las fascia en el deporte y su readaptación	29 Septiembre-1 Octubre Villanueva de la Cañada (Madrid)	web: http://www.ucjc.edu/congresowfattspain/
4th International Symposium on Intra-Articular Treatment	5-7 Octubre Praga (Rep. Checa)	web: www.isiat2017.com
II World Conference of Sports Physiotherapy	6-7 Octubre Belfast (Irlanda del Norte)	web: www.physiosinsport.org
International Scientific Conference on Applied Sports Science (ISCASS)	12-14 Octubre Alexandria (Egipto)	web: www.ierek.com/events/applied-sports-science-conference
Congreso Peruano de Ortopedia y Traumatología	12-14 Octubre Lima (Perú)	web: http://spotrauma.org
Congreso Internacional sobre la Enseñanza de la Educación Física y el Deporte Escolar	12-15 Octubre Villena (Alicante)	E-mail: info@profesport.org web: http://retos.org/feadef/congreso/index.html
XXI Congreso Internacional de Nutrición	15-20 Octubre Buenos Aires (Argetina)	web: www.icn2017.com
European Medical Fitness Congress	20-22 Octubre Barcelona	web: www.simphmedicalfitness.es www.medicalfitnesscongress.com
48 Congreso Nacional de Podología	20-22 Octubre Salamanca	web: www.aepode.org / http://www.cgcop.es/
37º Congresso Nacional de Ortopedia e Traumatologia - SPOT 2017	26-28 Octubre Coimbra (Portugal)	web: http://beta.jointogethergroup.com/spot2017
¿Qué hay de nuevo en la Traumatología de los deportes de nieve?	3-4 Noviembre Madrid	web: www.qhdn2017.com
I ESMA Open Meeting: "Stop sports injuries – back to sports"	3-4 Noviembre Munich (Alemania)	web: www.esma-conferencia.org
7º Congreso Mundial del Deporte Escolar, Educación Física y Psicomotricidad	9-11 Noviembre La Coruña	web: https://www.sportis.es
53º Congreso Chileno de Ortopedia y Traumatología - SCHOT 2017	15-18 Noviembre Villa del Mar (Chile)	web: www.schot.cl/congreso-chileno-de-ortopedia-y-traumatologia-2017/

10th EFSMA (European Federation of Sports Medicine Associations) Congress	16-18 Noviembre Cascais (Portugal)	Email: secretariat@efsma2017.org web: www.efsma2017.org
World Congress in Sports and Exercise Medicine	17-19 Noviembre Kuala Lumpur (Malasia)	E-mail: info@wcsem2017.org web: http://www.wcsem2017.org
VII Convención Internacional de Actividad Física y Deporte AFIDE 2017	20-24 Noviembre La Habana (Cuba)	E-mail: afide@inder.cu
VII Jornadas Nacionales de Medicina del Deporte	24-25 Noviembre Zaragoza	Información: femede@femede.es
Congress of Applied Sports Sciences	1-2 Diciembre Sofía (Bulgaria)	web: http://icass2017.com/
54° Congreso Argentino de Ortopedia y Traumatología	2-5 Diciembre Buenos Aires (Argentina)	web: http://www.congresoaaot.org.ar
2018		
World Congress on Osteoporosis, Osteoarthritis and Musculoskeletal Diseases	19-22 Abril Cracovia (Polonia)	web: www.wco-iof-esceo.org/
18th ESSKA Congress	9-12 Mayo Glasgow (Reino Unido)	web: http://esska-congress.org/
7thWorld Conference on Women and Sport	17-20 Mayo Gaborone (Bostwana)	web: www.icsspe.org/sites/default/files/e8_7TH%20IWG%20Conference%20docx.pdf
European Congress of Adapted Physical Activity (EUCAPA)	3-5 Julio Worcester (Reino Unido)	Andrea Faull. E-mail: a.faull@worc.ac.uk Ken Black. E-mail: k.black@worc.ac.uk
23rd Annual Congress of the European College of Sport Science	4-7 Julio Dublín (Irlanda)	web: www.ecss-congress.eu/2018/
World Congress of Biomechanics	8-12 Julio Dublín (Irlanda)	web: http://wcb2018.com/
XXXV Congreso Mundial de Medicina del Deporte	12-15 Septiembre Rio de Janeiro (Brasil)	web: www.fims.org
28° Congress European Society for surgery of the shoulder and the elbow (SECEC-ESSSE)	Ginebra (Suiza)	web: www.secec.org
2019		
12th Biennial ISAKOS	12-16 Mayo Cancún (México)	web: www.isakos.com

24th Annual Congress of the European College of Sport Science	3-6 Julio Praga (Rep. Checa)	E-mail: office@sport-science.org
14th International Congress of shoulder and elbow surgery (ICSES)	17-20 Septiembre Buenos Aires (Argentina)	web: www.icses2019.org
XV Congreso Nacional de Psicología de la Act. Física y del Deporte	Zaragoza	web: www.psicologiadeporte.org
2020		
25th Annual Congress of the European College of Sport Science	1-4 Julio Sevilla	E-mail: office@sport-science.org
XXXVI Congreso Mundial de Medicina del Deporte	24-27 Septiembre Atenas (Grecia)	web: www.globalevents.gr
2021		
26th Annual Congress of the European College of Sport Science	7-10 Julio Glasgow (Reino Unido)	E-mail: office@sport-science.org

Campaña de aptitud física, deporte y salud

La Sociedad Española de Medicina del Deporte, en su incesante labor de expansión y consolidación de la Medicina del Deporte y, consciente de su vocación médica de preservar la salud de todas las personas, viene realizando diversas actuaciones en este ámbito desde los últimos años.

Se ha considerado el momento oportuno de lanzar la campaña de gran alcance, denominada CAMPAÑA DE APTITUD FÍSICA, DEPORTE Y SALUD relacionada con la promoción de la actividad física y deportiva para toda la población y que tendrá como lema SALUD – DEPORTE – DISFRÚTALOS, que aúna de la forma más clara y directa los tres pilares que se promueven desde la Medicina del Deporte que son el practicar deporte, con objetivos de salud y para la mejora de la aptitud física y de tal forma que se incorpore como un hábito permanente, y disfrutando, es la mejor manera de conseguirlo.

Cursos *on-line* SEMED-FEMEDE

Curso "ENTRENAMIENTO, RENDIMIENTO, PREVENCIÓN Y PATOLOGÍA DEL CICLISMO"

Curso dirigido a los titulados de las diferentes profesiones sanitarias y a los titulados en ciencias de la actividad física y el deporte, destinado al conocimiento de las prestaciones y rendimiento del deportista, para que cumpla con sus expectativas competitivas y de prolongación de su práctica deportiva, y para que la práctica deportiva minimice las consecuencias que puede tener para su salud, tanto desde el punto de vista médico como lesional.

Curso "ELECTROCARDIOGRAFÍA PARA MEDICINA DEL DEPORTE"

ACREDITADO POR LA COMISIÓN DE FORMACIÓN CONTINUADA (ON-LINE 15/10/2015 A 15/10/2016) CON 4,81 CRÉDITOS

Curso dirigido a médicos destinado a proporcionar los conocimientos específicos para el estudio del sistema cardiocirculatorio desde el punto de vista del electrocardiograma (ECG).

Curso "FISIOLOGÍA Y VALORACIÓN FUNCIONAL EN EL CICLISMO"

Curso dirigido a los titulados de las diferentes profesiones sanitarias y a los titulados en ciencias de la actividad física y el deporte, destinado al conocimiento profundo de los aspectos fisiológicos y de valoración funcional del ciclismo.

Curso "AYUDAS ERGOGÉNICAS"

Curso abierto a todos los interesados en el tema que quieren conocer las ayudas ergogénicas y su utilización en el deporte.

Curso "CARDIOLOGÍA DEL DEPORTE"

ACREDITADO POR LA COMISIÓN DE FORMACIÓN CONTINUADA (VÁLIDA DEL 15/10/2016 AL 15/10/2017) CON 8,78 CRÉDITOS

Fecha límite de inscripción: 15/06/2017

Curso dirigido a médicos destinado a proporcionar los conocimientos específicos para el estudio del sistema cardiocirculatorio desde el punto de vista de la actividad física y deportiva, para diagnosticar los problemas cardiovasculares que pueden afectar al deportista, conocer la aptitud cardiológica para la práctica deportiva, realizar la prescripción de ejercicio y conocer y diagnosticar las enfermedades cardiovasculares susceptibles de provocar la muerte súbita del deportista y prevenir su aparición.

Curso "ALIMENTACIÓN, NUTRICIÓN E HIDRATACIÓN EN EL DEPORTE"

Curso dirigido a médicos destinado a facilitar al médico relacionado con la actividad física y el deporte la formación precisa para conocer los elementos necesarios para la obtención de los elementos energéticos necesarios para el esfuerzo físico y para prescribir una adecuada alimentación del deportista.

Curso "ALIMENTACIÓN Y NUTRICIÓN EN EL DEPORTE"

Curso dirigido a los titulados de las diferentes profesiones sanitarias (existe un curso específico para médicos) y para los titulados en ciencias de la actividad física y el deporte, dirigido a facilitar a los profesionales relacionados con la actividad física y el deporte la formación precisa para conocer los elementos necesarios para la obtención de los elementos energéticos necesarios para el esfuerzo físico y para conocer la adecuada alimentación del deportista.

Curso "ALIMENTACIÓN Y NUTRICIÓN EN EL DEPORTE" Para Diplomados y Graduados en Enfermería

ACREDITADO POR LA COMISIÓN DE FORMACIÓN CONTINUADA (NO PRESENCIAL 15/12/2015 A 15/12/2016) CON 10,18 CRÉDITOS

Curso dirigido a facilitar a los Diplomados y Graduados en Enfermería la formación precisa para conocer los elementos necesarios para la obtención de los elementos energéticos necesarios para el esfuerzo físico y para conocer la adecuada alimentación del deportista.

Curso "CINEANTROPOMETRÍA PARA SANITARIOS"

Curso dirigido a sanitarios destinado a adquirir los conocimientos necesarios para conocer los fundamentos de la cineantropometría (puntos anatómicos de referencia, material antropométrico, protocolo de medición, error de medición, composición corporal, somatotipo, proporcionalidad) y la relación entre la antropometría y el rendimiento deportivo.

Curso "CINEANTROPOMETRÍA"

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