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Control of the velocity loss through the scale of perceived effort in bench press

Physiological evaluation post-match as implications to prevent injury in elite soccer players

Hormonal and hematological effects in a low-altitude winter march in chilean military

Evaluation of physical fitness in spanish people over 80 years of age using the senior fitness test and the body mass index

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Exertional Rhabdomyolysis

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Predatory journals reach your desk

Las revistas depredadoras llegan a tu mesa

Rafael Arriaza Loureda

Profesor de la Facultad de Ciencias del Deporte y la Actividad Física de la Universidad da Coruña. Grupo de Investigación INCIDE. Director del Instituto Médico Arriaza y Asociados.

A few days ago, a resident who was working with us as part of his rotation told me about a clinical case that he intended to publish and how he had managed to find a journal that had accepted it. Expressing my surprise, I advised him to check whether or not it was a predatory journal. After explaining this term to him, his subsequent search led him to discover a problem that is affecting us all and, although there is a great deal of information about it, many people are still unfamiliar with this concept.

It is true to say that predatory journals, according to the term coined in 2012 by Jeffrey Beall[1], are mushrooming and it is now difficult to distinguish between those journals that are ready to publish anything in order to charge a fee for their "publication expenses" and those that remain true to a strict review model by a series of reviewers and an Editorial Board that maintains high standards of quality, either to subsequently publish these articles in Open Access format (if the authors or institution of origin are prepared to bear this cost) or in paper format. The matter probably arises from the fact that journals with a high impact level only accept a small percentage of the articles received. This means that there are many authors who, after having invested time and work in preparing an article (the publication of which is sometimes key to maintaining or renewing a grant, for example) are desperately seeking somewhere to publish it. And of course, compared to a review process that is uncertain, demanding and generally lasts several months (and which may finally end in rejection), the option of publishing in an "international" journal that offers a review process of between 3 days (yes, this is no typo, this is what some publishers are offering) and 3 weeks, this starts to seem attractive. If we were to add to this the European Union's Plan S directive (that will come into force in 2020) and which aims to ensure that any research work financed with public funds can solely be published in Open Access journals, it may be that the founders of the publishing companies responsible for issuing this proliferation of predatory journals have actually found the goose that lays the golden egg. It is interesting to note that the advocates of *Plan* S argue that science must be freely distributed and must not be restricted to the subscribers of the journals published by publishers that "obtain considerable profit from the dissemination of science". However, in my view, the ones to obtain considerable profit are those publishers that simply accept any work sent to them and limit themselves to converting it into publishable PDF, given that there are no expenses involved and there is nothing but profit.

The progressive change in the model for curricular advancement in Medicine, based on publications (either to get the accreditation of the ANECA (National Quality Assessment and Accreditation Agency of Spain) in order to obtain "sexenios" (salary supplements for each six year period based on research criteria), or to be eligible to apply for posts at the University or in the public healthcare system) has meant that not only are articles published in order to inform colleagues of progress or data that could enrich their ability to address or resolve problems experienced by patients, but also ways are sought to make the most of the investigation conducted. This has led to different types of fraud by authors: complete, plagiarism, or what is referred to as sliced or "salami" publications. It has also led to the appearance of a juicy market for pseudo-scientific journals that offer authors who are either novice, desperate, unsuspecting or unethical, the possibility of publishing their studies in "Open Access" format. Right now, the number of predatory journals is multiplying month by month. While most of these journals are based in India or China, almost all of them show a (false) postal address in the United States: a recent review found some of these locations in the middle of a motorway, in the town hall building, in a home on a housing estate, etc.[2].

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Over the last 2 weeks, 61 invitations have been sent to my main email account to entice me to send my "distinguished" or "relevant" investigation to one of these journals. The fact is that they are not very selective: there are journals in the area of sports medicine such as the *"International Journal of Sport Sciences and Medicine"* (by the publishers SciResLiterature, which indicates on its website that it publishes 50 different journals, all with titles that are vaguely similar to those of other prestigious journals), or the *"American Journal of Sport Sciences"* (by the publishers Science Publishing Group, which publishes 476 different journals and provides an address in New York when it is actually based in Pakistan); but there are also journals in the area of Neurology such as the *"Journal of Neurophysiology and Neurological Disorders"* (by the publishers JScience, offering me indexing in Pubmed if my article is funded by the NHI), or mesenchymal cell therapy (the *"Journal of Stem Cell Therapy and Transplantation"*, which also guarantees that I will be indexed in Google Scholar, Bing, Google, Yandex, Infotiger, Exalead, Baidu, ASR, etc.) or gastroenterology, and so on. Ah, and I was forgetting! Also, during this time, at least 3 Open Access journals have asked me to act as a reviewer - free of charge, of course - of their articles, sending them my "experienced" or "extremely valuable" opinion in less than 3 weeks.

We are definitely living in times of change. There is always the possibility that, in the future, even the world's most prestigious journals will be forced to change their publication policy or that some may even be left as atavistic reminders of a world in which people used to read in print, holding out against this wave of foolishness and mediocrity that is inundating us. Meanwhile, and as always recommended to all officers in the "Hill Street Blues" series, before starting their round, please, take care out there!

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Roles of National Swimming Federations in Health Promotion: An International Comparison- Developed *vs* Developing Countries

Clarence Pérez-Diaz[1], Juan Carlos De la Cruz-Marquez[1], Nuria Rico-Castro[2], Belén Cueto-Martín[1]

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Summary

Purposes: To determine the profile of the medical personnel, the priorities and the activities/ researches of the National Swimming Federations of Developing and Developed countries with respect to the athletes' health protection and the promotion of health in the general population.
Method: A descriptive transversal study through a confidential survey that was circulated to the 208 FINA National Member Federations. A statistical validity and reliability was obtained (Cronbach α coefficient of 0.8642 for n = 15). The NFs were divided based on their economic level, NFs of developed (n= 66) and developing countries (n=142) following the classification of the Organization for Economic Co-operation and Development, (2016). Analysis: A statistic comparison of measures with the test U of Mann- Whitney was executed.
Results: 80 of the NFs from developing countries (56.3%) responded and 55 NFs from developed countries (83.6%). Evident differences were found in Presence of physiotherapists (Developing NFs: 31.2%, Developed NFs: 58.1%; p<0.005) and psychologists (11.2% vs 21.8%; p=0.096). Top priority for both groups was Performance of the elite athletes, however Increasing the numbers of elite athletes was of major importance for the Developing NFs (4.1 vs 3.95, p <0.05). The programs based around drowning prevention are the most prevalent of the programs run by both (58.7% vs 74.5%; p=0.058).
Conclusion: The NFs did not have the necessary personnel to promote the health of their athletes. Top priority for the Developed NFs was to Increase the numbers of elite athletes but they have low levels of Prevention of injuries programs. Coming back after an injury and Medical examination preparation were also low in Developed and in Developing NFs. Prevention of drowning program was the most frequent program/activity for health of general population, for the recreational athlete and "Save Sport" (without sexual abuse) they were questions of low priority for all of them.

Key words:
Swimming. Health. Sport Organizations. Developed & Developing Countries.

Rol de las Federaciones Nacionales de Natación en la promoción de la salud: Comparación países desarrollados *vs* en vía de desarrollo

Resumen

Objetivos: Determinar el tipo de personal médico, las prioridades y actividades para la protección y promoción de la salud de las Federaciones Nacionales de Natación (FNN) según su nivel económico y determinar si aplicaban los programas relacionados con la salud de la Federación Internacional de Natación (FINA).
Método: Se realizó un estudio descriptivo transversal mediante una encuesta confidencial distribuida a las 208 FNN adscritas a la FINA. La encuesta fue validada y se obtuvo su fiabilidad estadística (coeficiente α de Cronbach de 0,8642 para n=15). Las FNN se dividieron según su nivel económico en FNN de países desarrollados (n=66) y FNN de países en desarrollo (n=142) siguiendo la clasificación de la Organization for Economic Co-operation and Development (2016). Análisis: Se realizó una comparación estadística de las medias mediante la prueba U de Mann-Whitney.
Resultados: Respondieron 80 FNN en desarrollo (56,3 %) y 55 desarrolladas (83,6 %). Hubo diferencias en la presencia de fisioterapeutas (FNN en desarrollo: 31,2%, desarrolladas: 58,1%, p <0,005) y psicólogos (11,2% *vs* 21,8%; p=0,096). La máxima prioridad para ambos grupos fue el Máximo rendimiento de los nadadores de élite, aunque Aumentar el número de nadadores de élite era de mayor importancia para las FNN en desarrollo (4,1 *vs* 3,95; p <0.05). Los Programas de Prevención de ahogamiento fueron los más frecuentes en ambos grupos, pero con diferencias significativas entre ellos (FNN En desarrollo: 58,7% *vs* FNN Desarrolladas: 74,5%; p=0,058).
Conclusiones: Las FNN no disponían del personal necesario para promover la salud de sus nadadores. La mayor prioridad de las FNN en desarrollo era Aumentar el número de atletas de élite, pero tenían bajos niveles de Prevención de lesiones, Vuelta a competir tras una lesión y de Exámenes médicos preparticipación, aunque en las FNN desarrolladas también eran bajos. La Prevención de ahogamiento fueron los programas más frecuentes pero la Salud de la población en general, la del atleta recreativo y el "Deporte Seguro" (sin acoso sexual) eran cuestiones de baja prioridad para todas.

Palabras clave:
Natación. Salud. Organización deportiva. Países en desarrollo y desarrollados.

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Introduction

The International Swimming Federation (FINA), in association with UNESCO, UNICEF, the UN, and the IOC, among others, has created the "Swimming for all" programmes, whose key objectives are to reduce the global drowning rates and to promote a healthier lifestyle throughout the world[1]. These programmes are indicators of how sport is becoming a means to promote health[2].

In developed countries, programmes such as USA Swimming ("splash at a time")[3] and Australia Swimming ("Go swim")[4] have been implemented to promote the health of the population through swimming and can be considered to be models to be followed by other National Swimming Federations (NSF). However, swimming is not accessible in the same way in all the NSF, given that each federation faces different barriers and challenges depending on its geographical location and socio-economic situation[5].

The IOC is also showing its interest in the protection of the health of its athletes, in developed and developing countries alike[6-9]. Since the FINA 2009 World Aquatics Championships, studies have been made in relation to injuries and diseases[10], but there is still room for improvement in the prevention of pathologies and injuries, specifically out of competition[11].

On the other hand, the levels of participation in international swimming events has increased significantly over the last 20 years. While only 46 NSF took part in the first edition of the FINA World Swimming Championships (25 m) in 1993[12], 168 NSF were present at the 12th edition of the FINA World Swimming Championships (25 m) in 2014[13]. However, participation in major swimming events may not be always related to the economic status of the NSF. The FINA, through its "Universality Rule", allows athletes from developing countries to take part in the World Championships[14] even with no standard entry times, thereby giving them the opportunity to take part in major events. However some of these athletes are attending these competitions despite the fact that their national team has limited access to injury prevention programmes and has no support from a medical staff structure, given that not all the NSF have the same health promotion and injury prevention programmes, before and after major events. Those NSF with fewer resources may not have the same capacity to implement health promotion programmes.

The study objectives were: To determine whether the economic level of the NSF is related to the promotion of the health of the general public, whether the economic level influences the application of the health-related rules, projects and programmes of the NSF, and whether the NSF in developing countries attending international swimming events have an adequate medical structure.

Material and method

A universal descriptive study was made of all the NSF recognised by the FINA on 31/12/2014 through an on-line survey. The survey used was based on that published by the International Federation of Sports Medicine (FIMS) for the Sports Federations[15] and on that by Mountjoy and Junge[16] for the International Swimming Federations taking part in the 2014 Olympic Games and the 2016 World Championships.

Participants: The questionnaire was sent to the chairpersons, managers, general directors or head of the Medical Committee, where applicable, of the 208 NSF that are members of FINA. The survey respondents were informed that their responses would form the basis of the study and their consent was requested to use these responses in the dissemination of the results in scientific journals.

The identification of the developing countries (NSF in developing countries) and developed countries (NSF in developed countries) was based on the Official Statistics of the Organisation for Cooperation and Development[17].

The survey was adapted to the specific objectives of this study and, for this purpose, a pilot study was conducted by two independent experts in the area of Sports Science from the University of Granada (Spain) through a blind review. This gave a validity and statistical reliability (Cronbach coefficient α of 0.8642 for n=27).

The survey comprised 11 items relating to the health of athletes, 16 on the promotion of health and on the implementation of the programmes proposed by the FINA, and respondent were requested to indicate whether or not their NSF had a Medical Committee, a medical representative on the Executive Board of the Federation, administrative personnel in the medical area and whether the national team was supported by a head doctor, physiotherapist, psychologist, dietician, physical trainer and other personnel to support the medical area.

All the questions were closed. For those related to the athletes' health, and for those related to health promotion and the implementation of the programmes proposed by the FINA, the items were measured on a Likert type scale from 1-5. A statistical comparison was made of the medians through the Mann-Whitney U test.

For the question on the medical personnel, the possible responses were dichotomous (yes/no). Statistical hypothesis testing was performed in equal proportions.

The description of the results included the percentages of affirmative responses for the dichotomous variables and the mean and standard deviation for the numerical responses. Unanswered questions were excluded from the analysis.

The survey was distributed online using the free software platform LimeSurvey (GNU/GPL v2) and was available at the Computer and Network Services Centre (University of Granada) from 01/10/2014 to 28/02/2015, guaranteeing the anonymity of respondents and observing the applicable EU data protection regulations. The data were imported from the UGR server, unprocessed and independently. The study was made known in person at the FINA World Swimming Championships (25m) (Doha; 29 November to 1 December 2014).

The survey was available in English, Spanish, French and Russian.

Results

The overall response rate was 64.9% (135 of the 208 NSF). The highest rate was from the NSF in developed countries (83.3% vs 56.3%). The NSF that responded to the survey represented 67,276 clubs and almost 1.4 million swimmers, of which more than 90% were from NSF in developed countries (Table 1).

Medical personnel: 27.2% of the NSF in developed countries and 37.5% of the NSF in developing countries had no medical personnel.

Table 1. Itemisation by continent of the NSF (developed / developing countries)

	Type of NSF	Total NFs* (n)	Responses NFs† (n; %)		Clubs†† (n)	Licences§ (n)
Europe	Developing	13	11	84.6	350	42.000
	Developed	38	28	73.6	53.568	704.710
	Total	51	39	76.4	53.918	746.710
Africa	Developing	49	29	59.1	668	16.318
	Developed	3	3	100	76	6.321
	Total	52	32	61.5	744	22.639
America	Developing	33	19	57.5	889	20.372
	Developed	12	11	91.6	3.718	394.487
	Total	45	30	66.6	4.607	414.859
Asia	Developing	37	17	45.9	546	19.700
	Developed	7	7	100	6.253	104.775
	Total	44	23	52.2	6.799	124.475
Oceania	Developing	9	4	44.4	18	940
	Developed	7	6	85.7	1.190	82.485
	Total	16	10	62.5	1.208	83.425
GLOBAL	Developing	142	80	56.3	2.471	99.330
	Developed	66	55	83.3	64.805	1,292.778
		208	135	64.9	67.276	1,392.108

*Total of NSF (n) that are members of the FINA; †NSF that answered (n; %); ††Number of clubs within the participating NSF; §Number of affiliated or licensed swimmers of the participating NSF.

Table 2. Profile of the medical personnel.

	NSF developed c. n= 55 (%)	NSF in developing c. n= 80 (%)	p
Physiotherapist	58.18	31.25	**0.002***
Doctor	41.82	32.5	0.266
Sport scientist	32.73	23.75	0.250
Dietician	27.27	17.5	0.174
Administrative personnel medical area	23.64	16.25	0.285
Medical committee	21.82	18.75	0.661
Psychologist	21.82	11.25	**0.096****
Medical personnel on the Board of Management	12.73	12.5	0.968
Other	9.09	5	0.936

*p<0.005; ** p<0.1

58.1% of the NSF in developed countries had a physiotherapist compared to 31.2% of the NSF in developing countries (p<0.005). 21.8% of the NSF in developed countries had a psychologist in relation to 11.2% of the NSF in developing countries (p<0.1). Only one in every five NSF had a Medical Committee (Table 2: Figure 1).

Programmes: The programmes based on the prevention of drowning (prevention/learning to swim/lifesaving) were the most used by the NSF in developed countries (58.7%) and also by the NSF in developing countries (74.5%; p<0.1).

The NSF in developed and developing countries alike had few injury prevention programmes (developed 28.7% vs developing 25.4%), Medical check-ups prior to participating (20% vs 16.3%) and Injury surveillance during the championships (25% vs 27.27%). 25% of the NSF in developing countries had return to swimming programmes following injury, in comparison to 7.27% of the NSF in developed countries (p<0.05) (Table 3).

Figure 1. Profile of the medical personnel.

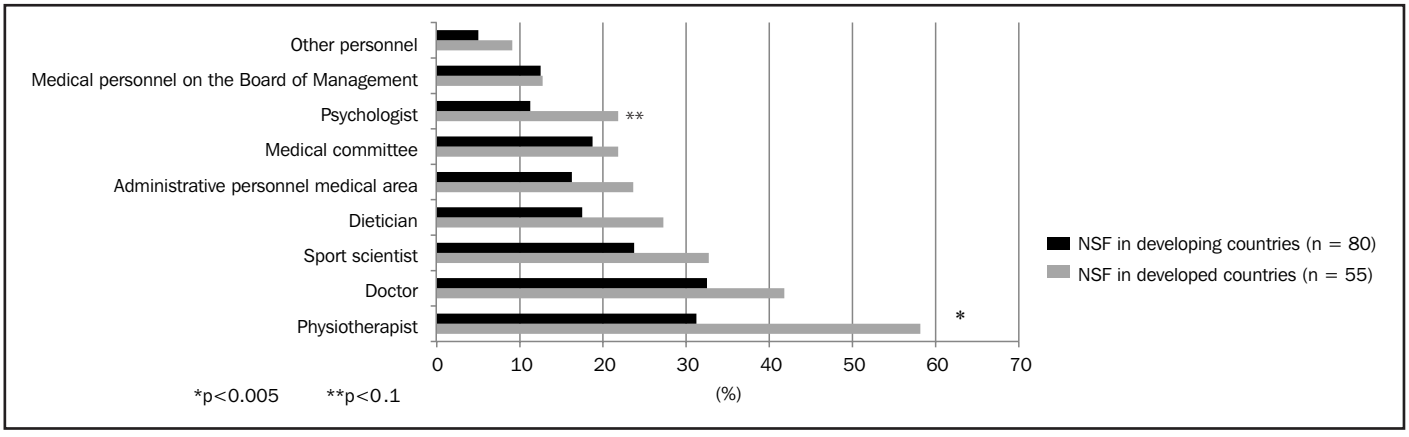
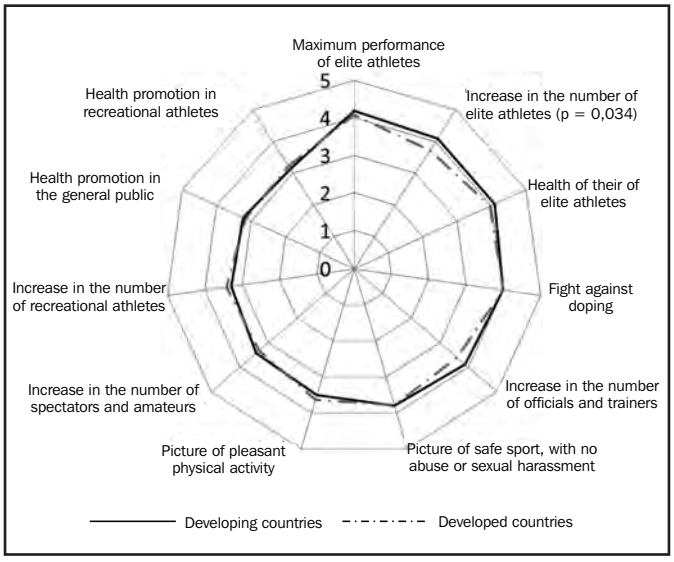


Table 3. Programmes for the promotion of healthcare, investigation activities or directives.

	NSF in developing c. n= 80 (%)	FNN in developed c. n= 55 (%)	p
Prevention of drowning, learning to swim, lifeguards	58.75	74.55	**0.058***
First aid (for example on-site doctor)	37.50	30.91	0.430
Inclusion of senior citizens	33.75	21.82	0.133
Injury prevention with programmes based on swimming	28.75	25.45	0.673
Control of injuries during championships	25.00	27.27	0.767
Return to training after injury	25.00	07.27	**0.008****
Pre-participation medical screening	20.00	16.36	0.593
Obesity and excess weight	18.75	20.00	0.856
Ambassador swimmers promoting health	16.25	12.73	0.566
Prevention of chronic diseases in the population	12.50	09.09	0.536

*p<0.1; **p<0.05

Figure 2. Classification of the health topics considered by the NSF.



Priorities: No significant differences were appreciated, except in relation to the Increase in the number of elite athletes (p<0.05). The maximum priority for the NSF in developing countries and those in developed countries (4.07/5) was the maximum performance of the elite athlete. Both groups of NSF classified the athlete's health as the 3rd priority. The fight against doping was considered to be the 4th priority for the NSF in developing countries (3.99/5) and the 2nd for the NSF in developed countries (Table 4, Figure 2).

Discussion

Through this study, for the first time a comparison has been made of the healthcare resources of the NSF throughout the world according to their economic level, helping to present a picture of the health problems affecting the NSF. Earlier studies did not consider the economic level of the NSF, but limited their focus to those NSF with a high sporting level. These surveys were supplied on the spot at the world swimming championships and were answered by the personnel attending the event[16]. By

Table 4. Classification of the health topics considered by the NSF. Likert Scale (0-5).

Temas de salud	NSF in developing c.		NSF in developed c.		Contrast
	$\bar{X}$	SD	$\bar{X}$	SD	p
Maximum performance of elite athletes	4.18	1.21	4.07	1.40	0.976
Increase in the number of elite athletes	4.10	1.25	3.72	1.35	**0.034***
Health of their elite athletes	4.09	1.21	3.96	1.33	0.579
Fight against doping	3.99	1.24	3.98	1.38	0.724
Increase in the number of officials and trainers	3.89	1.21	3.61	1.38	0.215
Picture of safe sport, with no abuse or sexual harassment	3.80	1.19	3.78	1.46	0.592
Picture of pleasant physical activity	3.51	1.25	3.63	1.26	0.409
Increase in the number of spectators and fans	3.44	1.23	3.33	1.33	0.725
Increase in the number of recreational athletes	3.28	1.19	3.41	1.46	0.273
Health promotion in the general population	3.23	1.25	3.17	1.33	0.815
Health promotion of recreational athletes	3.13	1.33	3.22	1.28	0.779

contrast, our study was distributed among all the NSF, being addressed to the heads of the NSF and giving ample time for their response. The questions did not refer to numbers of personnel, just to the presence or absence of the same, so as not to upset those NSF who did not have personnel in the categories studied.

Studies have been conducted on the prevention of injuries in developing countries in other sports, predominantly football[17], but no study had yet been made for swimming. In the case of African football, it was concluded that injury prevention required a pragmatic approach, knowledge of, and adaptation to the resources available[18] and, although care should be taken when applying the results of one sport to another, it was considered that these contributions could be useful in swimming.

In our study, the profile of healthcare-related personnel showed no significant differences between the two economic levels, except with regard to physiotherapists and psychologists, and always with values of less than 50% (except for doctors of the NSF in developed countries where the value reached 58%), despite the fact that a recommendation has been made to integrate a range of personnel in the sports medicine team[19]. Our results indicated that a large number of NSF did not have the necessary personnel to promote the physical and mental health of their swimmers and that they had not applied the recommendations to diagnose, treat and rehabilitate, even when sufficient financial resources were available[20,21]. Neither did the economic level appear to be significant with regard to having or not having a Medical Committee within the organisation chart of each NSF, in order to emphasise the importance of sports medicine for athletes and to demonstrate the readiness of the NSF to progress in this field[8].

Despite the economic divides between the NSF, no significant differences were found in their priorities, with the exception of Increasing the number of elite athletes, which was more marked for the NSF in developing countries. For both categories, the top priority was to Guarantee the best performance of the elite athlete, while the Health of the athletes was the third priority. The fact that the NSF in developing countries gave great importance to Guaranteeing the best performance of the athlete, while attending events without adequate medical support, indicated that they do not have the resources to allow them to offer the desired medical support to their athletes and many of these athletes could only be assisted by medical personnel forming part of the Championship staff.

For the NSF in developed countries, the Fight against doping was the second priority. Although the classification of this topic was the 4th priority for the NSF in developing countries, both groups gave almost identical levels of importance to this matter. This finding was to be expected given that all the governing bodies of the swimming organisations (FINA and the Continental Federations) are required, in accordance with the Code of the World Anti-Doping Agency (WADA) to adopt anti-doping measures during their national events and out of competition[22]. Compliance with the WADA code is also a precondition for taking part in the Olympic programme. Despite this, it was a matter of concern that the remaining 55% of the NSF did not consider doping to be a problem of top priority.

The NSF in developing countries had low levels for Injury Prevention and for return to competition following injury and very low levels in relation to the pre-participation medical Screening, however the NSF in developed countries also had low levels and, in some cases, these were even lower. Returning to swim following an injury was more prevalent in the NSF in developing countries (25%) than for those in developed countries (7.2%) ($p < 0.05$). Despite the fact that physiotherapists play a key role in injury recovery[23], they were under-represented in the NSF in developing countries in relation to those in developed countries ($p<0.005$).

The FINA Medical Rules emphasise the protection and promotion of the athlete's health during training and competition and the FINA conducts a comprehensive surveillance of injuries at its events[10,11]. However, it was observed that many of the NSF were unaware of this policy, given that only 25% of the NSF in developing countries and 27.27% of those in developed countries stated that they were implementing these programmes in their own championships.

Recreational sport can be used as an activity to promote good health and also to contribute to health-related quality of life[24]. However, up to now, the NSF have not been focussing on the Protection of the health of recreational athletes. Both NSF groups considered this problem to be either the last or penultimate priority. We believe that the lack of policies to promote the health of recreational athletes is a lost opportunity for the NSF given that there is a need to create policies to support and motivate the SF in general in order to address the health and wellbeing of non-elite athletes[16].

One of these opportunities could be in the anti-doping area; this is no longer limited to professional athletes but is increasingly becoming a problem among recreational athletes[25]. However, the NSF considered that they had more important matters than addressing the protection of the health of recreational athletes.

Governments and private institutions such as the NSF are responsible for establishing sexual abuse prevention policies to promote "Safe Sport" in which the team doctors must play an important role in the prevention and early detection of sexual harassment and abuse in sport[26], particularly in the "stage of imminent achievement", which is the period of maximum vulnerability of young athletes to sexual abuse[27]. It is vital to know that prevention and the successful eradication of abuse and harassment of athletes is based on the effectiveness of the leadership of the principal international and national sports organisation such as the NSF, in our case[28]. However, the NSF in developing and developed countries alike classified "Safe Sport" as a topic of medium priority. Only some NSF in developed countries were aware of the problem and had adopted real measures. For example, Swim Ireland[29], USA Swimming[30] and Scottish Swimming[31], have implemented harassment-free sports policies. Swimming South Africa also initiated its own child protection policy, including legislative initiatives and guidelines on this matter by the South African government[32]. Existing legislation and the guidelines established in the NSF in developed countries could serve to encourage other NSF to introduce the corresponding sexual harassment and child protection policies.

Exercise in water can benefit senior citizens, by improving their quality of life and reducing disability[33],improving or maintaining the bone health of post-menopausal women[34], reducing the risk of chronic and cardiac diseases and improving the health of persons with diabetes[35]. However, both categories of NSF considered that the health of the general public was a matter of low priority (penultimate and last priority

respectively). This indicates that the NSF were more concerned with the wellbeing of their elite athletes than with that of the general public. Moreover, the NSF are possibly losing the opportunity to increase the general popularity of their sport in population groups, such as senior citizens. Although global ageing is increasing[36], the NSF of both groups showed low levels of concern for the promotion of the health of senior citizens, given that only 33.7% of the NSF in developing countries and 21.8% of those in developed countries, had programmes directed at senior citizens. The European Swimming League (LEN) has shown its interest in taking part in activities to promote the health of senior citizens with the programme entitled "Healthy ageing and master swimming (HAMS)"[37], directed at developing an awareness of swimming and increasing the participation in the over-sixties category, organising a series of Pool Open Days throughout Europe. This top-down approach could encourage more NSF to implement similar programmes of their own.

The low levels of programmes based on the prevention of chronic diseases in the general public indicate that neither the NSF in developing countries (12.5%) nor those in developed countries (9.09%) considered this problem to be their responsibility, although the NSF could have a role to play, considering the high mortality rates due to chronic diseases throughout the world and the proven health benefits of swimming[38].

An area in which the NSF were particularly active was that relating to the prevention of drowning/learning to swim/life saving. These programmes were by far the most popular programmes among the NSF in developing countries (58.7%) and those in developed countries (74.5%) ($p<0.1$), being beneficial to recreational athletes and to the general public. Although no bibliographic reference has been found to orientate this point of the discussion, the Drowning prevention programmes may represent sources of income for the federations and for athletes, explaining why the presence of these programmes was significantly higher in the NSF than the other programmes assessed. Unquestionably these programmes could help attract swimmers and provide a social service to prevent death from drowning.

In future studies it would be interesting to obtain information on the available resources and the expenditure criteria in the health area for both NSF groups.

Conclusions

Despite the great economic differences between the NSF, there was hardly any difference in healthcare-related personnel, and a large number of federations did not have the personnel required to promote the physical and mental health of their swimmers.

No significant differences were found in their priorities, with the exception of Increasing the number of elite athletes, which was more relevant for the NSF in developing countries.

The NSF in developing countries had low levels for Injury Prevention and for return to competition following injury in relation to the pre-participation medical Screening, however the NSF in developed countries were also low and, in some cases, were even lower.

For both NSF categories, the drowning prevention programmes were the most frequent healthcare programmes, however the Health of the general public, that of Recreational Athletes and "Sport without harassment" were matters of low priority.

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Conflict of interest

The authors have no conflict of interest whatsoever.

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Control of the velocity loss through the scale of perceived effort in bench press

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Summary

Controlling the training variables is vital to ensure the desired adaptations in resistance training; intensity is the most important variable to improve maximum strength and rate of force development (RFD). The movement velocity has shown to be the best variable to monitor the intensity of resistance training, in particular the velocity loss related to fatigue. However, there are material impediments to use this variable. Therefore, the aim of this paper is to analyze the relationship between RPE and velocity losses as an alternative to control training. Sample included 5 subjects (4 men and 1 woman) from the Spanish Olympic Wrestling team who performed a total of 15 sets of bench press (3 set/subject), of which only 14 were included in the statistical analysis for breaching one of them the protocol, with 3 different relative loads (5 set/load) and a velocity loss between 20%-32%. The dependent variables were: RPE, the velocity loss, the number of repetitions performed in each set and the velocity of the best repetition of each set. The correlations between the RPE-velocity loss; RPE-number of repetitions; and RPE-velocity best repetition variables were analyzed, obtaining only significant correlation (r Pearson 0.843, P <0.001) between the RPE and the velocity loss; correlations between RPE-number of repetitions; and RPE-velocity best repetition did not show statistical significance . The results of the present work could indicate the possibility of managing fatigue and controlling training intensity using the RPE-velocity loss relationship, although it is necessary to carry out similar studies with larger sample sizes that reinforce the results of this study.

Key words:
Resistance training. Bench press. RPE. Monitoring. Movement velocity.

Control de la pérdida de velocidad a través de la escala de esfuerzo percibido en *press* de banca

Resumen

Controlar las variables de entrenamiento es vital para garantizar las adaptaciones deseadas en el entrenamiento de fuerza, siendo la intensidad especialmente importante para mejorar la fuerza máxima y el RFD. La velocidad de ejecución ha resultado ser la mejor variable para monitorizar la intensidad del entrenamiento de fuerza, en particular las pérdidas de velocidad relacionadas con la fatiga. Sin embargo, existen impedimentos materiales para poder utilizar esta variable. Por tanto, el objetivo de este trabajo es analizar la relación entre el RPE y las pérdidas de velocidad como alternativa para controlar el entrenamiento. Se midió a 5 sujetos (4 hombres y 1 mujer) pertenecientes a la selección española de lucha libre olímpica un total de 15 series de *press* de banca (3 series/sujeto), de las cuales solo 14 se incluyeron en el análisis estadístico por incumplir una de ellas el protocolo, con 3 cargas relativas distintas (5 series/carga) y una pérdida de velocidad entre 20%-32%. Las variables dependientes fueron: RPE, la pérdida de velocidad, el número de repeticiones realizadas en cada serie y velocidad de la mejor repetición de cada serie. Se analizaron las correlaciones entre las variables RPE-pérdida de velocidad; RPE-número de repeticiones; RPE-velocidad mejor repetición, obteniéndose solamente correlación significativa (r Pearson 0,843; P <0,001) entre el RPE y la pérdida de velocidad; la correlaciones entre el RPE-número de repeticiones y RPE-velocidad mejor repetición no mostraron significación estadística. Estos resultados podrían indicar la posibilidad de gestionar la fatiga y la intensidad del entrenamiento utilizando la relación RPE-pérdida de velocidad, aunque es necesario llevar a cabo estudios similares con tamaños muestrales mayores que refuercen los resultados obtenidos en este estudio.

Palabras clave:
Entrenamiento de fuerza. *Press* de banca. RPE. Monitorización. Velocidad de ejecución.

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Introduction

Strength training has been shown to be a key factor in improving health, physical appearance and sport performance[1-4]. It is essential to control the training variables in order to optimise the results[5] and, more specifically, training intensity appears to be the most important factor in improving maximum strength[6-9] and the RFD[7,8,10,11], considered to be the most determining factor in sport performance[4,12,13]. Although strength training intensity was traditionally prescribed according to the repetition maximum (RM) percentage or the maximum number of repetitions that a subject is able to perform with a load[5,14,15], over the last few years velocity of execution has been proposed as a more precise, reliable and safe alternative for the control of intensity[16-18]. A specific load (%RM)-velocity relationship has been demonstrated for different exercises, according to which each load is closely related to the maximum velocity at which it can be lifted[16-21]. On the other hand, it has been demonstrated that training up to muscle failure is unnecessary and is less beneficial than training at a far lower capacity than muscle failure for sport performance[22-25], having a particularly negative effect on the RFD[12]. A loss of velocity pattern was observed in relation to the maximum possible velocity during a set to failure in which the last repetition coincided with the RM velocity[26]. On the other hand, a linear relationship was described between the loss of velocity and lactate concentrations, as well as a non-linear relationship with ammonium concentrations, regardless of the number of repetitions made[27]. Recently it has been shown how, when comparing the effects of training protocols that differed in the total amount of work performed based on the velocity loss % during the set, the following was obtained: 1) improvements of more than $_1$RM and in execution velocity in trained subjects when compared to velocity losses of 20% in relation to training to muscle failure[28]; and 2) greater improvements in CMJ and smaller decreases in the percentage of myosin heavy chains (MHC-IIX), with similar improvements in maximum strength when comparing velocity losses of 20% in relation to 40%[29].

In view of the above, the velocity of execution was considered to be the most suitable variable to prescribe the intensity and monitor fatigue during strength training.

A number of devices are available to precisely and reliably control the velocity of execution, such as linear transducers, accelerometers or video analysis systems[30-32]. However these are relatively expensive and are still not accessible to all users. As an alternative, a mobile iPhone application (more affordable) was recently validated as a reliable and valid tool for measuring the velocity of execution[33]. Despite the fact that the means of monitoring the velocity of execution are becoming increasingly more accessible and affordable, other disadvantages still exist. For example, in order to monitor large groups of athletes in a number of different exercises, various devices would be necessary. All this means that we need to continue to seek reliable, valid alternatives to monitor strength training.

Another method to assess and monitor the strength training load are the subjective rating of perceived exertion scales (RPE)[34-37], based on the psychophysiological response of the body, whereby the information on physiological or environmental changes comes from the sensory perception of the individual, causing a subjective perception for a specific stimulus[38]. The scales commonly used to rate the perception of exertion are the Borg 6 to 20 scales and the 0 to 10 scale[38] , these were followed by the OMNI-RES scale from 0 to 10 which is accompanied by pictograms to make it easier for the subject to interpret exertion[39]. The RPE has been shown to be useful to predict the %RM or the 1RM[35-37], a number of studies have also found correlations between the RPE, the %RM, the velocity of execution[34,40-43], and mechanical power[44]. Finally, a speed perception scale has been developed, which has demonstrated its validity for the bench press and for the squat[44,45].

Therefore, the RPE has been shown to be a useful alternative to the traditional methods to control the intensity of strength training when more precise means cannot be used to measure of the velocity of execution.

Hypothesis

To the best of our knowledge, there are no investigations that have related RPE with loss of velocity during strength training. Based on the aforementioned existing evidence on the relationship between the RPE values and the velocity of execution; the relationship existing between metabolic markers for internal load (lactate and ammonium concentrations) and the losses of velocity during strength training[27]; and the validity of the RPE as a psychophysiological indicator[38] to relate the external load and internal load, we could think that there is a relationship between the losses of velocity and the RPE which would allow us to monitor fatigue when no suitable technological resources are available to do so.

Objective

The objective of this work is to analyse the relationship between the velocity losses and the RPE perceived by subjects during the bench press exercise.

Material and method

Sample

The sample comprised 5 subjects (23.2±5.3 years; 169.2±6.9 cm; 72.2±17.8 kg) (4 male (23±6 years; 171.3±6 cm; 75.3±19 kg) and 1 female (24 years; 161 cm; 60 kg) who are part of the Spanish Olympic wrestling team, selected incidentally. The subjects had at least 1 year's experience in strength training and they had been involved in a training routine that included 2 strength training sessions a week at least for the last 6 months. Table 1 provides a description of the characteristics of the total sample. Prior to the investigation, the participants signed an informed consent form, informing them of the procedures, risks and benefits of the investigation. The study protocol complies with the provisions of the Declaration of Helsinki for research involving human subjects.

Table 1. Characteristics of the sample expressed as a mean ± standard deviation.

Age	Height (years) (cm)	Weight (kg)	Prior RM (kg)	Estimated RM (kg)
23.2 ± 5.3	169.2 ± 6.9	72.2 ± 17.8	101.5 ± 31.8	106.7 ± 35.4

RM: repetition maximum.

Protocol

The subjects performed 3 bench press sets, each with a different load based on the average velocity (load 1→ ≈1-1.1 m/s; load 2→ ≈0.75-0.85 m/s; load 3→ ≈0.53-0.61 m/s) based on the data previously presented in the literature[21] in order to adapt the relative load between 40-45%RM for $load_1$, between 55-60%RM for $load_2$, and between 70-75%RM for $load_3$. In the first set (1-1.1 m/s) the subjects made repetitions until, in two repetitions, they reached a velocity of 8 m/s (velocity loss of 20%-27.3%) or less; in the second set (0.75-0.85 m/s) until, in two repetitions, they reached a velocity of 0.6 (velocity loss 22.1%-29.4%); and in the third set (0.53-0.61 m/s) until, in two repetitions, they reached a velocity of 0.42 m/s (velocity loss 20.7%-31.1%) or until a repetition achieved a velocity of 0.37 m/s (velocity loss 30.1%-39.3%) or less. After each set, the subjects rated the RPE with a value of between 0-10 using the OMNI-RES scale. Prior to the data collection, all subjects performed at least 4 bench press training sessions to become familiar with the OMNI-RES scale (Figure 1), giving their subjective perception of effort (0-10) after each set.

Material

The bench press exercise was conducted on a free weight bench. The bar weighed 20 kg without plates. To determine the average velocity, a linear transducer (EV PRO Dynamic Isocontrol 5.2 Quasar Control S.L. Madrid) with a sampling frequency of 1000Hz connected to the bar by a cable and by USB to a laptop, which recorded the data in real time (Figure 2).

Figure 1. OMNI-RES scale developed by Robertson et al. (2003).

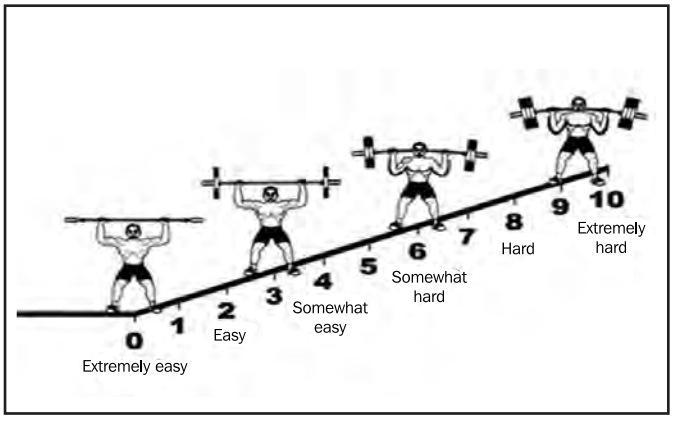


Figure 2. A. Connection between the bar and the linear transducer; B. Linear transducer; C. Laptop.

Statistical analysis

Firstly, the Shapiro-Wilk test was performed in order to determine the distribution normality of the values of the variables. The next step was to study the degree of correlation of the variables (RPE-loss of velocity; RPE-number of repetitions; RPE-best repetition velocity) through Pearson' correlation test and, more specifically, we studied the relationship of RPE-loss of velocity through a quadratic regression. For the data processing, statistical analysis software was used (SPSS v.23, SPSS Inc., Chicago, Illinois, USA). The statistical significance cutoff was set at $p < 0.05$.

Results

The data analysis was made on 14 bench press sets, given that one of the sets did not comply with the established protocol. The kinematic variables ("loss of velocity" and "best repetition velocity") in relation to the repetitions analysed, showed a normal distribution.

Correlations between variables

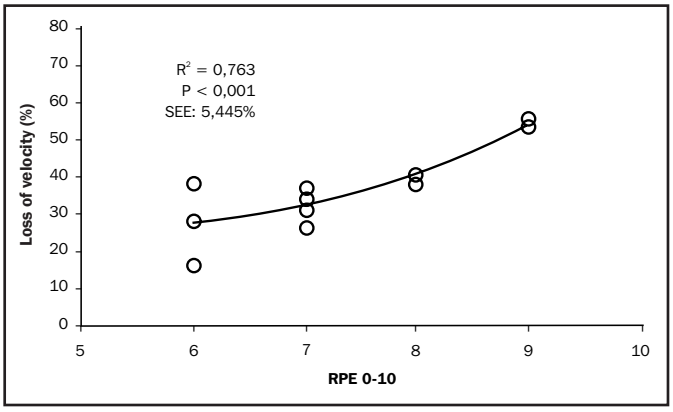
Table 2 shows the results for the relationships RPE-loss of velocity, RPE-number of repetitions, and RPE-best repetition velocity, analysed through Pearson's correlation.

Table 2. Pearson's correlations between RPE-velocity loss, RPE-number repetitions, RPE-best repetition velocity.

	Velocity loss		Number repetitions		Velocity best repetition	
	r	P	r	P	r	P
RPE	0.843	<0.001	-0.317	0.27	-0.463	0.096

RPE: rating of perceived exertions.

Figure 3. Relationship between the RPE and the loss of velocity derived from the 14 set measured on the bench press.



RPE-loss of velocity

Figure 3 shows the quadratic regression for the relationship RPE-loss of velocity. This regression has given the following predictive equation for the loss of velocity through RPE: loss of velocity (%) = 2.294RPE^2 - 25.68RPE + 99.29.

Discussion

To the best of our knowledge, this is the first study to analyse the relationship between velocity losses during a strength training set and the RPE. The objective of this work was, therefore, to analyse the relationship between the velocity loss and the RPE during the bench press exercise. The principal results of the study show how, considering all the variables analysed, only the relationship between loss of velocity-RPE was significant (Table 2). Moreover, it should be emphasised that this relationship shows a non-linear trend (Figure 3).

The results obtained can be related to prior studies which demonstrated the validity of the RPE based on the RIR of the subjects[43]; and, on the other hand, the relationship between the loss of velocity and the number of repetitions made in relation to the maximum possible number (muscle failure)[26,27]. Taking account of the fact that the RIR concept refers to the number of repetitions that subjects perceive that they could do until failure, these investigations show the relationship of the RIR with both the RPE and also with the loss of velocity. It therefore seems logical to think that there is also a relationship between RPE-loss of velocity, as shown by the results of this study.

The fact that no significant relationships were found between the RPE and the total number of repetitions, nor between the RPE and the velocity of the best repetition in the set (relative load marker), is in line with the results of Lodo *et al*.[46] who demonstrated that, when training with different relative intensities (%RM), but with the same total volume load, similar RPE values are obtained. However, our results are not in line with prior studies that have found higher RPE values when making fewer repetitions with high intensities than for more repetitions with low intensities[35]; and, on the other hand, when comparing strength training in circuits with high loads to strength training in a circuit directed at power training with light, moderate loads, it has been seen how the RPE is higher for strength training with high loads[47]. However, in these two studies, no comparison was made with the total load volume, nor the number of repetitions to muscle failure among the protocols analysed. This may explain the differences with our results, where the total load was controlled through the loss of velocity, which is related to metabolic markers and fatigue mechanics[27].

Of particular interest is the fact that velocity losses of between 30-35% have been found almost systematically at an RPE value of 7 (Figure 3). Sánchez-Medina and González-Badillo[27] found how velocity losses close to 35% on the bench press were reached after doing half the repetitions plus two, in relation to the maximum possible number, and at this point the ammonium concentrations started to rise above baseline levels. These authors recommend not to exceed the said velocity losses and even to stop the set before reaching this point, finding in subsequent studies that velocity losses of 20% are greater than velocity losses of 40% or training to failure[28,29]. Therefore, the limit could be established in RPE 7 to cut off the sets when this bench press fatigue management method is used.

Conclusions

In conclusion, the results of our study show a relatively high correlation between velocity losses and RPE, independently of the number of repetitions or relative load used. This appears to indicate that bench press fatigue can be monitored by RPE when it is not possible to directly measure the velocity of execution. Moreover, the trend observed in the results, according to which REP 7 is associated with velocity losses of 30-35%, could prove useful for marking the perceived effort limit when making more or less repetitions during a bench press set. Nevertheless, these results must be interpreted with caution, given that they are an initial approximation to the validity of the RPE to control velocity losses. There is a need to continue along this line of investigation, with more robust methodologies and larger samples in order to be in a position to more accurately establish the validity of our proposal.

Study limitations

The principal limitations of this study are as follows:

- The results were obtained with a very small sample.
- The results of the experimental verification have not been replicated with a second data collection.
- The results are only applicable to the bench press exercise. It would be necessary to check the validity of the relationship between loss of velocity-RPE in different exercises.
- Due to the small size of the sample, no analysis was made of possible differences between subjects for the RPE values associated with loss of velocity.

Future lines of investigation

This work shows signs of the possible validity of RPE as a useful tool to control velocity losses during strength training. Due to the limitations of this work, our analysis should be replicated with larger samples, for

different exercises and analysing the possible differences between subjects for the same exercise.

Conflict of interest

The authors have no conflict of interest whatsoever.

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Physiological evaluation post-match as implications to prevent injury in elite soccer players

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Summary

Introduction: The accumulated stress measured post-soccer match, often temporarily delays players' physical performance and, as a result, players may experience acute and chronic fatigue contributing to underperformance and/or injury.
Objective: This study investigatedchanges in physiological parameters such as thermographic profiles of the lower limbs, serum creatine kinase (CK) level, and skin conductance in elite soccer players post-match. Furthermore, perceived wellness was examined in relation to physiological parameters in an attempt to identify a possible relationship that might prove valuable to strength and conditioning and sport coaches in planning and implementing training schedules.
Methods: Ten healthy male professional soccer players (25.3 ± 4.6years; 178.4 ± 6.3cm; 76.3kg ± 6.2 kg; body fat 10.2 ± 4.2 %) from a club of the Brazilian first division soccer league participated in this study. GPS sensors were used to quantify the demand of match conditions among all participants along with post-match measures of serum CK, skin conductance, and thermographic images of lower limbs. These same measures, along with a psychometric questionnaire were administered 24 and 48 hours post-match.
Results: No significance difference ($p>0.05$) was found in contralateral thermal symmetry in the lower limbs. But, both values (maximal and mean values) of skin temperature shown significant difference ($p<0.05$) at rest when compared to 24h and 48h post-match. In addition, Serum CK level remained elevated for up to 48h post-match in relation to rest.
Conclusion: The results showed that 48 hours post-match is not sufficient to full recovery of soccer players. The use of physiological measures, wellness questionnaires, and thoughtful planning based on readiness may help reduce over-stress injuries and enable athletes to perform at their peak throughout the season.

Key words:
Recovery.
Physiological assessment.
Soccer players.

Evaluación fisiológica tras el partido como implicaciones para prevenir lesiones en jugadores de fútbol elite

Resumen

Introducción: El estrés acumulado medido después del partido de fútbol, a menudo retrasa temporalmente el rendimiento físico de los jugadores y, como resultado, los jugadores pueden experimentar fatiga aguda y crónica que contribuyen con un bajo rendimiento y/o lesión
Objetivo: Este estudio investigó los cambios en los parámetros fisiológicos, como los perfiles termográficos de las extremidades inferiores, el nivel de creatina quinasa sérica (CK) y la conductancia de la piel (SC) en los jugadores de élite de fútbol después del partido
Métodos: Diez jugadores profesionales de fútbol (25,3±4,6 años; 178,4±6,3 cm; 76,3±6,2 kg; grasa corporal 10,2±4,2%) de la liga de fútbol de primera división brasileña participaron en este estudio. Los sensores de GPS se utilizaron para cuantificarla demanda de esfuerzo entre todos los participantes junto con las mediciones posteriores al partido de la CK, la SC y las imágenes termográficas de las extremidades inferiores. Estas mismas medidas, junto con un cuestionario psicométrico, se administraron 24 y 48 horas después del partido.
Resultados: No se encontró diferencia de significancia ($p>0,05$) en la simetría térmica contralateral en las extremidades inferiores. Sin embargo, ambos os valores (valores medios y máximos) de la temperatura de la piel mostraron una diferencia significativa ($p<0,05$) en reposo en comparación con las 24 horas y 48 horas después de la partida de fútbol. Además, el nivel sérico de CK se mantuvo elevado durante hasta 48 horas después del partido en relación con el descanso.
Conclusión: Los resultados mostraron que 48 horas después del partido no es suficiente para La recuperación total de los jugadores de fútbol. El uso de medidas fisiológicas, cuestionario psicométrico y una planificación cuidadosa basada en la preparación pueden ayudar a reducirlas lesiones por sobrecarga.

Palabras clave:
Recuperación.
Evaluación fisiológica.
Jugadores de fútbol.

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Introduction

In soccer games, players need to make quick, precise movements that can be characterized as intermittent muscle actions with high demands on several physical components[1,2]. Physical stress during training and/or match playpromptsmorphological, metabolic, and functional adaptations that consequently enable an increase in performance[3,4]. At the same time, accumulated stress, measured post-soccer match, often temporarily delays players physical performance and, as a result, players may experience acute and chronic fatigue contributing to underperformance and/or injury[5]. A majority of injuries occur in the lower limbs (~70%), related to the nature of the sport (i.e. during jumping, after movements with a large eccentric component, or in response to a period of intensified training), consequently, resulting in a decline in physical performance during the hours and days following competition[6-8].

Muscle damage is characterized by a temporary decrease in muscle function, an increase in intracellular proteins in the blood, increased muscle soreness, and increased swelling in and around the involved muscle group[1,6-8]. Recovery is considered complete when the player is able to reach or exceed his benchmark performance in a particular activity such as strength, power, or balance[5]. The development of new technologies for diagnoses among soccer players is necessary to better understand the physiological responses to competition and advance injury risk prevention methods associated with training load and match intensity[1]. Valuable information may be identified regarding optimal recovery time following matches, more detailed evaluations of injury risk and performance, and other factors that may signal injury risk.

Biochemical markers (i.e. serum CK level) have previously been used to determine the magnitude of physical stress on the skeletal muscle system imposed on players participating in a soccer match[1,9]. Because this biomarker is correlated with the number of muscle micro traumas that lead to the secretion of this enzyme into the extracellular medium, analyzing post-match CK may provide relevant information about the physical state of athletes[10,11]. However, only one method of physiological evaluation may be insufficient for evaluatingpost-match soccer status. Biochemical markers combined with thermal imaging assessments may provide valuable information in this regard[1]. Infrared thermography is a non-invasive method used to visualize human body temperature changes in response to physiological processes or pathological reactions related to the control of the temperature of the skin, without exposing the patient to any type of radiation[12-14]. This technique has been used increasingly in medical and sports areaswith applications related to the diagnosis of musculoskeletal disorders and in the evaluation of muscle recovery after training or soccer matches[1,15]. Thermal symmetry of the human body is similar between the sides of the body which are identical in shape and size, being taken at the same angle[1]. On the other hand, injuries lead to vasodilatation and increase of inflammatory mediators in the area, which result in an increase of the metabolism and blood flow in the region, consequently, increase local body temperature and disturb this normal symmetric pattern[1,14,15]. However, no scientific studies have been identified that used these physiological evaluations post-match in elite soccer players.

In addition to physical stress of competition, match outcome (win vs. loss) may influence mood state, compromise sleep, increase psychological stress, and affect mental fatigue post-match in elite soccer players. Measures are needed to enable an evaluation of psychometric status with autonomic responses that are objective, sensitive, reliable, and easy to implement. Sympathetic nervous system activity is strongly associated with central activations related to the processing of cognitive and emotional information[16]. Skin conductance (SC) is another method of evaluating activity of sweat glands exclusively under sympathetic control[17,18]. SC has been used to identify human emotions, suggesting different levels of sympathetic activation in different emotional stages, which along with both tonic and phasic components can aptly identify subtle psychobiological changes in athletes[17,19]. Therefore, psychometric questionnaires and SC can be methods useful tool for monitoring perceived wellness, psychometric status and psychobiological changes of elite athletes[17,20]. However, scientific researchers are limited with use of SC during recovery post-match in professional soccer players.

Resulting from an examination of existing literature and professional interest, the aim of this study was to investigate changes in physiological parameters such as thermographic profiles of the lower limbs, serum CK level, and skin conductance in elite soccer players post-match. Furthermore, this study examined perceived wellness in relation to physiological parameters in an attempt to identify a possible relationship that might prove valuable to strength and conditioning and sport coaches in planning and implementing training schedules.

Material and method

Approach to the problem

To investigate the impact of competition on physiological measures and wellness, ten professional soccer players were recruited to participate in this study, which was approved by the local institutional Ethical Committee for Human Experiments and was performed in accordance with ethical standards in sport and exercise science research. Subjects provided written informed consent after all methods were explained to them. Various tests were performed at rest, immediately following a soccer match, and at 24- and 48-hours post-match for comparison. Statistical analyses were conducted to examine changes in test scores as well as possible relationships amongst the different assessments.

Participants and anthropometric measurements

The study included 10 healthy male professional soccer players (25.3 ± 4.6years; 178.4 ± 6.3cm; 76.3kg ± 6.2 kg; body fat 10.2 ± 4.2 %) from a club of the Brazilian first division soccer league that participates in national and international competitions organized by the Brazilian Soccer Confederation (CBF) and South American Soccer Confederation (CSF). The current training frequency was 6.3 ± 0.7 days/week and the training programs consisted of jumps, ball fights, sprints, accelerations and decelerations.

All soccer players included in the study participated of one official match for 88.6 ± 9.1 minutes. Data collection post-match were compared to data collection carried out at the beginning of the training season. Exclusion criteria included: 1) smoking history during the previous three months; 2) presence of any cardiovascular or metabolic disease; 3) systemic hypertension (≥ 140/90 mmHg or use of antihypertensive

medication); 4) use of anabolic steroids, drugs or medication with potential impact on physical performance (self-reported); 5) recent musculoskeletal injury; or 6) pain in any region of the body. The study was approved by the local institutional Ethical Committee for Human Experiments (CAAE: 76189817.0.0000.5235) and was performed in accordance with ethical standards in sport and exercise science research.

Body composition was measured using a bioelectrical impedance analyzer with hand and foot electrodes (InBody 720, inbody.com). The otherwise clothed subjects stood upright with their bare feet on the analyzer's foot electrodes and their arms abducted while grasping the hand electrodes. All analyses were performed after 8h of fasting. All biometric measures were carried out in a thermoneutral room (21º C). No clinical problems occurred during the study.

Training load monitoring and global position system (GPS)

During one official match, all soccer players' activity levels were monitored and quantified by means of portable global position system (GPS) devices (Minimax X, v.4.0, Catapult Innovations) operating at a sampling frequency of 10 Hz and incorporating a 100 Hz triaxial accelerometer. Each player wore a special harness which enabled this device to be fitted to the upper part of his back. The GPS devices were activated 10 min prior to the start of each official match, in accordance with the manufacturer's instructions. After the match, GPS files were downloaded to a computer and analyzed with the software provided by the manufacturer (Logan Plus v4.2.3 software; Catapult Innovations, Scoresby, Australia). The subjects' data were excluded from analysis if they failed to complete the match due to injury and /or replacement during match.

The GPS devices used in this study did not delineate among forward, backward, or lateral movement.The indicators of external load were as follows: 1) total distance covered; 2) frequency of efforts ≥18 km/h); 3) frequency of efforts ≥24 km/h); 4) maximal speed during matches. In addition, data obtained combining the accelerations produced in three planes of body movement by means of a 100 Hz triaxial accelerometer in the GPS device were used to classify external training load using the Player-Load equation. Player-Load is an indicator of the external load because acceleration is proportional to force and may provide a useful measure of the total load applied to a player in a match. Player-Load was calculated by Logan Plus software via thefollowing equation:

$$(ay1 - ay{-}1)^2 + (ax1 - ax{-}1)^2 + (az1 - az{-}1)^2$$

Where *ay* = antero-posterior acceleration, *ax* = medio-lateral acceleration, and *az*= vertical acceleration.

Procedures Plasma CK monitoring

Plasma CK monitoring was assessed by reflectance photometry at 37°C using the ReflotronAnalyser Plus (Reflotron Plus; Roche, Germany), previously calibrated. After the finger asepsis, by using 70% ethyl alcohol, a lancet device with an automatic trigger was used for puncturing finger and the blood was drained into strips for specific analysis (heparinized capillary strips). Blood sample (32 µl) was immediately pipetted into a CK test strip which was inserted into the instrument.All measurements were performed 24h and 48 h post-match between 8:00 and 9:00 A.M. with anthermoneutral room, temperature of 21ºC and relative humidity of 65%.Absolute values of CK were used for analysis.

Skin conductance recording

Skin conductance (SC) was recorded using a ProComp Infiniti multi-modality encoder from Thought Technology (Montreal, Canada) and a laptop computer. SC was recorded from two 10 mm diameter Ag–AgCl electrodes, attached with adhesive collars on the middle phalanges of the index and middle fingers of the participant's non-dominant hand. A constant voltage (0.5 V) was applied between the two electrodes and EDA was sampled at a frequency of 256 Hz. The signal was displayed in real-time on the computer screen as visual feedback for the participant and investigator. For the case wherein physiological filtering was attempted, the participant donned a piezoelectric belt positioned around the thoracic area, which translated the stretch due to expansion and contraction of the lung cavity into changes in voltages. These changes were recorded simultaneously with EDA by the Pro Comp Infiniti system. All records occurred 24h and 48h post-match with soccer players in supine position at normal room temperature (21ºC) in a quiet place under dim light with sound insulation

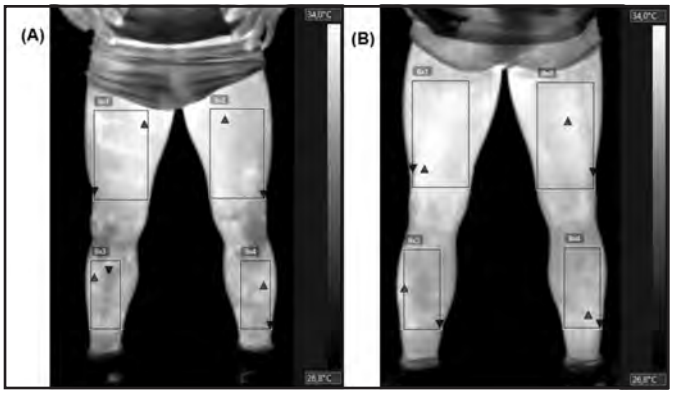
Acquisition of the thermographic images

All thermographic images were performed 24h and 48h post-match between 8:00 and 9:00 A.M. with anthermoneutral room with temperature of 21ºC with a relative humidity of 65%. The equilibration periodto evaluate skin temperature was set at 15 minutes. Thermal images sequences of lower limbs (thighs and legs) were acquired in an anteroposterior manner (i.e., frontal and dorsal views) by a digital infrared thermo-camera (Flir Systems Inc®, model T-420, USA) with a measurement range of 20 °C to 650 °C (accuracy of ± 2 °C or 2 %; sensitivity of ≤ 0.05 °C), an infrared spectral band from 7.5 to 14 microns, a refresh rate of 60Hz and an FPA (Focal Plane Array) of 320 x 240 pixels. The distance between the subject and the camera was standardized at four meters and the index of human skin emissivity was set to 0.98. Analyze of the body regions of interest (ROI) were selected by a drawing rectangular areas by the software (Smartview 3.1 - Fluke®, Everett, USA), which provided us with the average and maximum temperatures from each analyzed ROI[15,21,22]. Selection of the ROI utilized 5 cm above the upper border of the patella and groin line for the thigh, and for the leg, 5 cm below the lower border of the patella and 10 cm above the malleolus[15]. Figure 1 shows representative anterior and posterior thermal images from thighs and legs. Coffee, tea and alcohol intake was prohibited for four hours before testing. Soccer players not use physiotherapy before the test (e.g. massage, electrotherapy, ultrasound, heat treatment, cryotherapy, hydrotherapy) and without cosmetics products before the measurements to obtain thermal images most meaningful of skin temperature. All soccer players reported the absence of any type of sports injury according to these criteria.

Psychometric questionnaire

A psychometric questionnaire was used 24h and 48h post-match between 8:00 and 9:00 A.M. to assess general indicators of player

Figure 1. Thermal images anterior (A) and posterior (B) views from thighs and legs.



wellness[23,24]. The questionnaire comprised of 5 questions relating to perceived fatigue, sleep quality, general muscle soreness, stress levels and mood, with each question scored on a five-point scale (ranging from 1-5, with 1 and 5 representing very poor and very good wellness ratings, and 3 representing normality)[23]. Overall wellness was then determined by summing the five scores.

Statistical Analysis

Sample size calculation was performed for the physiological responses as the main outcome. A sample size of 10 participants was found to be required to detect a difference in the physiological responses between baseline and post-match follow-up (power = 0.9, alpha = 0.05) (G*Power, version 3.1.9).All data are presented as mean ± SD. The statistical analysis was initially performed using the Shapiro–Wilk normality test and the homocedasticity test (Bartlett criterion). Comparisons within-groups for physiological variables and psychometric questionnaire were performed with ANOVA one-way repeated-measures followed by Tukeys post hoc tests. Correlation between variables was assessed using Pearson correlation coefficients and corresponding 95% confidence intervals. The level of significance was set at $p<0.05$ for all statistical comparisons. The significance level was set $p<0.05$ for all statistical comparisons; the software used was GraphPad® (Prism 6.0, San Diego, CA, USA).

Results

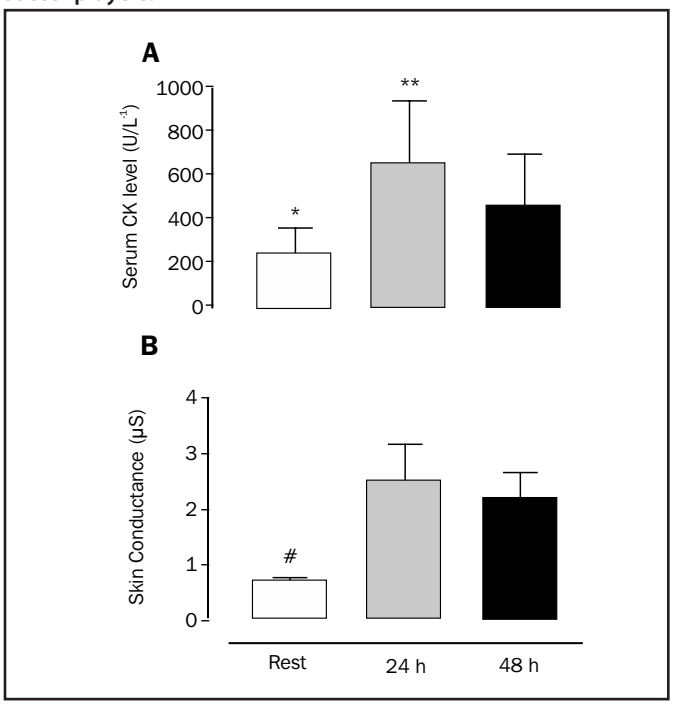
Table 1 shown descriptive statistic of theindicators of external load during match. Serum CK level revealed significant differences ($p<0.0004$) between rest, 24 h, and 48 h post-match (Figure 2A). On the other hand, SC recording showed significant difference ($p<0.0001$) only between restand 24h post-match (Figure 2B).

No significance difference ($p>0.05$) was found between left and right sides for anterior and posterior measurements of thighs and legs for maximal (Table 2) and mean (Table 3) values of skin temperature. However, both values (maximal and mean) of skin temperature showed significant differences ($p<0.05$) at rest when compared to 24 h and 48 h post-match.

Table 1. Indicators of external load during match.

Variables	Mean±SD	Maximal	Minimal
Total distance covered (m)	8740±1516	10489	5605
Horizontal velocity (m/min)	103.1±13	119	80
Frequency of efforts ≥18 km/h	48.7±19	77	17
Frequency of efforts ≥24 km/h	7.3±5	14	0
Maximal speed (km/h)	28.75±2	31.1	25.5
Player Load (A.U.)	878.3±167	1132	536
Player Load per minute (A.U.)	10.5±1	11	10
Total minutes	88.6±9	95	70

Figure 2. Mean ± SD values from serum CK level and Skin conductance in rest, 24h, and 48h post-match of professional soccer players.



*p<0.0004 - Rest vs. 24h and 48h post-match.
**p<0.0004 - 24h vs. 48h post-match.
#p<0.0001 - Rest vs. 24h post-match.

Table 4 showed psychometric variables of fatigue, sleep, and pain were lower at 24 h and 48 h post-match when compared to rest. Sleep was also significantly lower at 24 h when compared with 48 h post-match ($p<0.05$). In addition, SC showed significant correlation with fatigue ($r=0.73$; $p<0.01$) and sleep ($r=0.65$; $p<0.04$).

Discussion

Few studies evaluated the physiological response post-match of the elite soccer players which mean anessential to strategies of recovery post-match. The results obtained in the present study related significant difference between rest and up to 48 hours post-match, which showed

Table 2. Maximal values of skin temperature (ºC) of thigh and leg in elite soccer players.

Body regions of interest	Rest	24 hours Post-match	48 hours Post-match	Δ 24h Post-math	Δ 48h Post-math
Anterior thigh Right	33.25±0.62*	34.60±0.63	34.44±0.52	1.4±0.96	1.2±0.58
Posterior thigh Right	33.04±0.49*	34.00±0.54	34.27±0.70	1.15±0.89	1.25±0.71
Anterior leg Right	32.38±0,73*	33.80±0.44	33.87±0.62	1.3±0.69	1.2±0.67
Posterior leg Right	32.43±0,45*	33.74±0.86	33.41±0.67	1.15±0.91	1.15±0.75
Anterior thigh Left	33.18±0,72*	34.73±0,62	34.60±0.56	1.45±1.09	1.3±0.57
Posterior thigh Left	33.13±0,52*	34.09±0.53	34.34±0.54	1.15±0.87	1.1±0.65
Anterior leg Left	32.37±0.68*	33.59±0.86	33.92±0.69	1.3±1.3	1.65±0.65
Posterior leg Left	32.45±0.60*	33.26±0.89	33.49±0.86	0.75±0.83	1±0.74

*p<0.05 - Rest vs. 24h and 48h post-match. Δ values were calculated in relation to rest.

Table 3. Mean values of skin temperature (oC) of thigh and leg in elite soccer players.

Body regions of interest	Rest	24 hours Post-match	48 hours Post-match	Δ 24h Post-math	Δ 48h Post-math
Anterior thigh Right	32.12±0.81*	33.32±0.49	33.28±0.55	1.06±0.9	1±0.47
Posterior thigh Right	32.16±0.47*	33.03±0.63	33.36±0.63	1.03±0.6	1±0.77
Anterior leg Right	31.28±0.94*	32.78±0.42	32.77±0.90	1.4±1.10	1.5±0.81
Posterior leg Right	31.23±0.31*	32.88±0.59	32.53±0.66	1.5±0.78	1.35±0.67
Anterior thigh Left	31.98±0.75*	33.26±0.56	33.26±0.43	1.13±1	1.15±0.46
Posterior thigh Left	32.16±0.46*	33.16±0.62	33.40±0.68	1.25±0.90	1.25±0.78
Anterior leg Left	31.11±0.78*	32.78±0.42	32.81±0.66	1.6±0.94	1.6±0.66
Posterior leg Left	31.34±0.43*	32.39±0.73	32.46±0.70	1.25±1.13	1.15±1.02

*p<0.05 - Rest vs. 24h and 48h post-match. Δ values were calculated in relation to rest.

Table 4. Mean±SD values of psychometric questionnaire in rest, 24h, and 48h post-match.

Psychometric questionnaire	Rest	24 hours Post-match	48 hours Post-match
Fatigue (A.U.)	4.4±0.51*	2.9±0.31	3.4±0.51
Sleep (A.U.)	4.5±0.52*	2.4±0.51**	3.5±0.97
Pain (A.U.)	4.4±0.51*	2.9±0.56	3.5±0.7
Stress (A.U.)	4.4±0.51	3.6±0.96	3.9±0.99
Mood (A.U.)	4.9±0.31	4.1±1.1	4.3±0.05

*p<0.05 - Rest vs. 24h and 48h post-match; **p<0.05 - 24h vs. 48h post-match

that the athletes were not fully recovered. Scientific literature comments that recovery time between 48h and 72h post-match may be insufficient to restore normal homeostasis within soccer players[5]. In present study did not find a high correlation between physiological variables, possibly because this variable shows individual characteristics for each soccer players. However, the use of infrared thermography and CK plasma level can together estimate the magnitude of muscle damage, but SC also seems to be quite important to autonomic evaluation to shown significant correlation with fatigue and sleep described in the psychometric questionnaire.

Exercise intensity contributes with damages to the skeletal muscle cell structure at the level of the sarcolemma, including membrane damage, myofilament disorganization and loss of Z-disc integrity that results in an increase in total CK[10,11]. Our results showed increase significant of serum CK level 24h post-match, possibly by a greater recruitment of fast-twitch fibers at high-intensity exercise during match[11,25]. Some studies suggested that some specifics movement in field sports (accelerations, decelerations, and eccentric contractions) and speeds >25 km/h seem to have a strong correlation with CK levels[26,27]. A recent study showed a significant increase in serum CK level after more of 4 repetitions greater than 20 km/h in sprinters athletes when compared to endurance athletes[26]. In our study, despite of the low correlation between CK level and efforts > 24 km/h (r=0.14), were realized 7.3 ± 5 repetitions > 24 km/h. In addition, how increase the repetitions and intensity of efforts greater will be muscle cell disturbance and delays the appearance of a CK serum peak compared to less disruption and may be linked to the time course of inflammation[28]. Such muscle damage induced by intensity exercise altersthe muscle cell permeability and leads to cellular protein leakage, ultimately increasingthe serum activity of many enzymes[28,29]. Thus, serum CK level response observed after exercise induced muscle damage may be due to leukocytes infiltrating and destabilizing the cell membrane during the process of repair[28,29].

Considering that CK levels increase after exercise or soccer matches, applying two methods for muscle activity ismore accurate. Thus, the use of infrared thermography and CK plasma level can together determine muscle damage, because only biochemical markers do not show the anatomic location of the muscle injury. A recent study published by our research group showed thermal symmetry of the human body is similar between the sides of the body at rest, being identical in shape and size[1]. On the other hand, no studies were found that evaluated profile of infrared thermography in elite soccer players 24 h and 48 h post-match. Some studies shown that differences greater than 0.7°C between contralateral limbs or body areas have been associated with structural or physiological abnormalities in athletes[1,12,13]. Additionally, a temperature increase between 0.25°C to 0.9°C in a deep lesion situated in muscle is associated to inflammation, but a temperature decrease between −0.2°C to −0.5°C is considered local ischemia[30]. Our results showed maximal and mean values > 0.7ºC 24h and 48h post-match in front and back lower limbs in which an increase in thermal image (>0.7ºC) can contribute to decrease of quadriceps power in 7.9%[31]. We propose that a ROI below 27°C may be related to a condition of hypothermia caused by reduced local blood flow, whereas a ROI above 35°C could suggest an inflammatory process. This thermal response could be related to several physiological changes (e.g., increased muscle metabolism, anaerobic energy reserve, density of capillaries and nerve conduction rate) showing a relationship between muscle skin temperature change and muscle fatigue[1,31,32].

Stress perturbs the normal physiological or psychological functioning of an individual. There is a relationship between stress and sympathetic activity, although the electrical change alone does not identify which specific emotion is being elicited[19]. However, SC can identify autonomic sympathetic changes through changes in sweat and blood flow[17]. But it is important to comment that no study to date has used SC as a method for assessing recovery of elite soccer players. In present study was observed high correlation between SC and fatigue and sleep. We hypothesis that in 24 h post-match (score < 3 in psychometric questionnaire to fatigue and sleep) elite soccer players still showed the effects of stress caused by match play. Consequently, the perception of greater risk results in more vigilant autonomic nervous system activityand is reflected in skin conductance activity[18,19]. Thus, under a pre-sleep stressful condition, the increase in electrodermal activity during sleep can be a byproduct of a sleep inhibitory mechanism, which fits the notion that higher vigilance corresponds to higher sympathetic activity and increase fatigue state[33].

A limitation of this type of investigation could be age range, specific position of the soccer players, and climatic condition during match soccer since this parameter could influence serum CK level, skin temperature measurements, and autonomic response. While our sample was quite homogeneous, the sample size was not large enough to provide variations in physiological condition to specific positions. Future research should elucidate the influence of the external training load in the markers biochemical during training and/or matches in elite soccer players.

Conclusions

In conclusion, the combinations of our results contribute to two key findings. Firstly, 48 h post-match remain high levels of serum CK and thermal image in elite soccer players. Secondly, the results showed significant correlation of SC with fatigue and sleep reported in the psychometric questionnaire. Therefore, workouts held the day after a game may be counterproductive and impeded the recovery process, which may take more than 48 hours. The use of physiological measures, wellness questionnaires, and thoughtful planning based on readiness may help reduce over-stress injuries and enable athletes to perform at their peak throughout the season. Thus, these physiological evaluations may be a helpful for athletes, coaches, physicians and physical therapists regarding injury prevention, early detection, and recovery strategies.

Conflict of interest

The authors do not declare a conflict of interest.

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Hormonal and haematological effects in a low-altitude winter march on chilean military

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Summary

Introduction: Intermittent exposures at high altitude have acute effects on some biological markers, such as testosterone, but not at low altitude. Since the training of soldiers should carry out specific military activities, is very important to asses physiological changes that can occur in particular circumstances (such as altitude) but during the performance of the activities of the military units.
Objective: To identify the hematological changes and the hormones Free Testosterone (TL), Total Testosterone (TT) and Cortisol during a nocturnal march at low altitude in soldiers of mountain operations.
Methodology: 32 male military (26.3 ± 4.50 years, 75.1 ± 7.6 kg) performed a nocturnal winter march with equipment between 902 and 1648 m of altitude. Blood samples were obtained before and after the march, and TL, TT, cortisol and blood count were measured: red blood cells (Hmt), hemoglobin (Hb), hematocrit (Htto) and mean corpuscular volume (MCV).
Results: There was a significant decrease in TL and TT values without changes in plasmatic cortisol. A reduction in the values of Hmt, Hb, Htto and VCM has also been observed.
Conclusion: A winter march with combat equipment, at low altitude and with a unevenness of 746 m, produces a significant decrease in the plasma values of Testosterone (free and total) in soldiers of mountain operations. No changes in cortisol values are observed. A significant reduction of red blood cells, hemoglobin, hematocrit and MCV is detected, which could be due to a hemodilution effect.

Key words:
Cortisol. Testosterone. Mountain troops. March.

Efectos hormonales y hematológicos en una marcha invernal de baja altitud en militares chilenos

Resumen

Introducción: Las exposiciones intermitentes a gran altitud tienen efectos agudos sobre algunos marcadores biológicos, como la testosterona, pero no así en baja altitud. Dado que el entrenamiento de soldados debería ir asociado a tareas militares específicas, adquiere gran importancia valorar los cambios fisiológicos que puedan producirse en determinadas circunstancias (como la altitud) pero durante la realización de actividades propias de las unidades militares.
Objetivo: Identificar los cambios hematológicos y en las hormonas Testosterona Libre (TL), Testosterona Total (TT) y Cortisol en una marcha nocturna a baja altitud en soldados de operaciones en montaña.
Metodología: 32 Militares masculinos (26,3 ± 4,50 años, 75,1 ± 7,6 kg) realizaron una marcha invernal nocturna con equipo y un desnivel entre los 902 y 1648 m. Se obtuvieron muestras de sangre antes y después de la marcha y se midió TL, TT, cortisol y hemograma: hematíes (Hmt), hemoglobina (Hb), hematocrito (Htto) y volumen corpuscular medio (VCM).
Resultados: Se produjo un descenso significativo de los valores de TL y TT sin cambios en el cortisol plasmático. También se observó un descenso en las cifras de Hmt, Hb, Htto y VCM.
Conclusión: Una marcha invernal con equipo de combate, en baja altitud y con un desnivel de 746 m, produce un descenso significativo de los valores plasmáticos de Testosterona (libre y total) en soldados de una unidad de operaciones en montaña. No se observan cambios en los valores de cortisol. Se detecta una reducción significativa de hematíes, hemoglobina, hematocrito y VCM que podrían deberse a un efecto de hemodilución.

Palabras clave:
Cortisol. Testosterona. Tropas de montaña. Marcha.

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Introduction

In the Chilean Army, personnel in the mountain troops must be highly specialised and prepared, in order to offer rapid and effective responses in different scenarios under specific stressors.

One of the most common stressors for the Chilean Army in the mountain operating environment is fatigue caused by marching in combat simulated conditions, with regard to equipment and adverse weather conditions. However, occasionally, an added factor is marching at altitude conditions, with the influences that this has on the physical performance of the subjects[1]. Due to the fact that these two factors are often combined in mountain troop operations, it is difficult to differentiate the influence of each one.

In 2010 a retrospective analysis by the United States Army[2] brought to light a considerable decrease in cold-weather injuries since the Korean war (6,300 injuries) up to operations in Afghanistan (only 19), attributing this change to better knowledge of the circumstances and to improvements in the equipment of the armed forces.

On the other hand, altitude training traditionally takes place through long acclimatisation sojourns. However, given that the military operations to be performed in these environments generally have little time for preparation, it would be of interest to know how this preparation could be made more efficient. In 2014, the British Army[3] made a review of the sporting literature that dealt with this problem, in an endeavour to draw conclusions that could be applicable to military training. Given that, in all these strategies, it is necessary to combine the best physiological adaptation in the least possible time with training sessions at appropriate intensities, it is important to know the effect that both factors (altitude and intensity) have on physiological variables.

In 2007, Muza[4] conducted a review on the effects of daily intermittent hypoxic exposures to induce altitude acclimatisation, for the purpose of considering the potential utilization of this approach in military training. He concluded that exposures of at least one and a half hours are required for at least one week and at altitudes that are equal to or higher than 4,000 m and also that the effect of intermittent exposures at lower altitudes is not documented.

However, intermittent exposures at high altitudes have acute effects on some biological markers, such as testosterone[5]. Given that the training of soldiers must be associated with specific military tasks[6], it is extremely important to ensure that the assessment of the physiological changes that may occur in certain circumstances (such as altitude) is based on the performance of activities that are specific to the military units.

The problem lies in the fact no studies in these circumstances have been reported in the literature and, if we resort to sports training literature, we find some highly diverse information with regard to the blood count values of certain hormones due to some very different conditions and protocols. Thus, following exercise at high altitudes, some authors report increases in cortisol[7-9] while others find no changes[10,11].

With regard to the exposure time at high altitudes, some authors have observed that through gradual ascents, the cortisol levels at rest do not change[12], while others report that the subjects rapidly exposed to hypoxic conditions (either in a hypobaric chamber or using a vehicle or helicopters for a rapid ascent) do show increases in cortisol[9,13,14].

A similar situation occurs with testosterone at high altitudes. Some studies report a drop in testosterone in a mountain climbing training programme[15] while others find an increase in the testosterone values in situations of acute exposure to high altitudes[16].

However, isolated changes in the values of cortisol or testosterone are important, given that, in the sports field, the free testosterone to cortisol ratio has been used as an indicator of training load for some time now[17,18], being a marker of overexertion, even for soldiers subjected to extreme loads[19]. It is therefore a useful tool that makes it possible to intervene in the planning before any pathological changes occur in athletes[18,20-22].

It is important to ensure that the study of the physiological adaptations of the armed forces to altitude (or to any other variable) is associated with specific tasks. Given that no studies exist with these characteristics, the aim of this work is to analyse the changes occurring in the hormonal values and red blood cells of soldiers from the Chilean Army taking part in mountain operations during a low-altitude nighttime winter march with full combat equipment.

Material and method

Ethical aspects

This investigation was approved by the Health Science Research Ethics Committee, Military Hospital of Santiago, observing the provisions of the declaration of Helsinki.

The soldiers were informed of the procedure and agreed to voluntarily participate by signing a consent form.

Study population

Thirty-two male soldiers (aged 26.3 ± 4.50 years, weight 75.1 ± 7.6 kg) conducted a nighttime winter march in the locality of Lonquimay, Chile, with an initial altitude of 902 m and ascending to 1,648 m, carrying equipment weighing 28 kg. It took them 5 h 38 min. to go from the base camp (902 m) and climb to an altitude of 1,648 m and return by the same route. They travelled a distance of 24.2 km with an average slope of 6.5%, and a 20.1% maximum grade. The average environmental temperature during the march was 2ºC.

All the subjects had been at the base camp, located at 902 meters, for 12 weeks prior to the march.

Taking of blood samples

Two blood samples were obtained for each subject at the same time, at the start of the march (PRE) and at the return to the base camp (POST), for subsequent analysis. The PRE fasting sample was obtained at 06:00 and the subjects spent the day in the base camp classroom planning the route for the march, with no type of physical activity until the start of the march at 00:00 (midnight). The POST sample was taken on the return of the subjects to the base camp at 06:00.

All samples were obtained by the unit's military nurses through venipuncture in the forearm using the Venoject® system and following the stipulated procedure of the Clinical Laboratory of the Military Hospital of Santiago. The analytical process was conducted through the fully automated LAB CELL platform (Siemens) interfaced with the Advia 2120, Advia 1800 and Advia Centaur XP systems.

For the haemogram, the sample was stored in a BD Vacutainer in an EDTA tube and processed in an Advia 2120 through flow cytometry, optical laser and impedance. For the purpose of this study, the analysis comprised the number of red cells (RBC), haemoblobin (Hb), haematocrit (Hct) and mean corpuscular volume (MCV).

To measure the Cortisol and Total Testosterone (TT), the study used a BD Vacutainer with gel separator and coagulation activator and it was processed in an Advia Centaur XP by chemiluminescence. For the Free Testosterone (FT), the study used a BD Vacutainer with gel separator and coagulation activator. It was processed in an Immulite 2000 (Siemens) by radioimmunoassay (gamma counter).

Immediately after drawing the blood samples, these were sent to the clinical laboratory at the Military Hospital of Santiago, transported by personnel from the aforementioned laboratory in compliance with the regulations for the transport and storage of biological fluids.

An initial atmospheric pressure of 663 mmHg[23] was calculated and the oxygen saturation level ($Sa0_2$) was measured with a portable device (Nonin CMS50D, USA, 2014). Weight was measured with a Tanita scale (Tanita Ironman BC1500, Japan, 2015) and the tympanic temperature was taken before and after the march using an infrared thermometer. (Boeringher, Germany, 2015).

Statistical analysis

The data are presented as mean and standard deviation (SD) and were analysed using the Statistical Package for the Social Sciences 15.0 software (SPSS Inc, USA). For each analysis, the normality of distribution was tested using the Shapiro-Wilk test. The median and standard deviation were calculated for each measurement. In order to determine whether there were significant differences between the pre and post tests, the Student's paired t-test was applied to the variables with normal distribution and the Wilcoxon test to the not normally distributed variables. In all cases, we considered a confidence level of 95% (value $p < 0.05$).

Additionally, the difference between variables was valued by calculating the effect size (ES) through Cohen's d-test[24]. The d values were considered as: very small ($d<0.1$); small ($d = 0.1$ to 0.2); moderate ($d =$ 0.21 to 0.5); large ($d = 0.51$ to 0.8) and very large ($d > 0.8$).

Results

Table 1 shows the data for the variables analysed and corresponding to the PRE and POST samples, together with the values for the Cohen's d test and the effect size.

All the changes were significant, except for the SaO_2 and the cortisol.

Discussion

The main contribution of this study is that, following a winter march with combat equipment, at a low altitude and with a difference in height of 746 m, the soldiers of a mountain operations unit showed a significant drop in the plasma values of FT and TT, with no changes in the cortisol values.

With regard to the cortisol, changes have been reported due to the effect of height, but only at moderate or high altitudes and so that it appears that the exposure process is the factor determining the behaviour of cortisol at these altitudes. When exposure is acute, cortisol has been observed to increase[7-9,14] however, with gradual exposures, no changes are observed in cortisol levels[11]. When physical exercise is performed at these heights, following acute exposure, a drop is reported in previously high cortisol levels, for saliva[12] and blood[10] alike. At low altitudes (such

Table 1. Measurement and standard deviation (SD) of weight, $Sa0_2$, temperature, cortisol (C), free testosterone (FT) and total (TT), FT/C ratio, RBC, haemoglobin, haematocrit and mean corpuscular volume (MCV).

Variable	Pre-test	Post-test	d	ES
Weight (kg)	75.2±7.6	74.1±7.58*	0.15	Small
Sa02 (%)	97.4±2.99	97.1±2.7	0.11	Small
Temperature (°C)	35.5±0.43	35.9±0.36*	1.02	Very large
Cortisol (uM/L)	0.75±0.12	0.72±0.17	0.26	Moderate
FT (uM/L)	43.4±11.5	24.7±14.1*	1.84	Very large
TT (uM/L)	11.2±3.8	4.94±3.22*	2.31	Very large
FT/C Ratio	60.3±19.7	36.4±22.3*	1.44	Very large
RBC (M/uL)	5.11±0.24	5.05±0.23*	0.26	Moderate
Haemoglobin (M/uL)	15.2±0.73	14.9±0.76*	0.42	Moderate
Haematocrit (°C)	45.3±1.9	43.5±1.98*	0.89	Very large
MCV (uM/L)	88.7±2.22	86.4±2.3*	1.01	Very large

*$p<0.05$; ES: effect size calculated with Cohen's d: $d <0.1$ (ES very small); $d = 0.1$ to 0.2 (ES small), $d = 0.21$ to 0.5 (ES moderate), $d = 0.51$ to 0.8 (ES large) and $d > 0.8$ (ES very large).

as those forming part of this study) no effects on cortisol have been reported in the literature.

On the other hand, the cortisol response to exercise is extremely variable, depending on the time of day, the type of exercise and the accumulated fatigue (as well as other factors) and it could therefore either increase, decrease or stay the same[25].

Therefore, given that the low altitude in itself has no effect on cortisol, the fact that there were no variations of cortisol in our group would indicate (in general) that the specific task performed would not have involved a stress stimulus that was sufficiently intense to raise the levels of cortisol in response to the same. However, this explanation is somewhat inconsistent with the effort that these soldiers had to make, as part of their training, taking into account that the march was made at a considerable average speed for the equipment that they were carrying and that it took place at night, at low temperatures and with a difference in height of close to 750 m.

With regard to the decrease observed in testosterone values, the normal response at high altitudes is not clear in the literature, if there actually is an effect that is directly related to altitude. Most of the studies consulted determine testosterone levels during training sessions in high mountain areas[15] or else the long term effect of exposure to high altitudes[4,11,26]. In any case, we have found no effects reported in the literature attributable to low altitudes such as those in this study.

On the other hand, with regard to physical exercise, a large number of works published use values of salivary testosterone with highly varied results, which agrees with the meta-analysis by Hayes, *et al*.[27] which found that the effects are highly dependent on the type of exercise, the study design and the sampling time. Another recent review[28] reveals that high-intensity exercise produces a reduction in the activity of the hypothalamic–pituitary–gonadal axis with the subsequent decrease in testosterone levels, while it finds that the data published for moderate intensity exercises are inconsistent. Pursuant to this review, our data would be more coherent with the work load that this task represents and with the fatigue level experienced by the subjects.

The FT/C ratio shows a marked decrease with values similar to those found in athletes under high work load or overexertion conditions[27,29,30].

With regard to the parameters for the red blood cells, all of these (RBC, Hb, Hct, and MCV) showed significant decreases after the march and with a moderate ES for RBC and Hb and very large for Hct and MCV (Table 1). In this section, the existing data also support the idea that these altitudes do not induce haematological changes by themselves. Thus, Rietjens[31], following the 3-year monitoring of high level triathletes, found that altitudes of at least 2,000 m are required in order to attribute haematological changes to altitude, and works frequently report these changes at higher altitudes[32,33]. In our opinion, the changes in the red blood count could be conditioned by a haemodilution effect that has already been reported for marathon runners[34]. With regard to the decrease observed in the MCV, this agrees with what Sewchand already described in 198035 finding that any acute exposure to altitude would produce a decrease in MCV of between 12 to 14%.

The principal limitation of this study lies in the fact that we were unable to differentiate the effect of the physical work load from the additional stressors (such as cold, lack of sleep or accumulated fatigue) and from the possible effect of the change in altitude, although, based on the literature, this latter factor could reasonably be ruled out. A further limitation was the failure to control the fluid intake during the march, although this aspect is slightly mitigated by the fact that we monitored the level of dehydration through double weighing.

Conclusions

A winter march of soldiers from a mountain operations unit, carrying combat equipment, conducted at a low altitude and with a change of height of 746 m, produces a significant drop in their plasma Testosterone levels (free and total).

No changes in the cortisol levels were observed.

A significant reduction was detected in RBC, haemoglobin, haematocrit and MCV, that could be due to the effect of haemodilution.

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Conflict of interest

The authors have no conflict of interest whatsoever.

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Evaluation of physical fitness in spanish people over 80 years of age using the senior fitness test and the body mass index

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Summary

Life expectancy has increased significantly in western societies. Physical exercise adapted to the elderly is a key factor in achieving active ageing.

Objectives: Main objective was to assess the functional fitness of active, independent, over 80 years of age, Spanish subjects enrolled in a Senior Physical Fitness program using the Senior Fitness Test (SFT), and to compare the results with the SFT reference intervals. The secondary objective was to analyse the sample's results when distributed according to age and sex.

Material and method: A transversal study was conducted in 162 participants (142 women, 87%). They were administered the SFT to determine their physical abilities and their BMI was calculated in order to find out its influence on their physical condition.

Results: Our Spanish sample performed better in strength and agility but presented lower outcomes in endurance and flexibility when compared to the US target population. In the Spanish sample significant differences between the two sexes were only found in the resistance score, where men performed better than women, (p=0.006). Participants over 85 presented lower results in BMI (p=0,007), upper body strength (p=0.01) and lower body flexibility (p=0.02). The mean BMI of our sample was higher than that of the American population.

Conclusions: The Spanish population is stronger and has more agility, but it's also less flexible and has lower endurance when compared to the American population. The Fitness condition in our population > 80 is similar in men and women.

Key words:
Senior Fitness Test. Physical activity. Elderly. Ageing.

Valoración de la condición física mediante el *senior fitness test* y el índice de masa corporal en una muestra española de personas mayores de 80 años

Resumen

La esperanza de vida se ha incrementado notablemente en las sociedades occidentales. El ejercicio físico adaptado a personas mayores es clave para conseguir un envejecimiento activo.

Objetivos: El objetivo principal fue determinar los niveles de condición física con el *Senior Fitness Test* (SFT) en sujetos españoles, mayores de 80 años, activos e independientes, adscritos a un programa de Condición Física de Mayores (CFM) y compararlos con los valores estadounidenses de referencia del SFT. El objetivo secundario fue analizar los resultados de nuestra población distribuidos por sexo y edad.

Material y método: Se realizó un estudio transversal en 162 participantes, (142 mujeres, 87%), a los que se les aplicó el SFT para evaluar su condición física y se les midió el Índice de Masa Corporal (IMC) para valorar su influencia sobre la condición física.

Resultados: En el SFT, la muestra española presentó mejor desempeño en fuerza y agilidad y niveles más bajos en flexibilidad y resistencia que la población estadounidense de referencia. No se encontraron diferencias significativas entre sexos en la población española, excepto en la prueba de resistencia a favor de los hombres (p=0,006). El grupo mayor de 85 años presentó resultados inferiores del IMC (p=0,007), de la fuerza del tren superior (p=0,01) y de la flexibilidad del tren inferior (p=0,02). La media del IMC de la muestra estudiada fue superior a la media de la población estadounidense.

Conclusiones: La muestra española es más fuerte y ágil, pero menos flexible y resistente que la población estadounidense de referencia. La capacidad funcional en nuestra población mayor de 80, es similar en ambos sexos.

Palabras clave:
Senior Fitness Test. Actividad física. Mayores. Envejecimiento.

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Introduction

Life expectancy in western countries has risen notably over the last century thanks to improvements in social and health conditions[1]. In Spain, life expectancy stands at 85.8 for women and 80.3 for men[2]. The percentage of the population over 65 in the country is currently 18.7% and is expected to reach 25.6% and 34.6% by 2031 and 2066, respectively[3].

The European Commission promotes the idea of keeping older people active and independent[4], and if we know their physical activity habits, we can influence and improve their behaviour patterns. Functional capacity for day-to-day activities diminishes with age; strength, flexibility and aerobic endurance are the factors most affected[5]. Physical activity is positively related to degree of independence[6] and prolonged periods of immobility increase death due to disease in this population[7]. Various studies have found that a suitable physical activity programme improves muscle strength[8,9], aerobic endurance, agility, balance and flexibility[10,11], which are associated with a greater ability to perform everyday activities[12].

Studies have shown that physical exercise programmes improve the degree of independence of the over-60s[6,9,12], but we have not found any studies specifically focussing on populations aged over 80 in Spain or anywhere else. The Senior Fitness Test (SFT) is a validated test widely used to quantify the physical condition of the elderly[13-15].

The main aim of our study was to use the SFT and BMI to identify the fitness level of a population of active subjects aged over 80 taking part in Senior Physical Fitness programmes in the last quarter of 2017 and to compare the results obtained with the reference values of a US population aged over 80. The secondary objective was to analyse the SFT results of our population by sex and age.

Material and method

Population

People over 80 years of age, not in care homes and taking part in a Málaga City Council Senior Physical Fitness programme in the last quarter of 2017 were included. They all presented medical reports indicating that they did not suffer from any acute or chronic condition (cardio-pulmonary, renal, orthopaedic, neurological, etc.) which would make the SFT unadvisable. The characteristics of the study were explained to all the participants beforehand and they all signed an informed consent form. Those who did not wish to take part and those with one of the conditions mentioned were excluded from the study.

Material

The material used to conduct the study consisted of:

- Aluminium measuring rod.
- Jata non-digital scales.
- Analogue stopwatch for the strength, agility and endurance tests.
- 2.5 kg and 4 kg weights were used for women and men, respectively, instead of the 2.27 kg (5 lb) and 3.63 kg (8 lb) ones originally used in the SFT.
- A 150 cm flexible tape measure to measure flexibility.
- A plastic cone measuring 45.5 cm in height and with a 20x20 cm base for the agility test.
- A bench or chair without armrests.
- A rectangular 47.5 m perimeter for the endurance test.

Methodology

The study was cross-sectional with the prospective collection of the following variables: sex, age and BMI.

The other variables studied were obtained from the different tests included in the usual SFT battery[16]:

- *Arm curl test* (ACT): upper body strength.
- *Chair stand test* (CST): lower body strength.
- *Back scratch test* (BST): upper body flexibility.
- *Chair-sit and reach-test* (CRT): lower body flexibility.
- *Foot up-and-go test* (FT): agility.
- *6-minute walk test* (6-MWT): endurance.

In order to study the influence of age in our population, the subjects were divided into two age groups: one for those aged between 80 and 85, and the other for over-85s.

Statistical analysis

Los datos fueron recogidos en el programa SPSS (v 25) y se utilizó el softThe data were collected in SPSS (v 25) and Excel 2000 software was used for graphic data processing. The quantitative variables were expressed as means plus standard deviation. Mean and variance weighting was carried out to obtain the US reference values. The Kolmogorov-Smirnov test was used to test the normality of the variables. Because we were unable to assume normality, the nonparametric Mann–Whitney U test was applied to study the possible differences between sexes and age groups. A p-value of ≤0.05 was considered to be statistically significant.

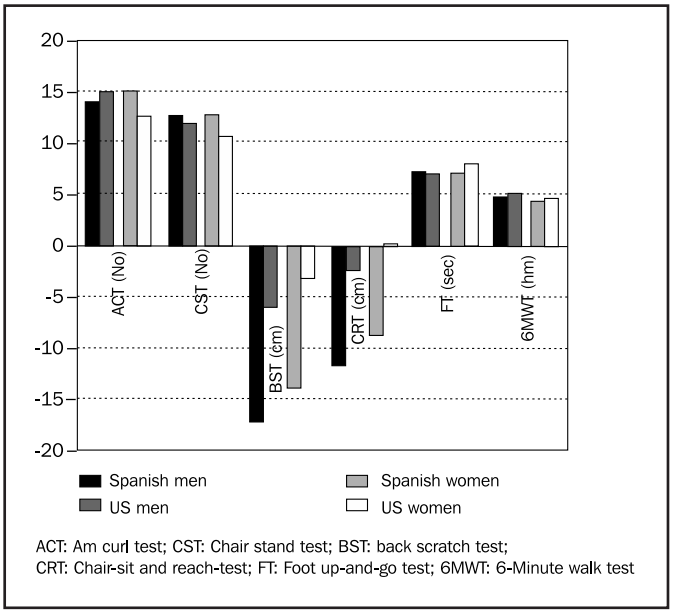
Results

The participants in the study were people over 80 years of age of Caucasian origin. 162 subjects were included, 20 men and 142 women. They all completed the SFT and their BMIs were calculated without incident. The age range was between 80 and 95. The mean age of the men was slightly higher than that of the women (84±3.4 *vs* 83±2.6). The mean BMI of the population was 28.63±4.20 kg/m^2 for the women and 26.82±3.81 kg/m^2 for the men.

Figure 1 shows the results of the SFT of the Spanish and US populations by sex. The Spanish women gave better strength test results than the American women.

Table 1 shows the BMI and SFT results by age group. As can be seen, all the age groups in the Spanish population obtained higher upper body (ACT) and lower body (CST) strength values. However, the

Figure 1. SFT results of the Spanish population and US population by sex.



ACT: Am curl test; CST: Chair stand test; BST: back scratch test; CRT: Chair-sit and reach-test; FT: Foot up-and-go test; 6MWT: 6-Minute walk test

Spanish sample obtained lower upper body (BST) and lower body (CSR) flexibility values than the American population[17].

Table 2 shows the SFT results by percentiles, split into 'low' (p0-p25) 'normal' (p25-p75) and 'excellent' (p75-p100), in line with Rikli and Jones[15,16]. Figures 2 and 3 show the same results by sex. In terms of upper (ACT) and lower body (CST) strength, 75% and 95% of our male sample, and 90% and 96.5% of our female sample achieved 'normal' and 'excellent' results, respectively. When it came to both lower body (CSR) and upper body (BST) flexibility, however, our sample scored worse than the reference sample, especially the Spanish women compared to the American women. When comparing the results of our population by sex, no significant differences were found, except for the endurance test (6-MWT, p=0.006), where the men obtained better results than the women (Table 2).

Table 1. SFT results of the Spanish population and US population by age.

Tests	Age	US population Mean±SD	Spanish population Mean±SD
BMI	80-85	25.14±3.84	28.93±4.27
	85-90	24.45±3.42	26.90±3.66
	>90	24.35±4.26	26.29±2.11
Arm curl test (ACT)	80-85	13.93±4.16	15.05±3.72
	85-90	12.56±3.93	13.19±4.20
	>90	11.26±3.70	14.25±4.79
Chair stand test (CST)	80-85	11.64±4.11	12.80±13.15
	85-90	10.50±4.17	11.72±5.26
	>90	8.57±4.70	10.78±7.84
Back scratch test (BST)	80-85	-3.54±4.59	-14.13±11.83
	85-90	-4.49±4.58	-15.85±15.71
	>90	-5.39±5.07	-15.07±1.68
Chair-sit and reach-test (CRT)	80-85	-0.28±4.15	-8.12±9.79
	85-90	-0.68±3.83	-11.35±12.20
	>90	-2.32±4.10	-24.01±10.90
Foot up-and-go test (FT)	80-85	6.95±2.08	6.65±1.46
	85-90	7.72±2.53	7.75±3.37
	>90	8.96±3.10	9.09±3.79
6-Minute walk test (6MWT)	80-85	481.85±117.97	420.89±93.35
	85-90	440.43±132.81	396.32±91.90
	>90	374.38±134.74	38.18±134.38

Table 3 shows the SFT and BMI results of our population by age group. A decrease in BMI (p=0.007), upper body strength (ACT, p=0.01)

Table 2. Spanish sample results by sex according to Rikli and Jones' reference percentiles.

Tests	Sex	Mean± SD	SFT result			p-value
			Low	Normal	Excellent	
Arm Curl Test (ACT)	M:	13.95±4.45	25%	70%	5%	>0.05
	F:	14.71±3.83	9.9%	47.9%	42.3%	
Chair Stand Test (CST)	M:	12.66±6.11	5%	45%	50%	>0.05
	F:	12.49±3.46	3.5%	46.5%	50%	
Back Scratch Test (BST)	M:	-17.32±10.18	30%	60%	10%	>0.05
	F:	-14.14±12.91	49.3%	35.2%	15.5%	
Chair-sit and Reach-test (CRT)	M:	-11.82±11.45	40%	60%	0%	>0.05
	F:	-8.86±10.55	62.7%	35.2%	2.1%	
Foot up-and-go Test (FT)	M:	7.06±3.12	15%	60%	25%	>0.05
	F:	6.93±2.00	13.4%	66.2%	20.4%	
6-Minute walk test (6MWT)	M:	463.61±148.21	15%	65%	20%	>0.05*
	F:	406.31±82.90	19%	66.9%	14.1%	

*Statistically significant.

Figure 2. Results of the Spanish men according to the SFT reference percentiles.

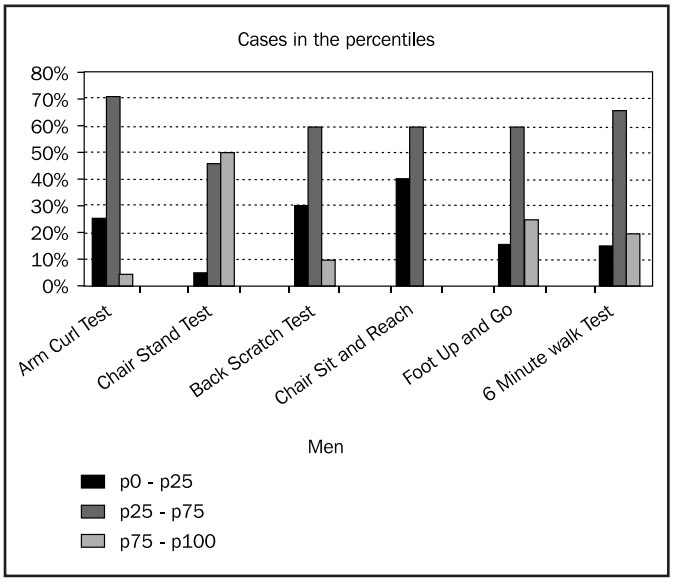
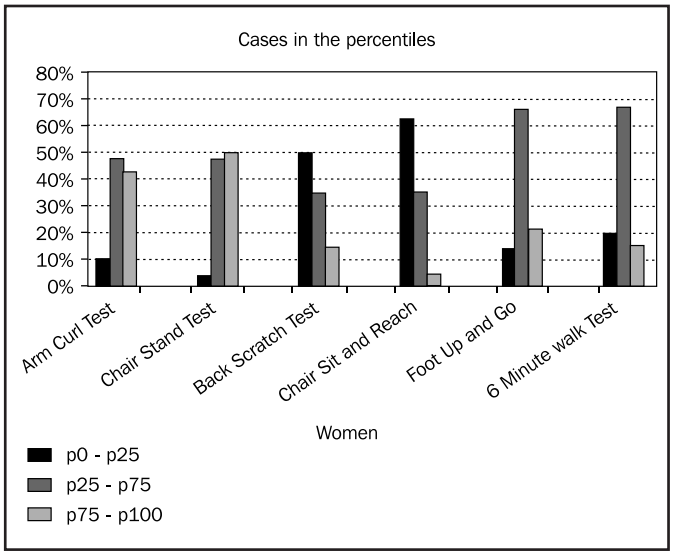


Figure 3. Results of the Spanish women according to the SFT reference percentiles.



and lower body flexibility (CRT, p=0.02) was observed as age increased, the other differences detected being statistically insignificant..

Discussion

According to estimates accepted by all social actors, life expectancy is expected to continue to follow an upward trend in the future. The lack of research on physical activity in people aged 80-95 was one of the main reasons why this research was conducted. Physical fitness was determined by means of the SFT, a widely validated test[15] used to highlight the weaknesses and strengths of Senior Physical Fitness programmes.

Table 3. SFT and BMI results in the Spanish sample by age.

Tests	Age	n	Mean± SD	p level
BMI	80-85	122	28.93±4.27	< 0.01*
	>85	40	26.84±3.52	
Arm Curl Test (AMC)	80-85	122	15.05±3.72	< 0.05*
	>85	40	13.30±4.21	
Chair Stand Test (CST)	80-85	122	12.80±3.15	> 0.05
	>85	40	11.63±5.45	
Back Scratch Test (BST)	80-85	122	-14.13±11.83	> 0.05
	>85	40	-15.77±14.90	
Chair-sit and Reach-test (CRT)	80-85	122	-8.12±9.79	< 0.05*
	>85	40	-12.61±12.55	
Foot up-and-go Test (FT)	80-85	122	6.65±1.46	> 0.05
	>85	40	7.88±3.38	
6-Minute walk test (6MWT)	80-85	122	420.88±93.35	> 0.05
	>85	40	390.51±96.33	

*Statistically significant; BMI: Body Mass Index.

Comparing the SFT and BMI variables of the two populations (Spanish and US), which was the chief objective of the study, we found that (Figure 1, Table 1):

- Our sample gave moderately higher strength values in all age groups compared to the American sample, especially for women. The Spanish population achieved higher upper limb strength values (ACT) despite using heavier dumbbells (change from lb to kg), which has had a negative impact in other studies18. Similar results were obtained in the measurement of lower body strength (CST), with all the participants scoring higher than the reference population.
- As for agility (FT), the Spanish and American populations gave similar results, although the Spanish women did slightly better. This difference could be due to greater lower body strength, a direct relationship between strength and agility having been observed in other studies[19].
- The levels of flexibility (CRT and BST) of the sample were considerably lower than the US population, especially for women (Table 2). It is striking that our population obtained worse results in flexibility despite taking part in a Senior Physical Fitness programme, in which stretching exercises are included at the end of each session.
- As for endurance (6MWT), although not appreciable due to the adjustment of the measurement unit in Figure 1 (from metres to hectometres), there were significant differences in favour of the US population. Waist circumference is inversely related to aerobic endurance[20]. The higher BMI found in our population could justify its poorer performance in the endurance test.

Considering it still a simple, valid method, the BMIs of the two populations were also compared in order to relate body fat percentage and cardiovascular risk[20]. 78.39% of our subjects were overweight or obese, especially the women[21]. However, our population aged >85 had a lower BMI than the population aged <85 (p=0.007), suggesting that the increase in BMI in our population tends to disappear with age[22]. New studies evaluating nutritional status or even questioning the validity of BMI when evaluating people of such advanced ages would be very useful.

As for the secondary objective, we compared the SFT results of our population by age and sex. A significant decrease was observed in the tests measuring upper body strength (ACT p=0.01) and lower body flexibility (CSR p=0.022) in the > 85 group (Table 3), perhaps due to the drop in physical capabilities as age increases5. Other studies[12,21] have applied a cut-off point of 70-75 years of age, which is when functional decline is most marked. Because our sample had an age range limited to 80-95, it is difficult to find other significant differences. A comparison of the SFT results by sex shows no significant difference except in the endurance test (6MWT, p=0.006) (Table 2). Further studies to justify the similarity in the results of the active population aged> 80 when compared by sex are needed.

The strengths of this study lie in the fact that we have found no other studies analysing the SFT in a population similar to ours, the subjects demonstrated great tolerance and readiness to carry out the SFT, no side effects at all were recorded and these results may be useful in order to improve the Senior Physical Fitness programmes used.

The imbalance in the sample between the number of men and women should be noted as a weakness.

Conclusions

Assessing the physical fitness of our population, by comparing it with the normative SFT values and the results within the population itself leads us to the following conclusions:

- The Spanish sample would appear to be stronger and more agile, but to be less flexible and to have less endurance than the reference population.
- The difference in functional capacity between men and women tends to disappear in the population aged over 80.
- The BMI may not be a reliable anthropometric parameter in populations aged >80.

Conflict of interest

The authors declare that they are not subject to any type of conflict of interest.

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Gastrointestinal illnesses in endurance sports women: a review

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Summary

It has been found that gastro-intestinal disorders are limiting factors in both endurance and ultra-endurance sports performance. Studies on the likely causes of such health conditions show that several elements are involved. It is estimated that 30% to 90% of runners suffer from digestive conditions leading to the detriment of both performance and rehabilitation. Considering the increase in the number of long-distance runners with a focus on females, it is of particular interest to analyse the presence of a greater percentage of such health problems in women. Therefore, it raises the hypothesis that women are more affected by gastrointestinal conditions than men in endurance sports. The aim of this review is to appreciate if there is a higher percentage of gastrointestinal problems in endurance sportswomen compared to that in endurance sportsmen. Results suggest that the numbers are high in percentage terms for woman compared to men presenting gastrointestinal symptoms. Although a study suggests there is evidence on the contrary, others report that there are no differences between the sexes. Women suffer more from diarrhea, flatulence, urge to defecate, etc (lower digestive tract) than vomiting, reflux, nausea etc (upper digestive tract). Other risk factors can be considered, namely younger age and a lack of experience in running. Even though there are no studies that analyse such cases, there is a marked tendency to affect women. However, it is of vital importance to carry out studies on greater populations with an emphasis on the sexes.

Key words:
Physical endurance. Gastrointestinal diseases. Inflammatory bowel diseases. Gastrointestinal distress.

Problemas gastrointestinales en deportes de resistencia en mujeres: revisión de literatura

Resumen

Los problemas gastrointestinales en los deportes de resistencia y ultra-resistencia se encuentran entre los factores limitantes del rendimiento deportivo. Se han estudiado las posibles causantes de estas afecciones y se plantea una situación multifactorial. Es cada vez más habitual el número de personas que practican deportes de resistencia, y se estima que entre el 30 y 90 % de ellos presentan problemas GI de diversa gravedad. Esto implica una limitación del rendimiento y también condiciona la recuperación posterior al esfuerzo. Dado el aumento de población que practica este tipo de deportes de resistencia a largas distancias, y en concreto del género femenino, resulta de interés estudiar el alcance de estos problemas en mujeres. Se plantea la hipótesis de que la mujer sufre más problemas gastrointestinales que el hombre en deportes de resistencia. Esta revisión pretende conocer si existe mayor frecuencia de problemas gastrointestinales asociados a la práctica de deportes de resistencia en mujeres. Los resultados de la presente revisión parecen mostrar que las mujeres presentan síntomas gastrointestinales con más frecuencia que los hombres, aunque uno de los estudios obtiene el resultado contrario y otros no ven diferencias. Parece que la mayor incidencia se da en problemas gastrointestinales del tracto bajo (diarrea, flatulencia, urgencia para defecar…) más que en el tracto alto (reflujo, náuseas, vómitos…). Otros factores de riesgo asociados encontrados son edades más jóvenes y menor experiencia en carreras a pie. Aunque no existen estudios específicos para la evaluación de estas afecciones y su incidencia por sexos, se puede observar una clara tendencia en la mayor presencia de estas afecciones en mujeres, si bien es preciso realizar estudios con muestras más grande de ambos grupos y que tengan en cuenta las diferencias fundamentales de ambos. Se requieren investigaciones específicas para una mejor evaluación de las afecciones gastrointestinales en función del sexo.

Palabras clave:
Resistencia física. Enfermedades gastrointestinales. Enfermedad intestinal inflamatoria. Estrés gastrointestinal.

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Introduction

The annual report published by the Ministry of Education, Culture and Sport in 2017 shows that the weekly pursuit of all kinds of sports has increased. This is particularly true of endurance sports, with 10.6% of the population engaging in running and 10.3% in cycling in 2015, compared to figures of 4.8% and 6.7%, respectively, in 2010. This growing interest in sporting activity and especially endurance sports, which occupy both the 2nd and 3rd positions in the ranking, is notable[1].

The 2015 survey on Sporting Habits in Spain (included in the 2017 report) shows that, although the number of men who do sport is still higher, 42.1% of women pursue sporting activities on a weekly basis, marking a significant increase on the figures in the previous survey conducted in 2010. The report also indicates that this increase in sporting activities among women is particularly notable in the younger age ranges.

Puig and Soler (2012) point out that men have engaged in sports more than women ever since records of sporting habits began and also that significant differences regarding the type of sporting activity pursued have always existed. Football, swimming and cycling are the most popular sports among men, while women prefer recreational or keep-fit swimming in first place, followed by aerobics, rhythmic gymnastics, dance and keep-fit gymnastics[2].

As for high-performance sports in Spain, men have taken part in the Olympic Games without fail since the start of the 20th century, while the first women did not compete until Paris 1924. It was not until the 1960 Rome Games that women reappeared and their presence has grown since then, at times even exceeding the number of men (Barcelona 1992, 141 women and 78 men in the Spanish team).

According to the latest annual report on sporting habits, the number of women who engage in the endurance sports of running and cycling increased from 3.4% to 8% in the former and from 3.2% to 5.5% in the latter between 2010 and 2015[1].

An endurance sport is anything from a sport which requires aerobic metabolism and lasts 60-90 minutes (10 km, half marathon, short road or mountain bike rides, depending on the level of training) to the so-called ultra-endurance sports, where the distances covered are superior to those of a marathon (42,195 km) or more than 160 km by bicycle.

From a metabolic point of view, endurance and ultra-endurance sports consume large amounts of energy and the role of carbohydrates and/or lipids during exercise and how they are regulated has been a subject of research for decades. We now know that the energy substrate source used depends on the intensity (%VO_2max.) and duration of the exercise, i.e. whether carbohydrates or lipids are used as an energy source[3,4].

At low levels of VO_2max., fat supplies the largest share of energy, losing prominence as VO_2max. increases and the exercise lasts, giving way to greater carbohydrate oxidation[3,4]. It has been seen that lipid oxidation peaks at mean intensities of 45% to 65% VO_2max., depending on sex, level of training, VO_2max. and diet.

Higher training levels result in improved use of fats as an energy source as training causes physiological adaptations associated with an increase in oxidative enzymes and mitochondrion content in muscle cells, regulation of lipid uptake in muscle fibres and the transportation of fatty acids (FA) through the mitochondrial membranes, and regulation of the hydrolysis of intramuscular triacylglycerols[3-5].

Exercise has a direct positive effect on health[6,7], although it may have less healthy implications at cardiac, musculoskeletal and renal levels[7,8].

At a digestive level, it may cause increased intestinal motility as a result of increased peristalsis, improved intestinal microbiota or normalisation of intestinal transit[9,10]. However, as the intensity of exercise is increased, these changes, which could be of benefit to the athlete a priori, may represent a limiting factor, between 20% and 50% of athletes experiencing gastrointestinal (GI) discomfort[6,11].

In the late 1980s, Rehrer studied the relationship between GI problems in long-distance runners and their hydration status, concluding that they were not so much related to high fluid intake when running as to the runner's hydration status[12]. Similarly, it would seem that a high level of dehydration coupled with a decrease in blood flow in the intestinal tract induced by exercise itself may be directly related to GI dysfunction[8,12].

The controlled intake of carbohydrates in the diet and its relationship with the onset of GI problems in endurance athletes has also been studied, suggesting that controlling the concentration and type of carbohydrates consumed, together with other dietary components, such as fibre, may be one of the keys to managing the onset of GI disturbances[13-16].

At high intensities, our GI system finds itself compromised at various levels. These intensities increase sympathetic tone, which may lead to an increase in peristalsis to extraordinary levels, alter GI secretions, compromising nutrition absorption pathways, and increase intestinal mucosal permeability, which may lead to bouts of diarrhoea or, contrarily, constipation, which may be accentuated if the individual is not properly hydrated[17].

The specific causes of these problems are not fully known[11,18], yet we do know that they multifactorial and, therefore, it is useful to study each individual in particular in order to offer him/her better advice about his/her sporting activity and diet.

Oliveira, Burini and Jeukendrup (2014) studied the causes and prevalence of GI problems during endurance exercise and found that depending on the methodology used and type of sport studied, 30–90% of participants experience GI problems[17].

Their study analysed the direct influence of exercise on intestinal function, possible mechanical factors and nutrition as the possible causes of GI problems.

In order to study GI disturbances, problems such as reflux, nausea, vomiting, stomach ache, belching and bloating were defined as "high GI symptoms", while stomach cramps, side stitch, flatulence, intestinal bleeding, the urge to have a bowel movement and diarrhoea were defined as "low GI symptoms"[19].

Due to the morphological and hormonal differences between men and women, the hypothesis of this review is that female endurance athletes suffer GI problems directly related to exercise more often than their male counterparts.

The objective of this review is to determine whether women are more prone to GI problems when they engage in endurance sports

Methodology

An exhaustive search was conducted in the PubMed database in May 2018 and the search strategy was translated to Google Scholar. Articles were also added using the snowball method.

The formula used to search PubMed was:

("Physical endurance" [mesh] OR "physical endurance" [tiab] OR "endurance" [tiab]) AND ("gastrointestinal diseases" [mesh] OR "gastrointestinal diseases" [tiab] OR "gastrointestinal disease" [tiab] OR "inflammatory bowel diseases" [tiab] OR "inflammatory bowel disease" [tiab] OR "gastrointestinal distress" [tiab]).

The eligibility criteria taken into account to discriminate studies for the review were described. A table was created using the PICOT method (Table 1) to better establish these criteria.

The data extracted from each article finally selected for this review (adapted from MacMaster University[20]) were: size of population, author/s and year of publication, type of intervention, what data they are compared with, what outcomes are measured in the study, what the study design was and what the main findings were.

Results

The search formula in the PubMed database and Google Scholar threw up a total of 227 articles. After screening and the inclusion of two articles through snowballing, a total of 9 scientific articles were included in this review.

Table 2 shows the data extracted from the articles discussed in the review.

Discussion

No specific research aimed at studying the significantly different incidence of GI problems in men and women were found, but research involving symptoms which revealed gender-based differences in results was.

In the literature, we found mixed results: GI problems are more prevalent in women than men[21-24,27], GI problems are equally prevalent in women and men[26,28,29], and GI problems are less prevalent in women than men[25].

Of those which revealed a prevalence in women, the first were conducted with marathon runners by Keeffe (1984) and Riddoch (1988)[21,22], both employing a basic study methodology: the existence or non-existence of GI problems after a run.

Using a simple questionnaire on completion, Keeffe[21] gauged the existence of GI disturbances during and after a run. 707 questionnaires (85.2% men and 14.8% women) were collected, addressing three areas: (a) demographic data -age, sex, years running, average weekly km run-, (b) GI habits- average number of daily bowel movements, frequency of abdominal cramps or diarrhoea- and (c) symptoms associated with running, during easy runs, during hard training or runs, or immediately after an easy or hard run, with four possible answers: never, rarely, occasionally or frequently. The frequency of the appearance of "high" and "low" symptoms was differentiated for each of the running categories (easy, hard and immediately after). Regarding "high" symptoms, no significantly higher frequency was observed in women except in the case of nausea during both easy and hard runs. No numerical data are provided for this observation. For "low" GI symptoms, however, the percentage of positive responses (sum of occasionally and frequently divided by total responses) was higher for women than for men in all 3 running categories (easy, hard and immediately after). The results are shown in Figure 1 (extracted from reference 21).

It was also observed that the <20 age group experienced "low" GI problems more frequently than the 20-40 age groups and significantly more frequently than the >40 age group.

Riddoch[22] sent runners his questionnaire with the final race information pack and the data were collected prior to the start of the run. The questionnaire was completed by 471 participants (92% men and 8% women). It consisted of 2 parts: (a) personal profile of the runner -age, sex, running experience, average weekly km run, dietary habits and best personal time- and (b) the frequency of a range of GI symptoms during easy runs, during hard runs and after runs, with four possible answers: never, rarely, occasionally or frequently. "High" GI symptoms were less common than "low" GI symptoms in all 3 running categories (easy and hard runs, and after hard runs) and, with the exception of dark urine measurements, the women showed a statistically higher frequency than the men. The results are shown in Figures 2 and 3 (extracted from reference 22).

Table 1. Eligibility criteria according to the PICOT method.

Population	Intervention	Comparison	Outcome	Type of study
Women	Endurance sports Ultra-endurance sports	Men	Gastrointestinal problems	Prevalence studies Randomised clinical trials

17% of all the participants were asymptomatic, responding that they had never or rarely experienced GI symptoms. Of those who had suffered GI symptoms, 73% thought that it could be directly related to physical activity and the most common strategies employed to prevent them included running on an empty stomach and being sure to have a bowel movement before a run. Only a small percentage of those affected were aware of their problem and took measures to prevent it (medications or nutritional strategies, such as decreased dietary fibre or fat intake).

Table 2. Characteristics of the studies included.

Number of participants	Author/s (year)	Intervention	Comparison	Results measured	Research design	Results (in women)
103 women (707 total)	Keeffe, E.B.; Lowe, D.K.; Goss, J. R.; Wayne, R. (1984)[21]	13th Annual Trail's End Marathon in Seaside (1982)	Men	"High" and "low" GI symptoms during easy and hard runs, and after runs	Retrospective prevalence study	– Women do not have significantly more "high" GI symptoms than men, except nausea in easy and hard runs – All the "low" GI symptoms were more common in women than men – > "low" GI symptoms in under-20s
38 women (471 total)	Riddoch, C.; Trinick, T. (1988)[22]	Questionnaire prior to the 1986 Belfast marathon	Men	"High" and "low" GI symptoms during easy and hard runs, and after runs	Retrospective prevalence study	– 60% ≥1 "high" GI symptom – 87% ≥1 "low" GI symptom – 74% urge to have a bowel movement – 68% diarrhoea – >% GI symptoms in woman than men, except dark urine – > "high" GI symptoms in younger participants – Only 2 women were symptomatic
74 female long-distance runners (164 total) + 89 female cyclists (169 total) + 63 female triathletes (142 total)	Peters H.P.; Bos, M.; Seebregts, L.; Akkermans, L.M.; van Berge Henegouwen, G.P.; Bol, E.; Mosterd, W.L.; de Vries, W.R. (1999)[23]	Questionnaire on GI symptoms in the last 12 months. Runners and cyclists, same questionnaire bar certain details. Broader questionnaire for triathletes	Men	"High" and "low" GI symptoms during and after training and races	Retrospective prevalence study	– Female long-distance runners: no significant differences in prevalence of GI symptoms compared to men – Cyclists: more nausea, belching, bloating than men – Triathletes: side stitch and acidity during training, and more nausea 2 hours after racing than men – No difference in GI symptoms in women with/without menstrual period – > symptoms in cyclists, lower mean age than the others
10 km, 123 (total 261) 21 km, 222 (total 766) 42 km, 25 (total 227)	ter Steege, R.W.F.; Van der Palen, J.; Kolkman, J.J. (2008)[24]	Enschede Marathon 2006, 5-, 10-, 21- and 42-km races Online questionnaire 48 hours after the event: Demographic data + GI symptoms during the race, food/ drink intake, time or reason for withdrawal, if relevant + GI symptoms 24 hours after the race	Men	"High" and "low" GI symptoms during runs	Retrospective prevalence study	– 10 km: 13% GI symptoms vs. 7% men – 21 km: 22% GI symptoms vs. 8% men – 42 km: 31% GI symptoms vs. 6% women, 3 times greater risk of having GI symptoms after a run – Independent factors in serious GI symptoms during a run: woman <age <level of training
5 women (15 total)	Stuempfle, K.J.; Hoffman, M.D.; Hew-Butler, T. (2013)[25]	Proposed food/fluid intake during the Javelina Jundred 100 Mile Endurance Run, where GI symptoms were measured after each 25-km loop	Men	"High" and "low" GI symptoms during the 161-km run	Cross-sectional prevalence study	– 1 woman (20%) had GI symptoms – 80% women had no GI symptoms – 80% men had GI symptoms – No significant differences between finishers and non-finishers

(follow)

(continuation)

Number of participants	Author/s (year)	Intervention	Comparison	Results measured	Research design	Results (in women)
14 women surveyed (68 total) 8 women in 60-km race (41 total)	Wardenaar, F.C.; Dijkhuizen, R.; Ceelen, I.J.; Jonk, E.; de Vries, J.; Witkamp, R.; Mensink, P. (2015)[26]	Texel Ultra-marathon, 60 or 120 km Survey of habitual dietary intake 2 months before the race + Questionnaire on dietary intake the day after the race and GI symptoms in 120-km runners + Continuous in-situ observation during 120-km race	Men	"High" and "low" GI symptoms during the 60-km and 120-km runs Percentage of compliance with the diet proposed diet for the day of the run	Combined prevalence study (cross-sectional and retrospective)	– 7/8 women reported GI symptoms (87% vs. 81% men) – Women and men reported practically the same amount of distress – Daily CHO consumption was lower in women
8 women (18 total)	Miall, A.; Khoo, A.; Rauch, C.; Snipe, R.M.J.; Camões-Costa, V.L.; Gibson, P.R.; Costa, R.J.S. (2017)[27]	120 minutes treadmill running at 60% VO_2 with CHO consumption (90 g CHO hour-1) or placebo + 60 minutes running at maximum effort without CHO + 2-weeks training + Treadmill running, same conditions	Men and placebo.	GI symptoms food tolerance during exertion caloric intake state of hydration	Randomised clinical trial	– In trial 1: all the women reported at least 1 GI symptom – Tendency to present > GI symptoms and intestinal discomfort in trial 1 – In trial 2: women improved less than men – In the placebo group, no improvement was seen between trials 1 and 2
75 mujeres (145 total)	Wilson, P.B. (2017)[28]	Training and GI symptoms + at the end of 30 days, retrospective questionnaire on the period + new retrospective questionnaire on 30-day period 24-36 hours later to establish reliability of GI symptoms	Men	GI symptoms during training	Combined prevalence study (retrospective and prospective)	– At least 1 GI symptom in 78.3% of runs (vs. 84% men, non-significant difference) – 47.6% had symptoms scored as ≥3 (vs. 43.1% men) – 27.3% had symptoms scored as ≥5 (vs. 13.8% men)
76 women (150 total)	Wilson, P.B. (2018)[29]	Training journal/GI symptoms for 30 days + Retrospective questionnaire: demographic data, training experience, presence of any medical condition related to the GI system, eating habits, use of medication, caffeine and sports drinks, and data related to level of stress and anxiety	Men	GI symptoms related to stress and anxiety level	Combined prevalence study (retrospective and prospective)	– No significant differences between men and women were found in incidence of GI problems – < age and < experience: negative correlation with GI problems

As for age groups, it was observed that the younger participants (<34) suffered more frequently from nausea, abdominal cramps, loss of appetite, the urge to have a bowel movement and diarrhoea.

As occurred with Keeffe (1984), a clear trend for more frequent GI problems was observed in women and younger participants.

More recent studies introduce other variables[23,24,27]. These new variables, starting with those included by Peters, also consider the appearance of "high" and "low" symptoms during training (thus differentiating it from competition), after competitions and training, and during rest periods.

Figure 1. Percentage of positive responses for "low" GI symptoms in men and women during and immediately after an easy and hard run. Symptoms studied: abdominal cramps, urge to defecate, bowel movements, diarrhoea and bloody stools.

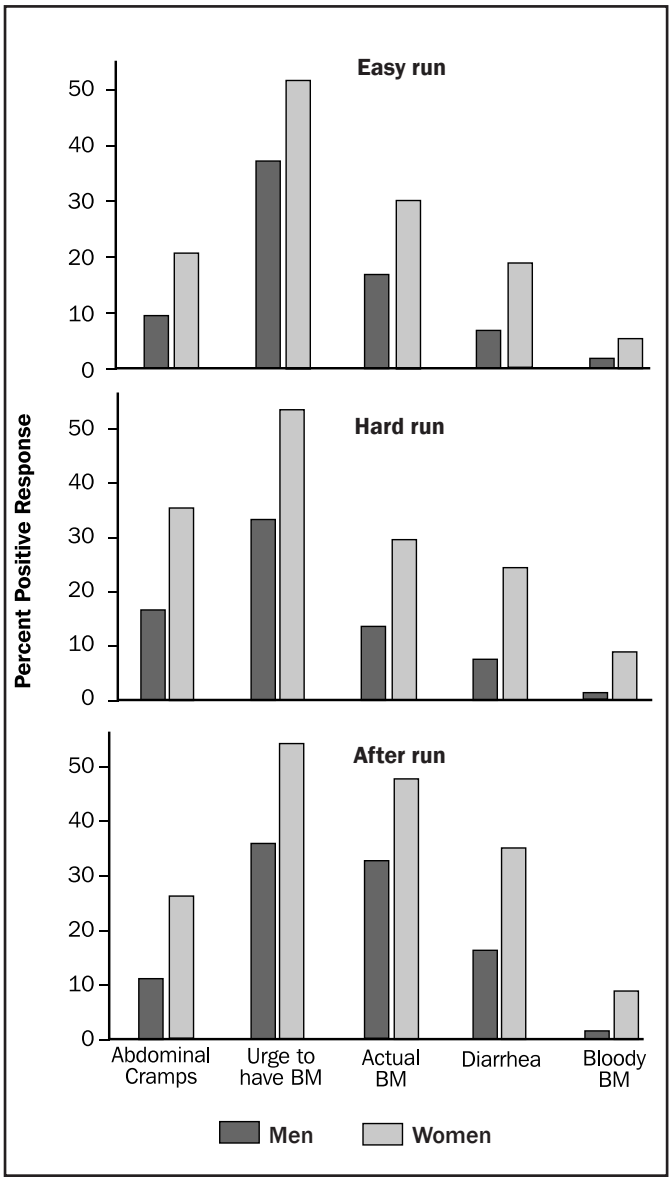
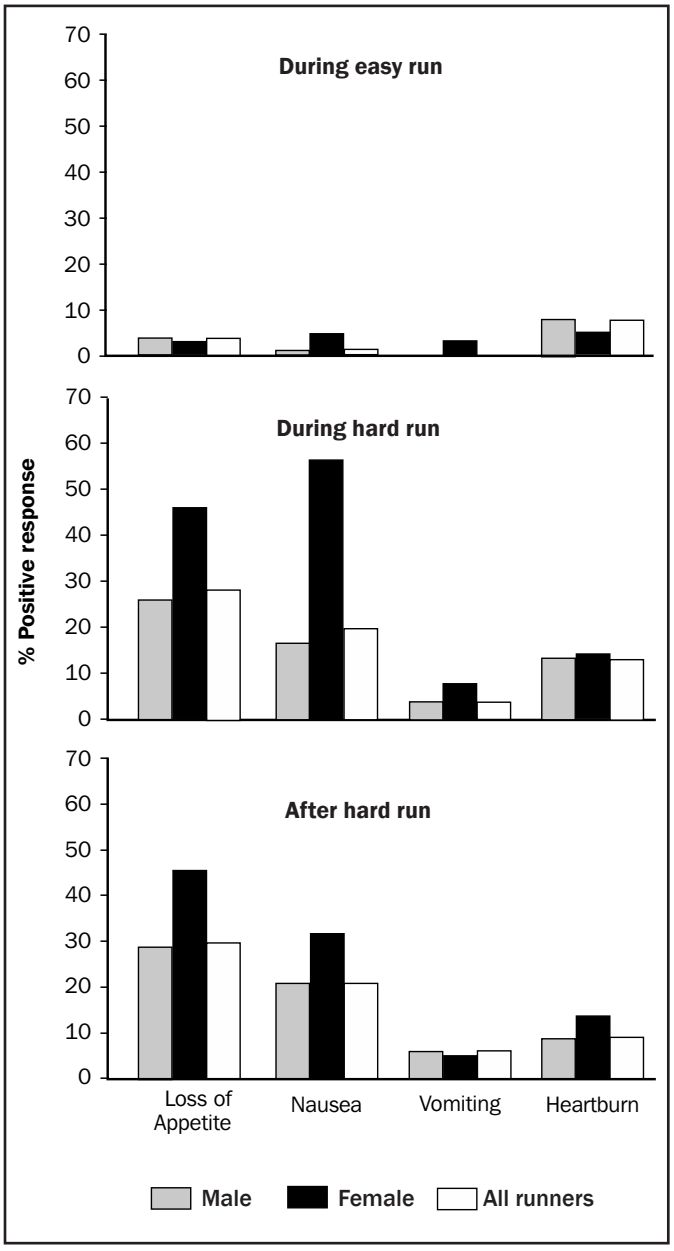


Figure 2. Percentage of positive responses for "high" GI symptoms in men and women during an easy run and during and after a hard run. Symptoms studied: loss of appetite, nausea, vomiting and heartburn.



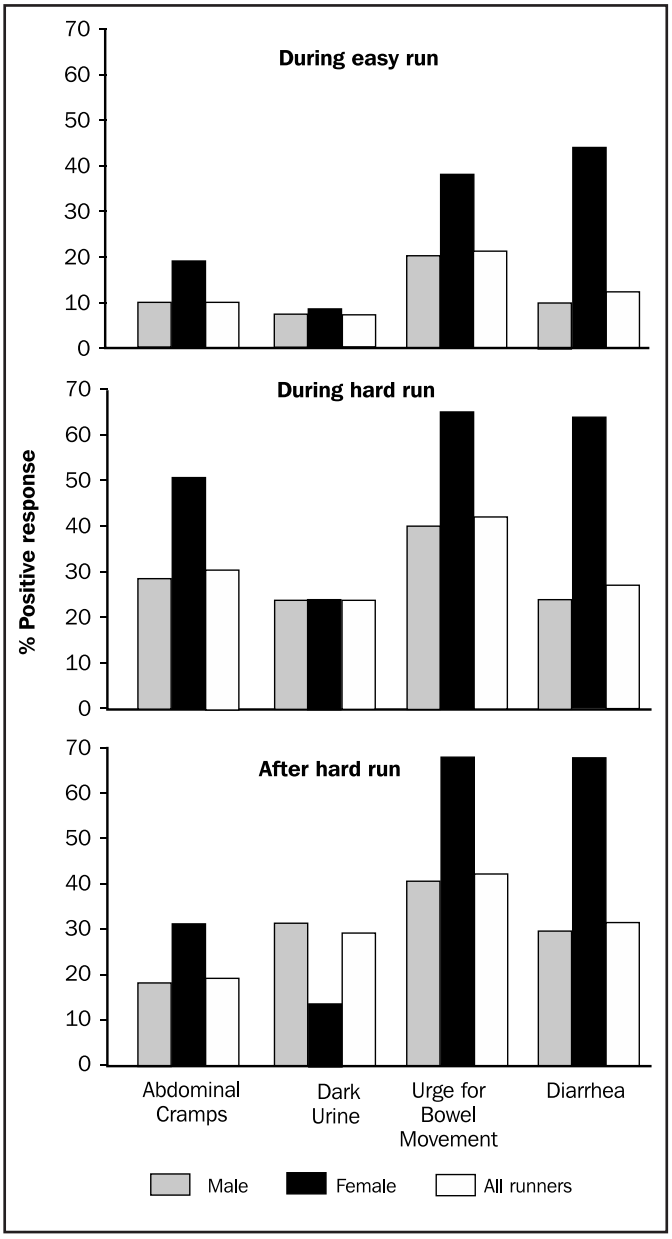
In Peters' study (1999), questionnaires were sent to long-distance runners, cyclists and triathletes to assess the prevalence of GI symptoms. Questions were asked about training, medication, GI symptoms and diet over the previous 12 months. The onset of GI symptoms was studied during periods of rest, training, competition and the 2 hours following training and competition.

Participation by gender and sport was: 1: 45% female and 55% male long-distance runners, 2: 53% female and 47% male cyclists, 3: 44% female and 56% male triathletes.

More "low" symptoms than "high" symptoms were observed during rest, training, competition and the 2 hours after training and completion, except in female cyclists during competitions and male cyclists in the 2 hours following competition. Female long-distance runners experienced more "high" and "low" GI symptoms than their male counterparts during competitions and in the 2 hours following competition, while the men had more problems during training.

They concluded that, in general, female cyclists had more complications of this kind than male cyclists 23 and that although there were women who said that they had not had a period in the last 12 months,

Figura 3. Porcentaje de respuestas positivas para sintomatología GI "baja" en hombres y mujeres durante carrera ligera, dura y post carrera dura. Sintomatología estudiada: rampas abdominales, orina oscura, urgencia para defecar y diarrea.



there was no greater prevalence of GI symptoms among these women than among those who had had a period.

No significant differences between male and female triathletes were observed. Broadly speaking, both "high" and "low" symptoms were less common in these athletes compared to long-distance runners and cyclists, and most complaints referred to "low" symptoms when running. The prevalence of "high" and "low" symptoms is shown in Table 3 (adapted from reference 23).

Ter Steege (2008) also took into account food and fluid ingestion before and after competitive races and training, and the general nutritional status of the participants, but found no positive correlation. Worse symptoms were found among those who did not habitually eat/drink during a race than among those that did[24].

Ter Steege (2008) was the first to suggest a possible relationship between the higher prevalence of intestinal ischemia in women, for reasons not entirely understood,[24] and the prevalence of GI problems associated with sports of this kind. He also refers to a possible similarity with the higher incidence of irritable bowel syndrome in women due to the relationship between gender, menstruation and hormonal differences, and intestinal motor and sensory function[24]. Ouyang (2006) previously related oestrogens and gonadal hormones with changes in bowel motility and autonomic nervous system and gastric smooth muscle function[30], suggesting that this may be the cause of the higher incidence.

Ter Steege's study (2008) consisted of an online questionnaire for participants in the *"Enschede Marathon"* 5-, 10-, 21- and 42-km races, focusing on perception of GI symptoms during and after running. It consisted of 3 parts (a) demographics of age, gender and level of training, (b) questions on the day of the competition, which included time achieved, whether they had dropped out of the race, why, what they had drunk and eaten (type and amount) during the race, and the presence of GI symptoms, and (c) the presence of GI symptoms 24 hours after the race.

45.2% of the runners experienced GI complaints during the race, side stich being significantly more common in 10-km runners compared to 42-km runners and more common in women than in men (8.2% *vs* 1.8%). The incidence of GI problems was greater in women than it was in men in all the race categories. A greater incidence in the under-25s than in the other age groups (25-45 and over-45s) was also observed[24].

Miall *et al.* (2017) also found that the prevalence of GI symptoms was higher in women than it was in men[27]. Their study tested "gut training" as a way to avoid GI problems and carbohydrate tolerance when running.

The study consisted of three stages:

- Gut challenge trial 1: 120 minutes running exercise at 60% VO_2max whilst consuming 30 g carbohydrates every 20 minutes, and 60 minutes at maximum exertion without carbohydrate intake, but with fluid as the participants wished.
- 2 weeks of gut training: the control group ran for 60 minutes at 60% VO_2max without carbohydrate intake on 5 consecutive days (2 days of rest between week 1 and week 2); the intervention group ran for 60 minutes at 60% VO_2max on 5 consecutive days (2 days of rest between week 1 and week 2), consuming 30 g carbohydrates every 20 minutes.
- Gut challenge trial 2: repetition of trial 1. 120 minutes running exercise at 60% VO_2max whilst consuming 30 g carbohydrates every 20 min, and 60 minutes at maximum exertion without carbohydrate intake, but with fluid as the participants wished.

The fact that the gastrointestinal tract can be trained and adapted to different situations means it may be a key target when it comes to

Table 3. Prevalence (in %) of "high" and "low" GI symptoms by sex in different periods. * Significant difference between men and women.

		Long-distance runners		Cyclists		Triathletes (cycling stage)		Triathletes (running stage)	
		"High" symp.	"Low" symp.	"High" symp.	"Low" symp.	"High" symp.	"Low" symp.	"High" symp.	"Low" symp.
Rest	Men	46	66	66	73	60		84	
	Women	46	75	67	84	46		78	
During training	Men	44	84	46	**64***	44	62	49	95
	Women	46	88	79	78	48	56	59	94
2h after training	Men	23	**46***	33	**51***	19	42	29	63
	Women	51	74	51	60	24	35	35	62
During run	Men	31	**69***	53	**60***	52	47	51	76
	Women	46	74	80	69	52	43	59	83
2h after run	Men	29	**42***	45	**39***	39		60	
	Women	58	65	64	54	35		48	

improving the delivery of nutrients during exercise and relief from intestinal discomfort[31].

Mach (2016) directly relates health and athletic performance with the state of the intestinal microbiota[7]. Although the role of the microbiota in individual athletic performance is unclear, there is sufficient evidence to support the claim that exercise itself induces changes in it[7].

Training the gut consists of (a) training with large volumes of fluid in the stomach, (b) training quickly after meals, (c) training with high carbohydrate intake during exercise, (d) race simulations following a competition diet plan, and (e) an increase in the total consumption of carbohydrates in the diet[31]. All this produces physiological effects which can result in a reduction of GI symptoms and consequent improvement in athletic performance.

Training the gut aims to improve tolerance to higher volumes of fluid during exercise and consequent gastric emptying, and tolerance to greater quantities of carbohydrates and their better assimilation by different routes depending on the type of sugar in question[31].

They found a tendency to report more GI problems among women compared to all the participants, especially concerning "high" symptoms in gut challenge trial 1. Improvements were observed in the intervention group in all the stages of gut challenge trial 2, whereas no improvements were noted in the control group. A greater improvement in symptoms was also noted in men compared to women.

Miall (2017) included the participants' history of recurring GI episodes during training/competitions in their baseline characteristics and saw that they were more frequent among women than among men, thereby predisposing the former to a greater percentage of problems[27], as occurred in the cross-sectional survey in the Marikenloop study[32]. Diduch stated that sport might attenuate GI conditions, but that strenuous exercise might actually aggravate them[10].

Age was also considered an aggravating variable, with greater GI problems appearing in younger age groups than in older ones[21-24,29]. This trend was seen by Keeffe (1984), Riddoch (1988), Peters (1999), ter Steege (2008) and Wilson (2017).

The mean age of the participants in those studies which conclude that women have more GI problems was approximately[33].

Those studies which do not observe significant differences between men and women have similar designs. They consist of a prospective training/GI symptoms journal kept for 30 or 60 days, followed by a survey (retrospective) on the period recorded[26,28,29].

The only study which records nutrition in women during ultra-endurance exercise was conducted in 2015[33], only one case-study having been carried out before that[34]. It is also the only one whose design considers these nutritional aspects, one of its objectives being to study the percentage of compliance with nutritional recommendations for ultra-endurance athletes.

Wilson (2017) related other everyday aspects such as stress and anxiety levels with a higher or lower prevalence of GI problems associated with exercise. Although he did not observe any differences between men and women, he did associate, in general, higher levels of stress and anxiety with an increase in the appearance of complications[29].

He also noted that age and years of running experience were negatively correlated with GI problems. Although the correlations found cannot explain any kind of cause and effect in the associations, they are significant in the correlation analysis of the data.

The mean age of the participants in those studies which conclude that women have the same likelihood of GI problems as men was approximately[44].

In 2015, Wardenaar studied ultramarathon runners to see if they complied with the nutritional recommendations for the sport[26]. The study consisted of 3 stages, (a) a questionnaire on dietary habits 2 months before the race, (b) a questionnaire on dietary intake on the day of the 60-km run and GI symptoms before and during the competition,

and (c) continuous observation during the 120-km run (in which no women took part).

Generally speaking, the nutritional recommendations for ultra-endurance sports were not met. The women studied did not reach the protein recommendations set by the literature. Both the men and the women ingested fewer carbohydrates than those recommended in the literature. Fluid intake during the run did not cover the recommendations either, both men and women ingesting a lower percentage than recommended[26].

During the run, 82.9% of the runners reported GI discomfort (scored from 0 to 9), with no significant difference between men (81.8%) and women (87.5%). In his conclusions, Wardenaar stresses that all >0 scores were considered positive (presence of GI distress), regardless of whether it caused moderate or more severe discomfort, questioning whether the severity of these symptoms might affect athletic performance[26].

Another 2017 study by Wilson looked into the validity and reliability of retrospective questionnaires to study the frequency of chronic GI distress in runners. He combined a prospective questionnaire via a 30-day journal recording data on training and GI symptoms, and a retrospective questionnaire 30 days after completion of the journal (to study the validity of the data obtained), which was resent 24-36 hours later (to study the reliability of the data obtained) to be completed within 7 days.

The questionnaires measured the appearance of defined "high" and "low" GI symptoms on a scale of 0 to 10.

Both men and women experienced at least one GI symptom during training, but no significant gender differences were recorded (84% male, 78% female)[28]. When compared with daily journals, retrospective questionnaires seemed to offer valid and reliable information with which to quantify GI symptoms over 30 days.

The results of Stuempfle's study (2013), by contrast, suggested than women were less likely to have GI symptoms associated with exercise[25].

This study was conducted in the Javelina Jundred 100 Mile Endurance Run, a 161-km run made up of 6.5 loops of a 25-km circuit.

A questionnaire was sent to the participants 1 week before the run with a proposed diet to consume during it. Food intake before the run was not taken into account. After each loop, their body mass was measured, they were asked about food, fluid and electrolyte capsule intake, and GI symptoms (separately), and all packaging of the food consumed was collected. A week after the run, they were sent all the data collected during the run and asked to add any food, fluid or electrolyte capsules that they might have forgotten to mention during the run.

The men had more GI problems than the women (80% *vs* 20%). All the participants were of a similar age and had similar running experience, distance completed and pace. There were no significant changes in body mass among those participants who did not suffer GI symptoms, whereas there were among those who did report GI problems[25].

Stuempfle (2013) found no difference in the incidence of GI problems between men and women, although she stresses that female participation in the study was low, which may have hindered the identification of any such differences. She also names hormonal differences, nutrition during the run and difference of pace during the run as factors which may contribute to this difference[25].

Since the diet followed on the day of the competition did not correspond to the participants' usual diet, better management of nutritional strategies may have led to a lower incidence in women.

Considering that most of the competitors were possibly amateurs and nutrition during the run was not measured thoroughly, it would be interesting to have a control group with no intervention in this aspect, especially if we consider that nutrition is one of the predisposing factors for GI distress during prolonged exercise indicated by Oliveira, Burini and Jeukendrup[17].

Limitations of the studies and research

Most of the studies found focused on running as a sport related to GI problems, although others such as cycling or swimming can also cause complications of this kind, but with a lower probability[6].

One of the greatest limitations of these studies, bar one randomised controlled study, is their observational design. Another major problems is the subjectivity of the participants when defining GI symptoms, using scoring scales and perceiving exertion.

The authors themselves refer to the limitations which come with using surveys; they may be more attractive to that part of the population that has experienced gastrointestinal problems and their validity may be compromised due to their retrospective nature.

The retrospective design of the research may lead to a lack of reliability and, although Wilson has confirmed the validity and reliability of questionnaires over 30-day periods[28], some of the studies reviewed involve recalling 12 months.

For this review, only two databases were researched and 13 articles selected after the first screening could not be consulted. Critical appraisal tools were not used to determine the quality of the studies reviewed nor was double-blind screening employed.

Conclusion

The current literature does not specifically study the difference in the incidence of gastrointestinal problems associated with endurance sports by sex, but differences between men and women have been observed in studies of sports-related conditions of this type.

Hormonal differences, nutritional strategies, age and running experience would appear to be important factors which predispose females to greater digestive stress and, consequently, more gastrointestinal symptoms related to sport. Women are more liable to suffer lower GI tract conditions in the form of abdominal cramps, side stitch, flatulence, intestinal bleeding, the urge to have bowel movements and diarrhoea.

As stated, age would seem to play a protective role in the development of symptoms and the participants in those studies which did not observe significant differences between men and women were of a higher mean age than the participants in those which did. This age

difference in the groups studied may bring to the fore this protective role, thus resulting in fewer digestive problems related to exercise.

In view of everything, the main contributions of this review for future research can be specified as follows:

- Specific studies to differentiate the prevalence of GI problems by sex are essential.
- The possible causes of these conditions advanced to date need to be taken into consideration in all groups under research.
- A methodology not limited to observational studies should be designed that caters for larger-scale studies in which, in addition to observing the participants' baseline, different interventions can be performed, with control groups and taking into account factors such as hormonal differences (and state), nutrition, hydration, etc.
- These studies should be applied not only to running, but also to other endurance sports in order to observe any differences (nutrition, hydration, level of impact, duration, etc.).

Conflict of interest

The authors have no conflict of interest whatsoever.

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Exertional Rhabdomyolysis

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Summary

Rhabdomyolysis is a clinical syndrome characterized by the destruction of striated muscular tissue and the dumping of the intracellular content of the muscle that presents with muscle pain due to myositis, loss of strength and muscular edema. It is characterized by the high elevation of creatine kinase, myoglobin, dehydrogenated lactate and it can cause important complications, especially renal complications. According to the CK figures, always higher than 5000 IU / l, which are at the beginning of the table, rhabdomyolysis is classified as light and severe.

From the point of view of sport, among the various etiological causes that can cause it, it is interesting to focus on stress-induced rhabdomyolysis.

This work reviews the etiology of the clinical picture, paying special attention to exercise as a trigger of the syndrome and the characteristics of the type of exercise (physical condition and experience of the athlete, intensity and duration of physical exercise, type of exercise, environmental conditions, etc.) that can cause it.

Although the causes of rhabdomyolysis are very varied and different, the final pathogenic pathway leading to muscle destruction is common to all and has to do with the alteration in the regulation of intracellular electrolytes and especially with cytoplasmic calcium levels.

Currently, in addition to the analytical diagnosis, ultrasound allows a rapid diagnosis and the observation of the evolution of the picture. Rhabdomyolysis shows muscle involvement patterns that are described in this work.

Different prevention strategies are described based on the execution of an adequate physical exercise (type, intensity and duration of the exercise), measures related to nutrition and feeding, as well as measures related to environmental end educational factors.

Finally, is presented the immediate treatment of the symptoms, with necessary hospitalization in some cases, and recommendations on re-incorporation to training and sports competition.

Key words:
Rhabdomyolysis. Effort. Exercise. Muscle. Muscle injury. Ultrasound. Prevention. Treatment.

Rabdomiolisis inducida por esfuerzo

Resumen

La rabdomiolisis es un síndrome clínico caracterizado por la destrucción de tejido muscular estriado y el vertido del contenido intracelular del mismo que cursa con dolor muscular por miositis, pérdida de fuerza y edema muscular. Se caracteriza pro la elevación muy importante de creatinquinasa, mioglobina, lactato deshidrogenada y puede provocar importantes complicaciones, fundamentalmente renales. En función de las cifras de CK, siempre superiores a 5000 UI/l, que se encuentran en el inicio del cuadro la rabdomiólisis se clasifica en ligera y severa.

De entre las diversas causas etiológicas que la pueden provocar, desde el punto de vista del deporte, interesa la rabdomiólisis inducida por esfuerzo.

Este trabajo revisa la etiología del cuadro, prestando especial atención al ejercicio como desencadenante o coadyuvante del síndrome y a las características del tipo de ejercicio (condición física y experiencia del deportista, intensidad y duración del ejercicio físico, tipo de ejercicio, condiciones ambientales, etc.) que pueden provocarla.

Aunque las causas de la rabdomiolisis son muy variadas y diferentes, la vía patogénica final que conduce a la destrucción muscular es común a todas y tiene que ver con la alteración en la regulación de los electrolitos intracelulares y especialmente con los niveles de calcio citoplasmático.

Además del diagnóstico analítico, actualmente, la ecografía permite un diagnóstico rápido y la observación de la evolución del cuadro. La rabdomiólisis muestra patrones de afectación muscular que se describen en el trabajo.

Se describen las estrategias de prevención basadas en la realización de un ejercicio físico adecuado (tipo, intensidad y duración del ejercicio), medidas relacionadas con la nutrición y alimentación, medidas relacionadas con los factores ambientales y medidas educativas.

Por último, se presenta el tratamiento inmediato del cuadro, con hospitalización necesaria en algunos casos, y las recomendaciones sobre re-incorporación al entrenamiento y a la competición deportiva.

Palabras clave:
Rabdomiolisis. Esfuerzo. Ejercicio. Músculo. Lesión muscular. Ecografía. Prevención. Tratamiento.

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Introduction

Rhabdomyolysis is a medical condition which consists of the breakdown of striated muscle tissue and the release of intracellular muscle components, creatine kinase (CK), myoglobin, lactate dehydrogenase (LDH), electrolytes, etc., into the extracellular fluid and bloodstream.

Among other symptoms, patients present muscle pain, calling for differential diagnosis to rule out other conditions. Some authors differentiate between myopathy (general muscle disease), myalgia (pain without rise in CK), myositis (with rise in CK) and rhabdomyolysis (symptoms: pain, swelling and loss of strength, significant rise in CK and occasionally myoglobinuria and kidney impairment)[1].

At present, mild rhabdomyolysis should be considered a clinical syndrome characterized by acute pain, loss of muscle strength and edema, accompanied by a rise in CK to at least 5 times the basal value (>1000 IU/L), and severe rhabdomyolysis is when these symptoms are accompanied by myoglobinuria and acute kidney failure, provided that concomitant diseases such as myocardial infarction, stroke, status epilepticus, chronic kidney failure and neuromuscular diseases have been counted out[2].

Exertional or exercise-induced rhabdomyolysis (exRML) meets all the clinical requisites outlined above, but must be preceded by exercise, not necessarily excessive or unhabitual, over the limits of fatigue, performed voluntarily or otherwise, with a rise in CK over the subsequent 12-36 hours, a peak level at 3-4 days and normalization after a few weeks of rest.

The condition also produces myoglobinemia and myoglobinuria, but for many authors laboratory quantification is not necessary and the criteria set out in the preceding paragraph are sufficient for diagnosis[3].

There are no reliable data on the prevalence of this syndrome and significant discrepancies exist according to baseline studies. In the US, 26,000 cases/year have been reported, of which 47% meet the diagnostic criteria for exRML, although other studies give lower percentages[4,5].

Rhabdomyolysis patients present both local and general symptoms. The most important local symptoms are muscle pain, loss of strength, edema and muscle fatigue. The general symptoms are malaise, fever, nausea, vomiting, confusion, choluria, delirium, anuria and heart arrhythmia[6].

On occasions, the CK level can increase up to 50 times or more above normal resting values.

In most cases, rhabdomyolysis is a mild condition which ceases with outpatients medical treatment, analgesics and rest.

More rarely, it gives rise to complications which may endanger the patient's life, such as: acute kidney failure, compartment syndrome, disseminated intravascular coagulation, hypovolemia and electrolyte disorders (hyperkalemia, hyperphosphatemia, hypercalcemia from the outset and delayed hypercalcemia)[1].

The most common and feared complication is acute kidney failure due to the vasoconstriction caused by the endotoxins released as a result of muscle fiber breakdown, hypovolemia and myoglobinuria, which lead to a decrease in the glomerular filtration rate[7]. It has been estimated that between 10% and 30% of patients with exRML develop this serious complication[8].

Table 1. Causes of rhabdomyolysis.

Acquired
- Drugs/Toxins
- Ethanol
- Infections
- Exercise
- Trauma:
Crush syndrome
Compartment syndrome
- Ischemia
- Metabolic disorders
- Neurological disorders:
Status epilepticus
Status dystonicus
- Idiopathic

Table 2. Causes of rhabdomyolysis.

Genetic
- Muscle metabolism disorders
Fat metabolism
Carbohydrate metabolism
- Mitochondrial disorders
Complexes I and II
Cytochrome b
- Disruption of the release of intramuscular calcium
- Muscular Dystrophies

Etiology

The causes of rhabdomyolysis can be divided into acquired (Table 1) and hereditary (Table 2). A third group would be rhabdomyolysis caused by anesthetics like propofol and volatile anesthetics.

The most important causes are[1,6,9,10]:

Recreational drugs

The recreational drugs which may cause rhabdomyolysis include alcohol, heroin, methadone, barbiturates, cocaine, amphetamines and benzodiazepines.

Alcohol can induce rhabdomyolysis through a combination of mechanisms, including myotoxicity, electrolyte derangement and immobilization.

Cocaine produces vasospasm and ischemia, coma with muscular compression and myofibrillar damage.

Hypnotics, barbiturates and benzodiazepines may cause depression of the central nervous system with prolonged immobilization and muscular compression, resulting in hypoxia and muscle damage[11,12].

Medications

Salicylates, fibrates, neuroleptics, anesthetics, propofol, corticosteroids, antidepressants, etc., may cause rhabdomyolysis.

Statin therapy has also been associated with the condition, suggesting the involvement of such mechanisms as sarcolemmal lipid disorders, protein disorders and Q10 coenzyme deficiency. The risk of triggering rhabdomyolysis is increased when associated with fibrates[13].

Trauma

Crushing, the sudden deceleration which takes place in car crashes, falls, high-voltage electric shocks and third-degree burns are particular risk factors.

Extreme temperatures

The body can withstand a maximum internal temperature of about 42°C for a period of between 45 minutes and 8 hours. Cell destruction occurs rapidly at high temperatures. The causes of excessive heat include heatstroke, neuroleptic malignant syndrome and malignant hypothermia[15].

Although rare, exposure to cold temperatures, with or without hypothermia, can also lead to rhabdomyolysis[16].

Muscle ischemia

Situations which can trigger rhabdomyolysis include the compression of blood vessels (tourniquets), thrombosis, embolism and compartment syndrome.

Muscle ischemia interferes with the release of oxygen to the cells, limiting the production of energy (ATP). If maintained for a long time, this can cause necrosis of the muscle cells[17].

Prolonged immobilization

Prolonged immobilization for various causes (coma, alcohol-induced unconsciousness, anesthesia) can lead to rhabdomyolysis.

The primary mechanism involved is the reperfusion of damaged tissue following a period of ischemia and the release of intracellular content into the general bloodstream.

Cases of patients with morbid obesity, diabetes, high blood pressure and undergoing prolonged surgery have been reported[18].

Infections

The most common infections are those caused by influenza virus types A and B. Other viruses which can induce rhabdomyolysis include HIV, Ebstein-Barr, cytomegalovirus, herpes simplex and varicella-zoster.

Bacteria such as *Legionella, Salmonella, Streptococcus, Staphylococcus, Mycoplasma, Leptospira* and *Escherichia coli,* fungal infections and malaria may also be involved[19].

The mechanisms proposed include tissue hypoxia, the activation of lysosomes and endotoxins.

Electrolyte and endocrine disorders

Electrolyte disorders, such as hyponatremia, hypernatremia, hypokalemia, and hypophosphatemia, may cause rhabdomyolysis due to alterations in the cell membrane, primarily by affecting the operation of the sodium-potassium pump.

Endocrine disorders, such as hypothyroidism, hyperthyroidism, diabetic ketoacidosis and diabetic coma, may also be behind the syndrome[9].

Genetic disorders

Family history, repeated episodes with not particularly intense exercise and very high levels of CK which remain high for a long time may point in the direction of this cause. In these cases, rhabdomyolysis may be the first sign of genetic myopathy[3].

Rhabdomyolysis may be induced by alterations in the carbohydrate metabolism, such as a deficiency of myophosphorylase (McArdle's disease), phosphorylase kinase, phosphofructokinase or lactate dehydrogenase, or alterations in the lipid metabolism, such as a shortage of carnitine palmitoyltransferase I and II, and others like MADA deficiency, Duchenne muscular dystrophy or malignant hyperthermia.

In recent years, mutations have been identified in the LPIN1 gene in children and the RYR1 gene in adults. Variants/polymorphisms of the ACTN[3] gene have also been reported, as have other polymorphisms in a number of other genes which may be related to rhabdomyolysis and especially with exercise-induced rhabdomyolysis: CK-MM, MYLK2[20,21].

Physical exercise

Exercise in itself or in combination with one or more of the factors noted above can cause rhabdomyolysis.

The factors which can precipitate or contribute to the syndrome are[22,23]:

- The experience and fitness level of the athlete. People with less experience and who are less physically fit more frequently present episodes of rhabdomyolysis.
- The intensity and duration of exercise; high intensity exercise in people unaccustomed to exercise or a particular type of exercise would seem to generate a greater risk.
- The type of exercise. Eccentric contractions, whether in strength or dynamic exercise, are directly related to rhabdomyolysis. The sports in which this condition most commonly appears include marathon, triathlon, football, weightlifting and CrossFit.
- Hot environments and dehydration.
- Electrolyte disorders, as indicated above.
- Nutritional problems, such as insufficient protein intake in strict vegetarian or vegan athletes and in athletes who employ extreme carbohydrate loading strategies.
- Other factors already mentioned, such as genetic factors, medications, particularly statins in combination with fibrates, psychiatric medications and infections.

Most studies show a lower incidence of rhabdomyolysis in women compared to men; this is probably due to the protective effect of estrogen[24].

Pathophysiology

Although the causes of rhabdomyolysis are very varied and different, the final pathogenetic pathway leading to muscle breakdown is common to all of them and is associated with alteration of intracellular electrolyte regulation and especially with cytoplasmic calcium levels.

Although the pathophysiology is common no matter what the cause, with specific reference to exRML, various alterations are triggered following excessive, intense, fast, new forms of exercise in those unaccustomed to exercise which, alone or in combination, can precipitate the condition.

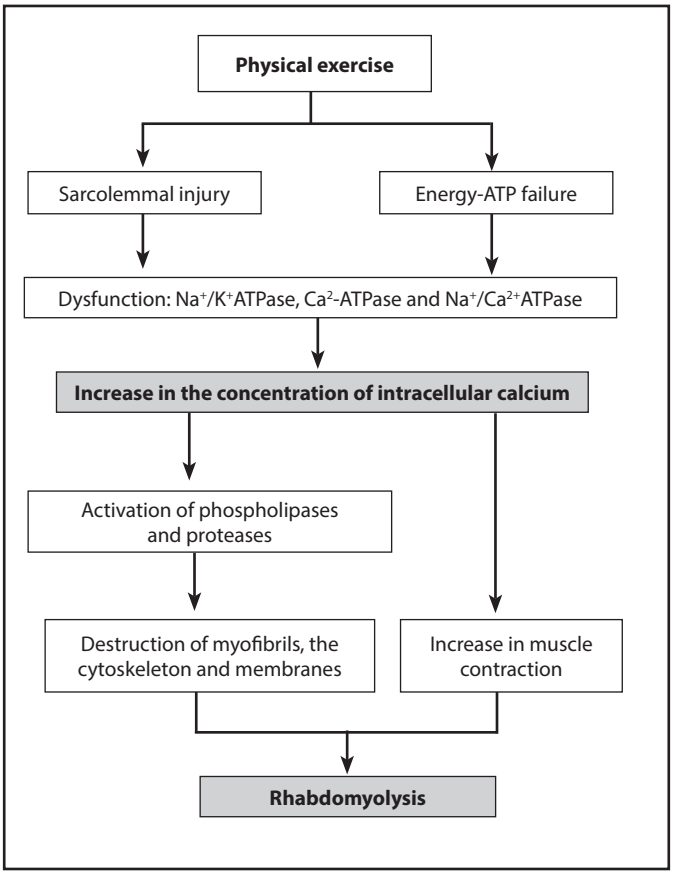
Damage to the membrane of muscle fibers (sarcolemma) or an increase in the permeability of this membrane together with a decrease in energy production (ATP) alters the mechanisms which regulate intracellular electrolytes. Of the complex regulatory mechanisms, the most important are the exchangers Na^+/K^+ATPase and Na^+/Ca^{2+}ATPase, and the pump Ca^2+ATPase[3]. Energy depletion (ATP) or cytoplasmic membrane injury/rupture causes dysfunction in the exchanger Na^+/K^+ATPase and the pump Ca^{2+}ATPase in the sarcolemma, and those regulatory mechanisms which act in the membranes of the internal organs of muscle fibers (sarcoplasmic reticulum and mitochondria).

This leads to an increase in the Na^+ in the cytoplasm, which then triggers failure of the Na^+/Ca^{2+}exchanger, thereby increasing the concentration of intracytoplasmic Ca^{+}[10].

The Na^+/Ca^{2+} pump needs energy, accentuating the ATP deficit, which in turn affects the Ca^{2+}ATPase and causes it to malfunction, increasing calcium concentration in the cytoplasm to an extreme. This leads to increased muscle contraction, which further depletes ATP and activates calcium-dependent proteases and phospholipases. These then initiate destruction of the myofibrils, the cytoskeleton and the proteins of the cell membranes[23].

This produces cell apoptosis and release of the cell contents (calcium, potassium, phosphates, aldolases, myoglobin, CK, LDH, etc. (Figure 1)) into the extracellular medium and bloodstream. In severe cases of rhabdomyolysis, this can lead to serious complications, such as acute kidney failure, heart arrhythmias or disseminated intravascular coagulation.

Figure 1. Diagram of the pathophysiology of exercise-induced rhabdomyolysis.



Changes in the ultrasound pattern for rhabdomyolysis

The sonographic signs describing rhabdomyolysis have increased over recent years due to different articles which have been published. Initially, rhabdomyolysis was characterized by a decrease in echogenicity and local disorganization of the injured muscle[25]. Later, further sonographic diagnosis data relating to the syndrome indicated intramuscular hyperechoic areas, which were believed to be due to hypercontractile muscle fibers in the acute stage. Complete loss of muscle texture in the muscle involved, with reduced echogenicity, normal vascularity and preservation of the muscle boundary, was sometimes observed. These findings made it necessary to perform differential diagnosis with muscle strain and muscle tear, although muscle texture is preserved in these cases[26]. More recent publications[27] describe a reverse image where the muscle septa are shown as distended and hypoechoic, and the muscle fibers appear relatively hyperechoic. Furthermore, the formation of hypoechoic/anechoic intramuscular areas usually occurs when there is breakage of the muscle fibers representing edema or bleeding[28].

Ultrasound signs specific to the cause of rhabdomyolysis

In sporting contexts, other causes of rhabdomyolysis in addition to muscle trauma need to be considered, such as intense or strenuous physical activity and ischemia associated with compartment syndromes. The ultrasonic signs may be specific to the cause behind rhabdomyolysis.

Rhabdomyolysis associated with muscle trauma is characterized by the presence of ground glass-like or cloudy images, together with irregular anechoic areas in the muscular and intramuscular periphery (Figure 2). Generally, the muscle fibers are uneven and heterogeneous, and there are usually no blood flow signals[27].

However, when rhabdomyolysis occurs as a result of strenuous exercise in physically unprepared patients, areas of lower echogenicity (ground glass or cloudy image) with hyperechoic intramuscular areas, creating an environment of muscular disorganization, are observed (Figures 3 and 4). The diameter of the muscle fascia also increases, covering uneven anechoic areas in the muscular and intramuscular periphery, with no signals of blood flow compatible with edema. Doppler ultrasonography reveals normal vascularization with preservation of waves and flow velocities[27].

Finally, in cases of rhabdomyolysis associated with a compartment syndrome, an increased volume of striated muscle with reduced flow velocity in the distal arteries is observed. The muscle presents a heteroechoic pattern and sometimes dissection of the aponeurosis (Figure 5).

Prevention

Rhabdomyolysis prevention should consist of steering clear of the pathophysiological mechanisms which trigger the muscle injury itself and the complications which can come afterwards.

Figure 2. This cross-sectional image of rectus femoris and vastus lateralis muscle contusion shows the presence of hyperechoic images with loss of fibrillar pattern and anechoic areas with uneven edges on the periphery of each muscle.

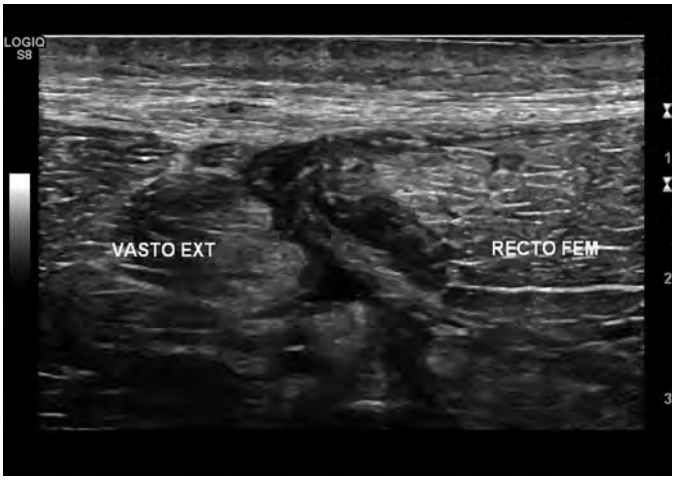


Figure 3. This cross-sectional image of the back of the thigh shows areas with lower echogenicity and intramuscular hyperechoic areas on the surface. Note that the hyperechogenicity of the muscle is similar to that of the semimembranosus tendon (arrow) and the sciatic nerve (SN).

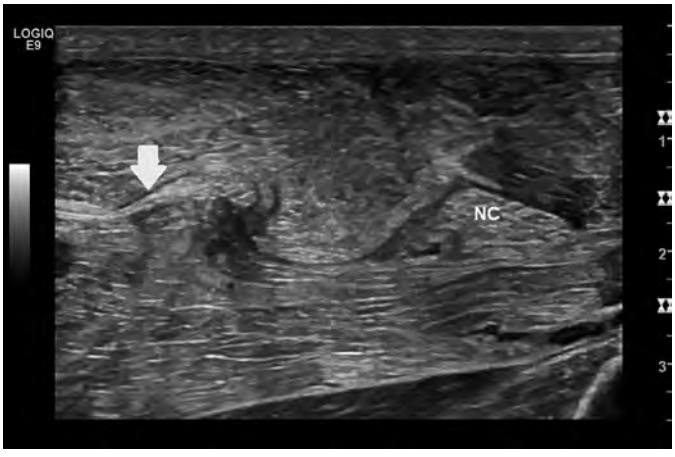


Figure 4. In a cross-sectional examination, ground glass opacities can be seen in the muscle belly.

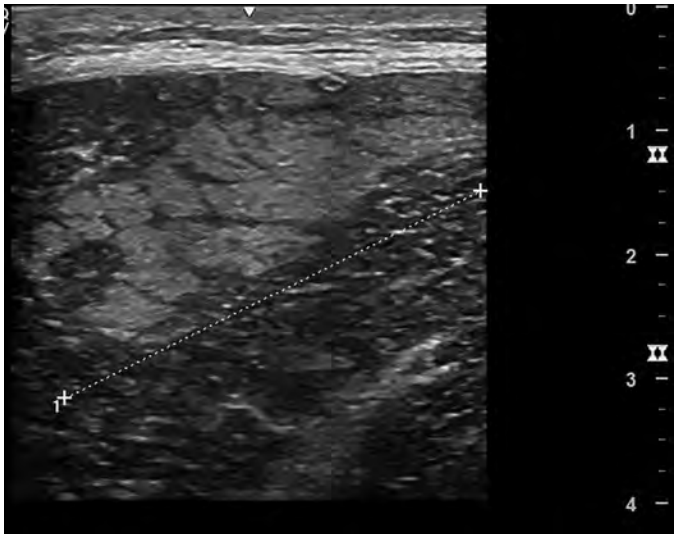
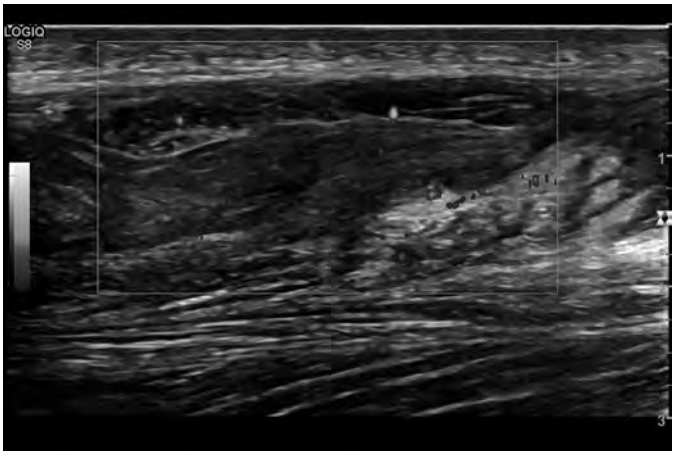


Figure 5. In a short-axis examination of the gastrocnemius muscle, a heteroechoic pattern and an increase in muscle volume can be observed.



Adequate physical exercise

The exercise carried out should be adapted to the individual's level of fitness and specifically prescribed in terms of the intensity, duration and type of exercise, and how it should be performed. Variations in these variables can lead to muscle damage and, ultimately, rhabdomyolysis.

Generally, those less fit are at more risk of suffering rhabdomyolysis, which is uncommon in top-level athletes[29]. Preventive measures, therefore, need to be considered more in the earlier stages of fitness training.

The progression of exertion from the start of each training or competition session is an important factor, as is a suitable warm-up stage, which is the first preventive measure to take into account[30] and one of the most effective.

Type of exercise

Exercises with a greater eccentric component are prone to cause greater muscle damage, increasing CK and LDH levels, especially exercises which involve jumping, running on land at different gradients or muscle training consisting of squats and arm and shoulder extensions with heavy weights or a lot of repetitions[23]. It has been shown that sports such as marathon running, triathlon, football and CrossFit involve a greater risk of both muscle injury and rhabdomyolysis[23,31].

As a preventive measure, it is advisable to start with a low number of repetitions and only 1-2 sets, and gradually increase the repetitions and sets of exercises with a greater eccentric component, using the onset of pain the day after training as a control variable[23].

Exercise intensity

Higher intensity exercises increase the risk of muscle damage and rhabdomyolysis, especially in less fit athletes, whose exercise-induced adaptive responses are poorer, thereby exposing them further. For this reason, the intensity of exercise should be increased gradually according to how the athlete tolerates and assimilates it, particularly controlling loads in the initial phases of training programs.

Duration of exercise

Longer exercises (like marathon running, triathlon, etc.) expose athletes to the risk of greater muscle damage and increase the risk of rhabdomyolysis. It is advisable to exercise for progressively longer periods of time, apply a weekly frequency which permits full physical recovery and perform exercises which involve an eccentric component in line with the athlete's muscular development[31].

Food and nutrition

Carbohydrate and protein intake must be adapted to the intensity, duration and type of exercise in order not only to improve performance but also to prevent excessive muscle damage resulting from an energy deficit, which can lead to rhabdomyolysis.

Exercises which involve a greater eccentric component and last longer lead to greater catabolism and call for a greater supply of protein (1.5-2.0 g protein/kg of body weight) and carbohydrates to enhance structural and functional muscle, and liver and muscle glycogen recovery[32].

Electrolyte and fluid imbalances (chiefly hyponatremia and hypokalemia) increase the risk of rhabdomyolysis, particularly when exercising in hot environments that induce greater sweating and electrolyte loss, which interferes with fatigue and muscle damage[3]. Proper hydration and mineral supplementation prevent the nutritional imbalances which predispose athletes to excessive muscle damage.

Finally, since the exercises which most predispose athletes to rhabdomyolysis also lead to an increase in oxidative processes which affect energy and muscle function, they may also affect kidney function if major oxidative damage occurs. This potential situation makes it advisable to increase the intake of antioxidants (vitamin C, coenzyme Q10) to prevent the consequences that could lead to these forms of muscle and kidney damage which accompany and complicate rhabdomyolysis[33].

Environmental factors

Exercise conducted in excessively hot environments can cause varying degrees of dehydration and even heatstroke. Such scenarios produce greater muscle damage, which becomes more complicated the higher the level of dehydration and electrolyte loss[23], thereby increasing the risk of rhabdomyolysis.

Adequate fluid and electrolyte replacement minimizes health risks when exercising in hotter environments.

Educational measures

Rhabdomyolysis is considered a serious complication of exercise, so coaches, physical education teachers and athletes themselves should have a good knowledge of its clinical features and be aware of the risks associated with the condition. Familiarization with preventive measures would prevent the appearance of the syndrome and its complications, helping to preserve athletes' health.

Treatment

The treatment of rhabdomyolysis in the acute phase, with significant enzymatic alterations, can be differentiated from treatment once the analytical figures and ultrasound images have returned to normal and sporting activity can be considered again.

Here, we are more interested in exertional rhabdomyolysis, about which not much literature nor many guidelines have been published[34,35], possibly due to its low prevalence.

Studies of the condition when related to sport, conducted with significant sets of hospital admissions, although few cases, with average CK figures on admission of more than 30,000 IU/L34,35 report an

Table 3. General criteria for resuming sporting activity.

Biological criteria	• Follow-up ultrasound (essential) • Follow-up MRI (not essential) • No pain at the site of the injury • CK blood test
Functional criteria	• Full joint mobility • All kinds of contraction without pain • Stretches without pain • Load bearing without pain • No pain after exercise • No signs of inflammation after exercise • No neurological signs
Sporting criteria	• No pain in basic movements • No pain in specific movements or technical sport movements • Adequate athletic performance
Psychological criteria	• No negative symptoms (fear, apprehension, distress, etc.)

Adapted from: Fernández TF, Guillén P. *Arch Med Deporte*. 2017[36].

Table 4. Positive criteria for an optimum return to competition.

• Positive factors for quick reincorporation
• No strength deficit compared to the uninjured limb
• No flexibility deficit compared to the injured limb
• No problem completing more than one training session
• Normal ultrasound and MRI scans

Source: adapted from Servicios Médicos del FC Barcelona. *Apunts Med Esport*. 2009[37].

absence of major complications like severe kidney damage, electrolyte disorders, compartment syndrome, disseminated intravascular coagulation, arrhythmias and seizures.

In such cases, initial treatment consists of fluid therapy and alkalinization, and the patients are discharged after an average of 2.5 days.

Once the acute phase has ended, complete rest from physical activity until the test results and ultrasound images return to normal is usually sufficient, bar the administration of analgesics in the event of pain.

As for resuming sporting activity, the guidelines set out in Table 3 can be applied, the progressive application of workloads to the injured area, starting out with very low intensities and progressing according to the tolerance of each load tried, being recommended. In lower limbs, it is very useful to start with anti-gravity exercise (in a swimming pool) before beginning bicycle exercise, leaving running for the final phase of recovery.

Table 4 shows the most important positive criteria for returning to competition.

Conflict of interest

The authors have no conflict of interest whatsoever.

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EL SECRETO ES QUE TÚ CREAS QUE EXISTE UN SECRETO

Por: Raquel Ladín Cobos
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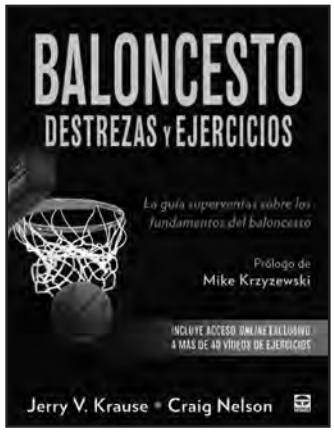
Raquel Landín, atleta, entrenadora, viajera y escritora, narra desde su conocimiento y experiencia de toda una vida dedicada al atletismo y al mundo de la actividad física, la esencia descubierta en sus cinco intensas estancias en Iten: pequeño y remoto pueblo de Kenia situado en el valle del Rift, donde su arco de bienvenida reza: "Welcome to Iten. Home of Champions" (Bienvenidos a Iten. Cuna de campeones).

Páginas repletas de un profundo trabajo de investigación sobre aquello que sucede en las tierras altas de Kenia. El lector puede descubrir la formula #TheKenyanEndurance su compuesto marca la diferencia. Apoyada de historia, datos, curiosidades, interesantes testimonios de algunos de los mejores entrenadores de fondo del mundo y atletas. Que a la vez se ve contrastada con #Somethingischanging que refleja todo lo nuevo que está sucediendo en aquellas tierras que, puede o no, cambiar el futuro de sus corredores y de su innegable dominio.

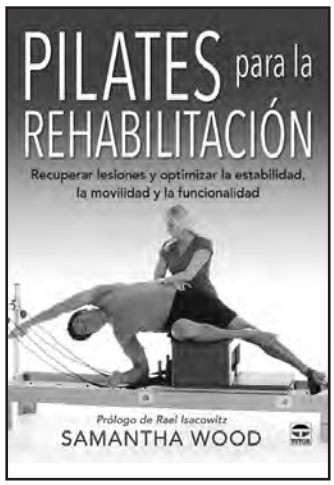


BALONCESTO, DESTREZAS Y EJERCICIO

Por: Jerry V. Krausse y Craig Nelson
Edita: Ediciones Tutor. Editorial El Drac.
Impresores 20. P.E. Prado del Espino. 28660 Boadilla del Monte. Madrid.
Telf.: 915 599 832 - Fax: 915 410 235
E-mail: info@edicionestutor.com Web: www.edicionestutor.com
Madrid 2019. 352 páginas. P.V.P.: 35 euros

LeBron James y Stephen Curry hacen que el baloncesto parezca fácil. Pero antes de que estos jugadores ascendieran a la élite, debían dominar los fundamentos en todas las fases del juego. Como obra puntera de este deporte, este libro ha sido fundamental en la formación de jugadores y entrenadores de todo el mundo. Ahora, en esta nueva edición ofrece el plan perfecto para sentar las bases que todos los jugadores completos y todos los equipos campeones necesitan.

El lector encontrará 103 ejercicios formativos sobre todos los aspectos, desde la postura y el trabajo de pies hasta las jugadas anotadoras y las transiciones. Mejorado con el acceso online exclusivo a 42 vídeos que muestran las destrezas en acción, tendrá una guía óptima para dominar: la posición de los jugadores, los movimientos sin el balón, el manejo del balón y la visión de juego, los tiros, los movimientos en el perímetro, los movimientos en el poste y los rebotes.



PILATES PARA LA REHABILITACIÓN

Por: Jerry V. Krausse y Craig Nelson
Edita: Ediciones Tutor. Editorial El Drac.
Impresores 20. P.E. Prado del Espino. 28660 Boadilla del Monte. Madrid.
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Madrid 2019. 352 páginas. P.V.P.: 35 euros

Clientes y deportistas demandan y se merecen soluciones personalizadas y adaptables cuando sus movimientos y rendimiento se ven afectados por una lesión o dolor crónico. El pilates, conocido por su enfoque de acondicionamiento físico, es la manera perfecta de ayudarlos a recuperarse, a rehabilitarse y a alcanzar sus objetivos. Con este libro, el lector, aprende a aplicar métodos demostrados del pilates para tratar disfunciones y ayudar a lograr un rendimiento óptimo. Respaldada por estudios y protocolos probados, la autora proporciona asesoramiento experto y ejercicios detallados para rehabilitar y curar lesiones, mejorar la fuerza funcional, fomentar movimientos eficientes y gestionar el dolor.

Junto con las instrucciones detalladas de los movimientos con las máquinas de pilates y los ejercicios de suelo, se aprenden las indicaciones y contraindicaciones de cada ejercicio, y los principales músculos implicados, para saber determinar cuándo el ejercicio es apropiado para un usuario en concreto. Las variantes y progresiones permiten adaptar los ejercicios en función de la fase de rehabilitación o la gravedad de la lesión o problema a tratar.

Sociedad Española de Medicina del Deporte

AJUNTAMENT DE REUS

VIII JORNADAS NACIONALES DE MEDICINA DEL DEPORTE

MEDICINA DEL BALONCESTO

22-23 DE NOVIEMBRE DE 2019

SOCIEDAD ESPAÑOLA DE MEDICINA DEL DEPORTE (SEMED)
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Esports

REUS és ESPORT

Ciutat del Bàsquet Català
REUS 2019

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	Jordi Salas Salvado
	Ángel Sánchez Ramos
	José Luis Terreros Blanco

PROGRAMA CIENTÍFICO (PRELIMINAR)

DÍA 22 DE NOVIEMBRE, VIERNES

09.00-10.30 **PONENCIA: La Medicina del Deporte en el Baloncesto.**
Moderador: ***Francisco Javier Rubio Pérez***

Baloncesto femenino. ***Silvia Treviño Monjas***

Organización y control médico en Selecciones Españolas. ***Pilar Doñoro Cuevas***

Baloncesto en la discapacidad – baloncesto en silla de ruedas. ***Josep Oriol Martínez Ferrer***

11.00 -12.30 **PONENCIA: Lesiones y Baloncesto**
Moderador: ***Alfredo Rodríguez Gangoso***

La rodilla. ***Jaume Perramon Llavina***

El tobillo. ***Cristóbal Rodríguez Hernández***

Músculo y tendón. ***Javier Valle López***

12.30 -13.30 **CONFERENCIA INAUGURAL**
Presentación: ***Luis Franco Bonafonte***

La historia del dopaje en el deporte olímpico
Eduardo Henrique De Rose

15.30 -17.00 **PONENCIA: Muerte Súbita y Deporte**
Moderador: ***J. María Alegret Colomé***

Recomendaciones sobre participación deportiva en la cardiopatía isquémica. ***Mats Borjesson***

El electrocardiograma en la prevención de la muerte súbita del deportista. ***Gonzalo Grazioli***

Arritmias y muerte súbita del deportista.
Xavier Viñolas Prat

17.30 -19.00 **TALLER**
Electrocardiograma en deportistas.
Emilio Luengo Fernández

DÍA 23 DE NOVIEMBRE, SÁBADO

10.00 -11.30 **PONENCIA: Controversias: Nutrición - Ayudas Ergogénicas. Los mitos de la alimentación en el deporte.**
Moderador: ***Mónica Bulló***

¿Influye el tipo de dieta en la microbiota y el rendimiento deportivo?
Teresa Gaztañaga Aurrekoetxea

Dietas détox y antioxidantes alimentarios en la práctica deportiva. ***Nuria Rosique***

Ayudas ergogénicas, realidad o mito.
Begoña Manuz González

12.00 – 13.00 **PONENCIA: Manejo del dolor en Medicina del Deporte.**
Moderador: ***Isabel Tello Galindo***

Bloqueos nerviosos en lesiones del aparato locomotor en Medicina del Deporte.
Eduardo Marco Sánchez

Distrofia Simpático Refleja y Lumbalgia – Síndrome facetario en deportistas. ¿Qué ofrece la Unidad de Dolor? ***Guillem Bujosa Portells***

13.00 -13.45 **CONFERENCIA DE CLAUSURA**
Presentación: ***Pedro Manonelles Marqueta***

Actualización en dopaje. ***José Luis Terreros Blanco***

COMUNICACIONES CIENTIFICAS

El Comité Científico invita a todos los participantes a remitir comunicaciones científicas (comunicaciones orales y póster-presentación interactiva) a las VIII Jornadas Nacionales de la Sociedad Española de Medicina del Deporte.

Temas para presentación de Comunicaciones Científicas:

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

INFORMACIÓN GENERAL

22-23 de noviembre de 2019

Lugar

Auditorio y aulas
Hospital Universitari Sant Joan de Reus
Av. del Dr. Josep Laporte, 1
43204 – Reus (Tarragona)
Tfno: 977310300
Unidad de Medicina del Deporte.
Tfno: 977308305
Fax: 977337753
Correo electrónico: lfranco@grupsagessa.com
Localización del hospital: http://www.hospitalsantjoan.cat/contacteu/

Secretaría Científica

Sociedad Española de Medicina del Deporte
Calle Canovas 7, local. 50004 Zaragoza
Teléfono: +34 976 024 509
Correo electrónico: congresos@femede.es
http://www.femede.es/page.php?/interno/OtrasActividades

Secretaría Técnica

Viajes El Corte Inglés S.A.
División Eventos Deportivos
C/ Tarifa, nº 8. 41002 Sevilla
Teléfono: + 34 954 50 66 23
Correo electrónico: areaeventos@viajeseci.es
Personas de contacto: Silvia Herreros

Derechos de inscripción	Antes del 18-7-2019	Del 18-7-2019 al 19-9-2019	Desde 27-9-19 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	30 euros	30 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.

2019		
Sports Nutrition Summit Europe 2019	4-6 Septiembre Amsterdam (Países Bajos)	web: www.sportsnutritionsummit-europe.com
9th VISTA Conference	4-7 Septiembre Amsterdam (Países Bajos)	web: www.paralympic.org/news/amsterdam-host-vista-2019
Congress on Healthy and Active Children	11-14 Septiembre Verona (Italia)	web: http://i-mdrc.com/fourth-assembly/
Euro Global Conference On Food Science & Nutrition 2019	17-18 Septiembre París (Francia)	web: http://foodscience.jacobsconferences.com/
4th International Conference on Nutrition	17-18 Septiembre San Diego (EE.UU.)	web: https://www.meetingsint.com/conferences/nutrition
14th International Congress of shoulder and elbow surgery (ICSES)	17-20 Septiembre Buenos Aires (Argentina)	web: www.icses2019.org
Congreso Sdad. Francesa de Medicina del Deporte	19-21 Septiembre Reims (Francia)	web: https://www.congres-sfmes-sfts.com/fr/
8th European Exercise is Medicine Congress	20-21 Septiembre Amsterdam (Países Bajos)	Información: Lisa Kempter E-mail: lisa.kempter@uniklinik-ulm.de
56º Congreso SECOT	25-27 Septiembre Zaragoza	web: www.secot.es
1º Congreso Mundial de Educación Física (FIEP)	30 Septiembre - 4 Octubre Santiago del Estero (Argentina)	web: http://www.fiepargentinaoficial.com/
IX Congreso de la Sociedad Cubana de Medicina Física y Rehabilitación	1-4 Octubre La Habana (Cuba)	web: http://www.rehabilitacioncuba.com
11th European Congress on Sports Medicine	3-5 Octubre Portorose (Eslovenia)	web: http://www.efsma.eu
I Congreso de Reeducación Funcional Deportiva CERS-INEFC	4-5 Octubre Barcelona	web: http://inefc.gencat.cat/ca/inefc/jornades_congressos/congres-cers-2019/informacio
6th Annual Congress on Medicine & Science in Ultra-Endurance Sports	11-13 Octubre Cape Town (Sudáfrica)	web: https://ultrasportsscience.us/congress/
13th European Nutrition Conference On Malnutrition In An Obese World	15-18 Octubre Dublín (Irlanda)	web: www.fens2019.org
Jornadas SAMEDE: deporte y deportistas en situaciones especiales	18-19 Octubre Almería	web: https://www.jornadassamede.es/
50 Congreso Nacional de Podología y VI Encuentro Iberoamericano	18-19 Octubre Santander	web: https://50congresopodologia.com/
World Congress of Tennis Medicine and Sports Science	18-19 Octubre Estocolmo (Suecia)	web: www.shh.se/stmswc2019
Congreso Internacional de Fisioterapia	25-26 Octubre Toledo	web: congreso@coficam.org
10th International Physical Education and Sports Teaching Congress	31 Octubre-3 Noviembre Antalya (Turquía)	web: https://2019.tubed.org.tr/en/
5th World Conference on Doping in Sport	5-7 Noviembre Katowice (Polonia)	web: http://www.wada-ama.org

15º Congreso Internacional de Ciencias del Deporte y la Salud	8-9 Noviembre Pontevedra	web: www.victorarufe.com
Jornadas Andaluzas de Podología	8-9 Noviembre Sevilla	web: www.colegiopodologosandalucia.org
26th Word Congress TAFISA	13-17 Noviembre Tokyo (Japón)	web: www.tafisa.org
XVII Simposio Internacional Clinica Cemtro: Nuevos horizontes sobre cirugía mínimamente invasiva en cirugía ortopédica y traumatología" "Medicina Regenerativa en el Aparato Locomotor"	14-16 Noviembre Madrid	web: https://www.clinicacemtro.com/
2019 FIP World Congress of Podiatry Conference	14-16 Noviembre Miami (EEUU)	web: www.podiatry2019.org
International Sport Forum on Strength, Conditioning and Nutrition	15-16 Noviembre Madrid	web: https://congress.esns.academy/
VIII Jornadas Nacionales de Medicina del Deporte: "Medicina del Baloncesto"	22-23 Noviembre Reus (Tarragona)	E-mail: femede@femede.es web: www.femede.es
10th Annual International Conference: Physical Education Sport & Health	23-24 Noviembre Pitesti (Rumanía)	web: http://sportconference.ro/
7th World Congress on Physiotherapy and Rehabilitation	26-27 Noviembre Abu Dhabi (Emiratos Árabes)	web:https://physiotherapy.conferenceseries.com/middleeast/
56 Congreso Argentino de COT	28 Noviembre-1Diciembre Buenos Aires (Argentina)	web: www.congresoaaot.org.ar
2020		
V Congreso Internacional de Readaptación y Prevención de Lesiones en la Actividad Física y el Deporte	Enero Valencia	web: https://congresojam.com/
I Congreso actividad física, deporte y nutrición	28 Febrero-1 Marzo Valencia	Web: http://congresodeporte.es/
14th ISPRM World Congress – ISPRM 2020	4-9 Marzo Orlando (EE.UU.)	web: http://www.isprm.org/congress/14th-isprm-world-congress
Congreso FESNAD	11-13 Marzo Zaragoza	web: http://www.fesnad.org/
IOC World Conference Prevention of Injury & Illness in Sport	12-14 Marzo Mónaco (Principado de Mónaco)	web: http://ioc-preventionconference.org/
I Congreso actividad física, deporte y nutrición	27-29 Marzo Sevilla	web: http://congresodeporte.es/
37º Congress International Society for Snowsports Medicine-SITEMSH	1-3 Abril Andorra la Vella (Principat d'Andorra)	E-mail: andorra2020@sitemsh.org
9º Congrés Societat Catalana de Medicina de l'Esport-SCME	3-4 Abril Andorra la Vella (Principat d'Andorra)	E-mail: andorra2020@sitemsh.org

25th Annual Congress of the European College of Sport Science	1-4 Julio Sevilla	E-mail: office@sport-science.org
32nd FIEP World Congress / 12th International Seminar for Physical Education Teachers /15th FIEP European Congress	2-8 Agosto Jyväskylä (Finlandia)	Información: Branislav Antala E-mail: antala@fsport.uniba.sk
2020 Yokohama Sport Conference	8-12 Septiembre Yokohama (Japón)	web http://yokohama2020.jp/overview.html
International Congress of Dietetics	15-18 Septiembre Cape Town (Sudáfrica)	web: http://www.icda2020.com/
XXXVI Congreso Mundial de Medicina del Deporte	24-27 Septiembre Atenas (Grecia)	https://www.fims2020.com/
VIII Congreso HISPAMEF	15-17 Octubre Cartagena de Indias (Colombia)	web: http://hispamef.com/viii-congreso-hispamef-15-17-de-2020/
XXIX Isokinetic Medical Group Conference: Football Medicine	24-26 Octubre Lyon (Francia)	web: www.footballmedicinestrategies.com
26th TAFISA World Congress	13-17 Noviembre Tokyo (Japón)	web: www.icsspe.org/sites/default/files/e9_TAFISA%20World%20Congress%202019_Flyer.pdf
XVIII Congreso Internacional SEMED-FEMEDE	Murcia	web: www.femede.es
2021		
Congreso Mundial de Psicología del Deporte	1-5 Julio Taipei (Taiwan)	web: https://www.issponline.org/index.php/events/next-world-congress
26th Annual Congress of the European College of Sport Science	7-10 Julio Glasgow (Reino Unido)	E-mail: office@sport-science.org
22nd International Congress of Nutrition (ICN)	14-19 Septiembre Tokyo (Japón)	web: http://icn2021.org/
European Federation of Sports Medicine Associations (EFSMA) Conference 2021	28-30 Octubre Budapest (Hungría)	web: http://efsma.eu/
Congreso Mundial de Podología	Barcelona	web: www.fip-ifp.org
2022		
8th IWG World Conference on Women and Sport	5-8 Mayo Auckland (N. Zelanda)	web: http://iwgwomenandsport.org/world-conference/
XXXVII Congreso Mundial de Medicina del Deporte FIMS	Septiembre Guadalajara (México)	web: www.femmede.com.mx

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 1/5/2018 A 1/5/2019) CON 2,93 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 (ON-LINE 1/5/2018 A 1/5/2019) CON 6,60 CRÉDITOS

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"

Curso dirigido a todas aquellas personas interesadas en este campo en las Ciencias del Deporte y alumnos de último año de grado, 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.

Más información:
www.femede.es

Guidelines of publication Archives of Sports Medicine

The ARCHIVES OF SPORTS MEDICINE Journal (Arch Med Deporte) with ISSN 0212-8799 is the official publication of the Spanish Federation of Sports Medicine. This journal publishes original works about all the features related to Medicine and Sports Sciences from 1984. This title has been working uninterruptedly with a frequency of three months until 1995 and two months after this date. Arch Med Deporte works fundamentally with the system of external review carried out by two experts (peer review). It includes regularly articles about clinical or basic research, reviews, articles or publishing commentaries, brief communications and letters to the publisher. The articles may be published in both SPANISH and ENGLISH. The submission of papers in English writing will be particularly valued.

Occasionally oral communications accepted for presentation in the Federation's Congresses will be published.

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1. The papers must be submitted at the Editor in Chief's attention, written in double space in a DIN A4 sheet and numbered in the top right corner. It is recommended to use Word format, Times New Roman and font size 12. They must be sent by e-mail to FEMEDE's e-mail address: femede@femede.es.
2. On the first page exclusively it should include: title (Spanish and English), authors' first name, initial of the second name (if applicable), surname and optionally the second one; Main official and academic qualifications, workplace, full address and corresponding author e-mail. Supports received in order to accomplish the study – such as grants, equipments, medicaments, etc- have to be included.
   A letter in which the first author on behalf of all signatories of the study, the assignment of the rights for total or partial reproduction of the article, once accepted for publication shall be attached.
   Furthermore, the main author will propose up to four reviewers to the editor. According to the reviewers, at least one must be from a different nationality than the main author. Reviewers from the same institutions as the authors, will not be accepted.
3. On the second page the abstract of the work will appear both in Spanish and English, and will have an extension of 250-300 words. It will include the intention of the work (aims of the research), methodology, the most out-standing results and the main conclusions. It must be written in such a way to allow the understanding of the essence of the article without reading it completely or partially. After the abstract, from three to ten key words will be specified in Spanish and English, derived from the Medical Subject Headings (MeSH) of the National Library of Medicine (available in: http://www.nlm.nih. gov/mesh/MBrowser.html).
4. The extension of the text will change according to the section applicable:
   a. Original research: maximum 5.000 words, 6 figures and 6 tables.
   b. Review articles: maximum 5.000 words, 5 figures and 4 tables. In case of needing a wider extension it is recommended to contact the journal Editor.
   c. Editorials: they will be written by Editorial Board request.
   d. Letters to the Editor: maximum 1.000 words.
5. Structure of the text: it will change according to the section applicable:
   a. **ORIGINALS RESEARCH**: It will contain an introduction, which must be brief and will contain the aim of the work, written in such a way that the reader can understand the following text.
      Material and method: the material used in the work will be exposed, as well as its characte¬ristics, selection criteria and used techniques, facilitating the necessary data in order to allow the reader to repeat the experience shown. The statistical methods will be detailed described.
      Results: Results must report and not describe the observations made with the material and method used. This information can be published in detail in the text or using tables and figures. Information given in the tables or figures must not be repeated in the text.
      Discussion: The authors will expose their opinions about the results, their possible interpretation, relating the observations to the results obtained by other authors in similar publications, suggestions for future works on the topic, etc. Connect the conclusions with the aims of the study, avoiding free affirmations and conclusions not supported by the information of the work.

   The acknowledgments will appear at the end of the text.

b. **REVIEWS ARTICLES:** The text will be divided in as much paragraphs as the author considers necessary for a perfect compre-hension of the topic treated.
c. **LETTERS TO THE EDITOR:** Discussion about published papers in the last two issues, with the contribution of opinions and experiences briefed in 3 pages, will have preference in this Section.
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